Appendix G: FERC Environmental Assessment of Woronoco Hydro Project No. 2631

Project No. 2631-007 - Massachusetts
Woronoco Hydroelectric Project
Woronoco Hydro LLC

Re: Issuance of Environmental Assessment (EA)

To the Party Addressed:

In accordance with the National Environmental Policy Act of 1969 and the Federal Energy Regulatory Commission's (Commission) regulations, 18 CFR Part 380 (Order No. 486, 52 F.R. 47897), the Office of Energy Projects has reviewed the application for license for the Woronoco Hydroelectric Project and prepared the attached Environmental Assessment (EA). The EA contains staff's analysis of the environmental effect of the proposal and concludes that approval, with additional staff recommended measures, would not constitute a major federal action significantly affecting the human environment.

Please file any comments (an original and 8 copies) within 30 days from the date of this letter. The comments should be addressed to Magalie R. Salas, Secretary, Federal Energy Regulatory Commission, 888 First Street, NE, Washington, D.C. 20426. Comments may be filed electronically via the internet in lieu of paper [see 18 CFR 385.2001(a)(1)(iii) and the instructions on the Commission's web site at http://www.ferc.gov under the "e-filing" link]. Please affix the project number to all comments.

Please contact Allan E. Creamer at (202) 219-0365, or by e-mail at allan.creamer@ferc.gov if you have any questions.

Enclosure: Environmental Assessment

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ENVIRONMENTAL ASSESSMENT
FOR HYDROPOWER LICENSE

Woronoco Hydroelectric Project

FERC Project No. 2631-007

Massachusetts

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Environmental and Engineering Review
888 First Street, NE
Washington, DC 20426

February 21, 2002

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Summary

On August 31, 1999, International Paper Company (IP) filed an application for a new license for its Woronoco Hydroelectric Project No. 2631. On May 22, 2001, the Federal Energy Regulatory Commission (Commission) authorized the transfer of the project from IP to Woronoco Hydro LLC (Woronoco Hydro). The Woronoco Project has an installed capacity of 2,700 kilowatts (kW) and historically generated an average of 7,700 megawatt-hours (MWh) of electricity annually. The project is located on the Westfield River, in the town of Russel, Hampden County, Massachusetts. The project does not occupy any federal lands. Woronoco does not propose any new capacity at the project, but does propose to rehabilitate two non-functioning turbine/generator units.

In the environmental assessment (EA), we evaluate the effects associated with the issuance of a new license for the existing Woronoco Project, and recommend conditions for inclusion in any license issued. For any license issued, the Commission must determine that the project adopted would be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and development purposes for which licenses are issued, the Commission must give equal consideration to energy conservation, the protection and enhancement of fish and wildlife, aesthetics, cultural resources, and the protection of recreational opportunities. The EA for the Woronoco Project reflects staff's consideration of these factors.

Based on our consideration of all developmental and non-developmental resource interests related to the project, we recommend the following measures be included any license issued for the project:

- Operate the project in a run-of-river mode, with minimal fluctuations;

- Provide a year-round minimum flow of 57 cubic feet per second (cfs) to the project's bypassed reach, with 22 cfs in the north channel and 35 cfs in the south channel;

- Prepare and implement a plan for releasing the recommended bypass minimum flow, as well as to monitor run-of-river operations and the bypass flow;

- Prepare and implement a comprehensive fish passage plan that includes provisions for (a) operating the existing downstream fish passage facility; (b) installing an eel ladder at the south dam and providing upstream passage routes at two additional locations in the north and south channels, (c)

providing support, financial or otherwise, towards implementing the Massachusetts Division of Fish and Wildlife's upstream trap-and-truck program for Atlantic salmon on the Westfield River, and (d) evaluating the effectiveness of the existing downstream fish passage facility for passing salmon smolts, post-spawning adult salmon, and American eel, as well as developing appropriate protection measures for out-migrating eels;

- Reserve the U.S. Department of the Interior's authority to prescribe fish passage facilities in the future;

- Develop and implement a drawdown management plan;

- Consult with the State Historic Preservation Officer and implement appropriate measures before engaging in any activity that may result in an alteration to the National Register-eligible properties (*i.e.*, project powerhouse and the Strathmore Mill complex), and at any time during the project license if significant undiscovered properties are found in the project area during normal project operations; and

- Develop and implement a final recreation enhancement plan for enhancing access in the project area.

We recommend these environmental measures to protect and enhance water quality, fisheries, terrestrial, land use, aesthetics, recreational, and cultural resources. In addition, the electricity generated from the project (6,700 MWh) would be beneficial because it would continue to: (1) reduce the use of fossil-fuel, electric generating plants; (2) conserve non-renewable energy resources; and (3) continue to reduce atmospheric pollution.

Section 10(j) of the FPA requires the Commission to include license conditions based on recommendations provided by the federal and state fish and wildlife agencies, for the protection of, mitigation of adverse impacts to, and enhancement of fish and wildlife resources. We have addressed Interior's concerns and have included measures consistent with those recommendations (see section VII.).

On August 26, 1999, IP applied to the Massachusetts Department of Environmental Protection (MDEP) for Section 401 Water Quality Certification (WQC) for the Woronoco Project. The MDEP issued a Section 401 WQC on August 30, 2000, and amended the 401 WQC on September 29, 2000.

In a letter dated February 9, 2001, Interior reserved its authority to prescribe, through the U.S. Fish and Wildlife Service, the construction, operation, and maintenance of fishways at the Woronoco Project, including measures to evaluate the need for fishways, and to determine, ensure, or improve the effectiveness of such fishways. Interior states that the fishways would be for existing anadromous, catadromous and riverine fish species, and any fish species to be managed, enhanced, protected, or restored in the Westfield River Basin during the term of the license.

Based on our independent analysis of the projects, including our consideration of all relevant economic and environmental concerns, we conclude that the Woronoco Project, as proposed by Woronoco Hydro and with our additional staff-recommended enhancement measures, would be best adapted to a comprehensive plan for the proper use, conservation, and development of the Westfield River. In addition, we conclude that issuing a new license for the Woronoco Project, with our recommended measures, would not constitute a major federal action significantly affecting the quality of the human environment.

ENVIRONMENTAL ASSESSMENT

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Environmental and Engineering Review

WORONOCO HYDROELECTRIC PROJECT
FERC NO. 2631-007, MASSACHUSETTS

I. APPLICATION

On August 31, 1999, International Paper Company (IP) filed an application for a new license, under Part I of the Federal Power Act (FPA), to continue operating its existing Woronoco Project (FERC Project No. 2631). [1] The Woronoco Project is located at river mile (RM) 18.5 on the Westfield River, in the town of Russell, Hampden County, Massachusetts (figure1). There are no federal lands within the Woronco Project boundary.

II. PURPOSE AND NEED FOR ACTION

A. Purpose of Action

The Commission must decide whether to relicense the Woronoco Project and what, if any, conditions should be placed in any license issued. The purpose of the proposed action is to ensure the provision of electric power service to the public in compliance with FPA requirements. Part I of the FPA provides for the regulation of non-federal hydropower development. A project is licensable as long as it meets public interest standards and other regulatory requirements of the FPA, taking into account its development and non-developmental merits.

In deciding whether to issue any license, the Commission must determine that the project would be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued, the Commission gives equal consideration to the purposes of energy conservation;

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[1]On December 12, 2000, IP and Woronoco Hydro LLC, jointly filed an application to transfer the Woronoco Project from IP to Woronoco Hydro LLC (Woronoco Hydro, or the applicant). The Commission approved the transfer application on May 22, 2001. [see 95 FERC ¶ 62,153]

protection of, mitigation of damage to, and enhancement of fish and wildlife; protection of recreational opportunities; and preservation of other aspects of environmental quality.

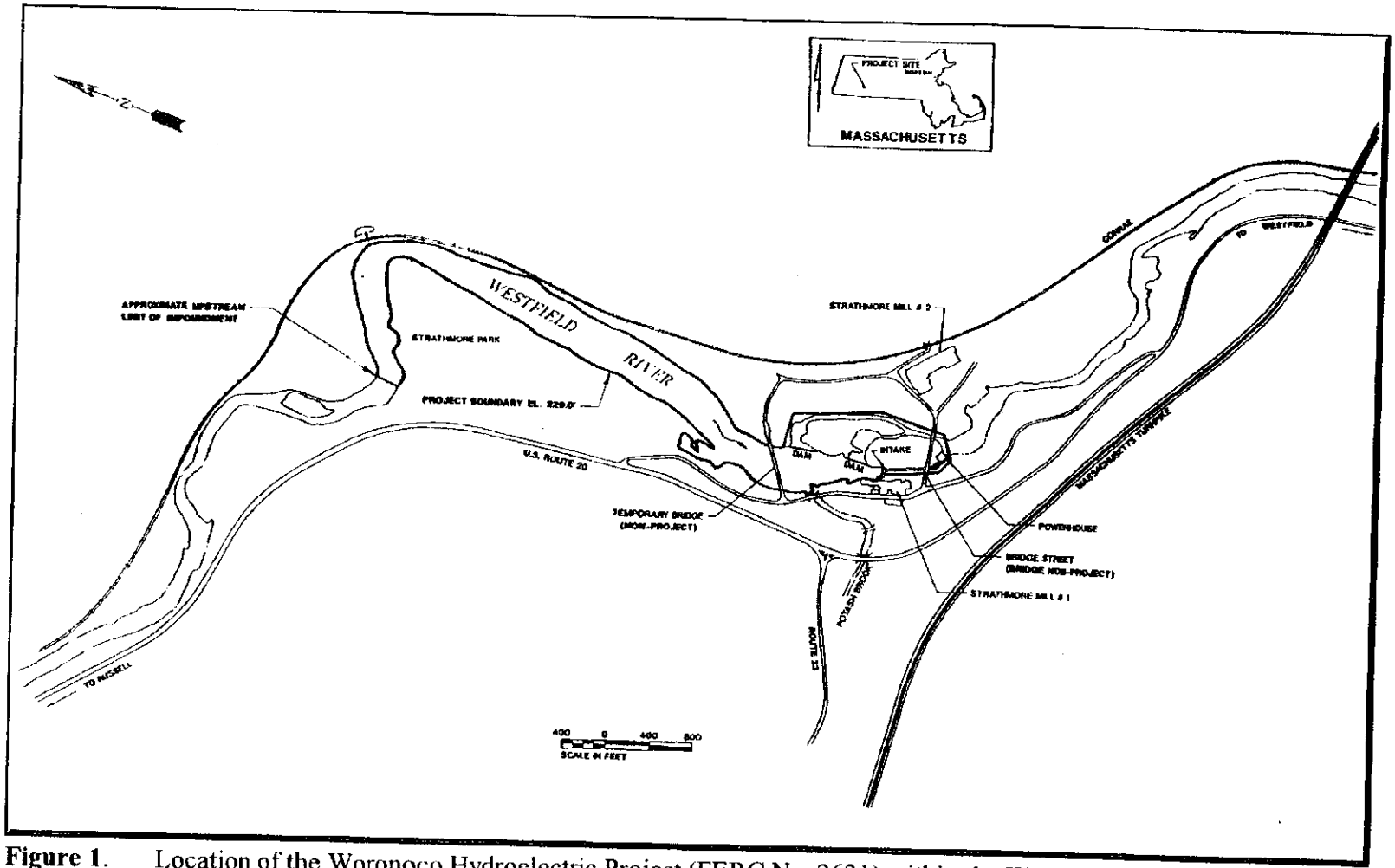

Figure 1. Location of the Woronoco Hydroelectric Project (FERC No. 2631) within the Westfield River Basin (Source: Commission staff, as modified from Kleinschmidt Associates, 1999).

This environmental assessment (EA) analyzes the effects associated with the continued operation of the Woronoco Project and alternatives to the proposed project, and makes recommendations to the Commission on whether to issue a license, and if so, recommends terms and conditions to become a part of any license issued.

B. Need for Power

Historically, the Woronoco Project generated an average of 7,700 megawatt-hours (MWh) annually. However, because two of the project's three units are currently off line (see sections III.B. and III.C), the project has generated an average of 6,130 MWh annually in recent years. As proposed by Woronoco Hydro and recommended for licensing by staff (including rehabilitating two of the project's generating units and releasing a bypass minimum flow), the Woronoco Project would generate an average of 6,700 MWh of energy annually.

Woronoco Hydro does not serve end use customers. Rather, Woronoco Hydro sells the power generated by the project to the Western Massachusetts Electric Company (WMECO), which is an operating subsidiary of Northeast Utilities. The applicant proposes to continue selling the power generated by the project to WMECO.

To assess the need for power that could be generated under any new license, we reviewed the future use of the project's power, together with the power needs of of the operating region in which the project is located. The Woronoco Project is located in the New England area of the Northeast Power Coordinating Council (NPCC) region of the North American Electric Reliability Council (NERC). The NERC annually forecasts electrical supply and demand in the region for ten-year periods. In NERC's 2001 Reliability Assessment, [2] the NPCC shows an electric energy growth rate of 1.2 percent, annually, for the New England area.

Hydropower is a low cost form of electric power generation. It produces no atmospheric pollution and it derives its primary energy from a renewable resource. The Woronoco Project displaces existing and planned non-renewable fossil-fueled generation (*e.g.*, gas, oil, coal), which contributes to the production of nitrogen oxides, sulfur dioxides, and carbon dioxide. These gases create air pollution and may exacerbate global warming. In addition, hydroelectric generation contributes to the diversification of the generation mix in Massachusetts and the NPCC region.

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[2]Reliability Assessment 2001-2010, The Reliability of Bulk Electric Systems in North America, NERC, October 16, 2001.

Hydroelectric facilities are operated to maximize: (1) net energy; (2) the value of energy produced; (3) recreational potential; and (4) voltage support. Hydro facilities are also operated to: (1) eliminate or minimize adverse environmental effects; (2) enhance environmental benefits; (3) increase system reliability; and (4) minimize required maintenance. Hydro units are critical to system restoration following large-scale outages because they can be brought on-line quickly. In the era of deregulation, hydropower is important because the cost of producing electricity at hydro facilities is typically low, and low-cost energy is purchased first on the market. While the Woronoco Project is not very large, every kW and MWh produced using low-cost, renewable resources is important to our national energy supply, as well as our efforts to control or reduce air pollution caused by burning fossil-fuels.

We conclude that the continued operation of the Woronoco Project and the future use of power generated from the project would displace non-renewable, fossil-fueled generation and contribute to a diversified generation mix. Also, project generation would help WMECO meet its need for generation in the short and long term.

III. PROPOSED ACTION AND ALTERNATIVES

A. Description of Existing Project Facilities

The Woronoco Project (figure 2) is an existing licensed hydropower project. The proposed project would have a total rated capacity of 2,700 kilowatts (kW), and an average annual generation of about 6,700 MWh.

The project's principal features are: (1) two concrete-gravity dams and an earthen dike; (2) an intake area leading to a powerhouse; (3) an interim downstream fish passage facility; (4) an impoundment; (5) a bypassed reach; and (6) appurtenant facilities. In detail, the existing project's principal features consist of:

1. two non-contiguous dam sections, with (a) a height of about 25 feet above the riverbed, (b) lengths of about 351 feet (south dam) and 307 feet (north dam), (c) a steel sluice gate adjacent to the trashracks (south dam; see

below), (d) a steel mud gate (north dam), (e) a 655-foot-long earthen dike with a sheet steel core, and (f) a crest elevation of 229.0 feet National Geodetic Vertical Datum (NGVD); [3]

[3]The normal headpond elevation for the project is governed by the north dam. Flashboards (30-inch) are authorized by the project's current license, but have not been used for decades. All elevations are stated as NGVD, unless otherwise noted.

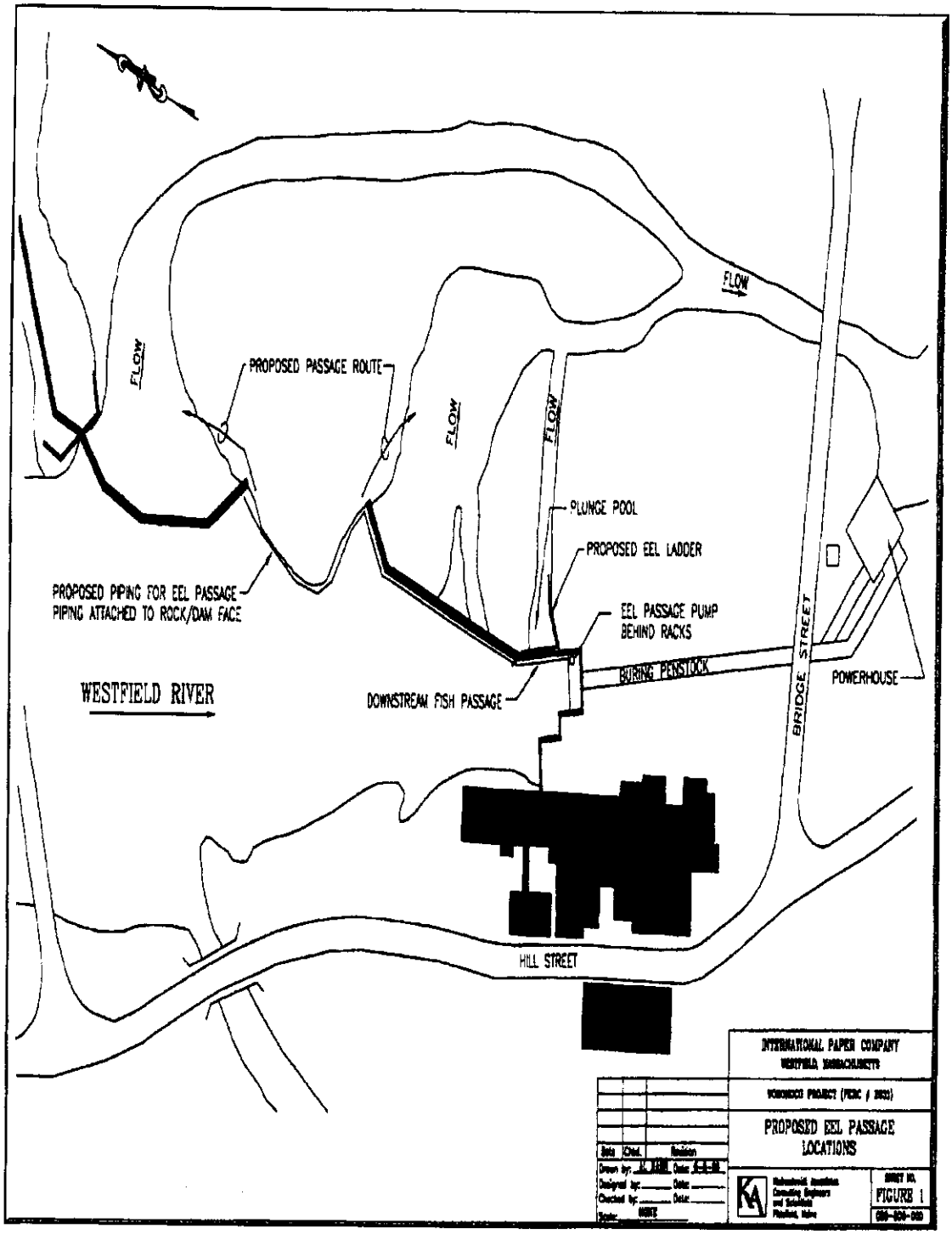

Figure 2. Woronoco Hydroelectric Project No. 2631 facilities (Source: Commission staff, as modified from Kleinschmidt Associates, 1999).

2. a 40-foot-wide by 15-foot-high intake structure, having trashracks with 1.25-inch clear bar spacing, and a 550-foot-long by 11-foot-diameter steel (with concrete liner) penstock;

3. a 59-foot-long by 59-foot-wide concrete and brick powerhouse containing three Francis turbines and generating units, having (a) minimum and maximum hydraulic capacities of 130 cubic feet per second (cfs) and 710 cfs, respectively, [4] (b) a horsepower (hp) rating of 3,300 hp, (c) a gross head of 55 feet and a design head of 50 feet at 710 cfs, (d) a total installed capacity of 2,700 kW, and (e) a tailwater elevation of 174.0 feet.

4. an interim downstream fish passage facility, constructed in 1998 and located immediately in front of the trashracks (with its discharge at the base of the south dam; [5]

5. a 1.2-mile-long impoundment, with (a) a normal pool elevation of 229.0 feet, (b) a surface area of 43 acres, and (c) negligible usable storage;

6. a bypassed reach, varying in length from about 200 to about 1,000 feet; and

7. appurtenant facilities.

B. Description of Current Project Operation

Currently, the applicant operates the Woronoco Project in an automated, run-or-river mode. When inflow to the generating station is equal to, or less then, the hydraulic capacity of the station (currently limited to Unit 3; see section III.C. below), Unit 3 is

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[4]The minimum hydraulic capacities of the three units are 15 cfs each for Units 1 & 2 and 100 cfs for Unit 3. The maximum hydraulic capacities of the three units are 130 cfs each for Units 1 & 2 and 450 cfs for Unit 3.

[5]The interim downstream fish passage facility is designed to pass Atlantic salmon smolts, using a modified existing surface-draw gate. The draw gate opening is reduced to 36 inches wide using a steel plate bolted to the downstream side of the south dam face. Attraction and conveyance flow through the surface-draw gate is estimated at 25 cfs. From the gate, smolts enter a 3-foot-wide by 6-foot-long discharge chute, which directs smolts away from a retaining wall and exposed rocks into a plunge pool (about 14 feet downstream of the dam). Smolts then move downstream via the third, and shortest, channel of the bypassed reach.

throttled to maintain a stable headpond at the top of the project's two dams. Flows less than the station's minimum capacity, as well as those exceeding its maximum capacity, are spilled over the dams.

C. Proposed Action

1. Operational and Management Changes

As described in section III.A. above, the Woronoco Project is equipped with three generating units. However, Units 1 and 2 were taken out of service in 1996 and 1997, respectively. As part of its license application, Woronoco Hydro proposes to rehabilitate Units 1 and 2 (maximum hydraulic capacity of 130 cfs each). The combined hydraulic capacity of the three units would be 710 cfs. The project would continue to be operated in a run-of-river mode.

2. Environmental Measures

In addition to the aforementioned developmental proposal, Woronoco Hydro proposes the following measures to protect and enhance environmental resources that may be affected by the operation and maintenance of the Woronoco Project:

- operate the project in a run-of-river mode, by maintaining the impoundment elevation at 229.0 feet, with minimal fluctuations; [6]
- provide a year-round minimum flow of 57 cfs to the project's bypassed reach, with 22 cfs in the north channel and 35 cfs in the south channel; [7]
- evaluate the effectiveness of the existing downstream fish passage facility during the first downstream passage season for Atlantic salmon, following issuance of a new license for the project;

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[6]The applicant expects to operate the project as a run-of-river facility, in the following manner: (1) spill flows less than 157 cfs [100 cfs minimum plant capacity and 57 cfs minimum flow release]; (2) Unit 3 (157 to 507 cfs); (3) Units 1, 2, and 3 (507 to 767 cfs); and (4) spill flows greater than 767cfs. Unit 3 would be throttled back as Units 1 and 2 are brought on-line between the range of 507 and 767 cfs.

[7]North channel flows would be released through a notch in the north dam. South channel flows would be released through the existing downstream fish passage facility (20 cfs) and through a notch cut in the center of the south dam.

- develop an agreement to participate in the Massachusetts Division of Fisheries and Wildlife's (MDFW) trap-and-truck program for Atlantic salmon in the Westfield River;

- install upstream fish passage facilities for American eel at the south dam and provide upstream passage routes at two additional locations in the north and south channels;

- develop an impoundment drawdown management plan that outlines measures to protect mussel species and recover stranded fish, and that includes an evaluation of alternatives to drawing down the impoundment for extended periods of time; and

- develop and maintain three new carry-in boat access sites at the project.

D. Proposed Action with Additional Staff-Recommended Measures

In considering appropriate environmental protection and enhancement measures for the Woronoco Project, we evaluated the measures proposed and/or recommended by the applicant, the resource agencies, and non-governmental organizations (NGOs). These measures are discussed in section V.C. and summarized in section VII.

Under staff's preferred alternative, the project would include all the measures proposed by the applicant. Staff's alternative would also include a project operation and flow monitoring plan, as well as requirements to consult with the State Historic Preservation Office (SHPO) under certain situations.

E. No-Action

The No-Action alternative would result in no change to the existing environment. The project would continue to operate as required by the existing project license. If the project were allowed to operate as it has in the past, there would be continued energy production, but no enhancement of natural resources values. Any ongoing effects of the project would continue. We use this alternative to establish baseline environmental conditions for comparison with other alternatives.

F. Alternatives Considered but Eliminated from Detailed Analysis

We considered three other alternatives to Woronoco Hydro's relicensing proposal, but eliminated them from detailed study, because they are not reasonable in the

circumstances of this case. The alternatives considered are: (1) federal government takeover and operation of the project; (2) issuance of a non-power license upon expiration of the original project license; and (3) project decommissioning.

Federal Government Takeover - Federal takeover and operation of the project would require congressional approval. While that fact alone wouldn't preclude further consideration of this alternative, there is no evidence to indicate that Federal Takeover should be recommended to Congress. This alternative has not been raised, to date, as a reasonable alternative or appropriate alternative, nor has any federal agency expressed an interest in operating the project. Thus, we do not, in this case, consider federal takeover to be a reasonable alternative.

Non-power License - A non-power license is a temporary license which the Commission would terminate whenever it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license, and we have no basis for concluding that the project should no longer be used to produce power. Thus, we do not consider a non-power license to be a realistic alternative to relicensing in this circumstance.

Project Decommissioning - Project decommissioning could be accomplished with or without dam removal. Either alternative would involve: (1) denial of the relicense application; (2) ceasing power generation; and (3) surrender or termination of the existing license with appropriate conditions. At a minimum, project decommissioning would have the following effects.

- The energy generated by the project would be lost (≈6,700 MWh annually).
- There would be significant costs associated with dam removal, or decommissioning the project powerhouse, penstock, and appurtenant facilities. [8]

[8]International Paper estimated that the costs for decommissioning could range from about $50,000 (for disconnecting from the grid and ensuring the safety of the facilities) to $500,000 to $1,000,000 (for removing the dam, sealing/failing the penstock, and removing the powerhouse and electrical equipment) [reported in 1999$].

- Absent removal of the project's two dams, which would be costly and has not been recommended, the environmental enhancements currently proposed by the applicant would be foregone.

No participant has suggested that dam removal would be appropriate in this case, and we have no basis for recommending dam removal. Thus, dam removal is not a reasonable alternative to relicensing the project with appropriate protection and enhancement measures.

Project decommissioning without dam removal would involve retaining the dam and disabling or removing equipment used to generate power. Project works would remain in place and could be used for historic or other purposes. This would require us to identify another government agency with authority to assume regulatory control and supervision of the remaining facilities. No agency has stepped forward, and no participant has advocated this alternative. Nor have we any basis for recommending such an alternative. Because the power supplied by the project is needed, a source of replacement power would have to be identified. In these circumstances, we don't consider removal of the electric generating equipment to be a reasonable alternative.

IV. CONSULTATION AND COMPLIANCE

A. Agency Consultation and Interventions

The Commission's regulations (18 CFR §§ 4.38 and 16.8) require that applicants consult with appropriate resource agencies and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, the Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

The Commission issued a public notice on December 7, 2000, indicating that the application for the Woronoco Project was ready for environmental analysis, and that all comments should be filed within 60 days of the notice. The following entities provided comments:

Commenting Entities	Filing Date
Trout Unlimited	February 8, 2001
U.S. Department of the Interior	February 9, 2001

On December 15, 1999, the Commission issued its public notice accepting the relicense application for the Woronoco Project and soliciting motions to intervene and protest. This notice set February 4, 2000, as the deadline for filing protests and motions to intervene. In response to the notice, the following entities filed motions to intervene:

Intervenors	Filing Date
U.S. Department of the Interior	January 28, 2000
Trout Unlimited	February 3, 2000

B. NEPA Scoping Process

Before preparing this EA, we conducted scoping for the Woronoco Project to determine what issues and alternatives should be addressed. A scoping document (SD1) was distributed to interested agencies and others on September 20, 2000. It was noticed in the Federal Register on September 26, 2000. The following entities provided written comments pertaining to the scope of issues for the Woronoco Project:

Commenting Entity	Filing Date
Trout Unlimited	November 6, 2000
Massachusetts Division of Fisheries and Wildlife	November 20, 2000

As outlined by the Commission, in a letter dated August 24, 2001, the comments provided by the two entities listed above raised no new issues or support compelling changes to the scope of the NEPA document, but rather reiterated each entities' position relative to the issues. Therefore, no revised scoping document was issued. The comments provided by Trout Unlimited (TU) and the MDFW are addressed, as appropriate, in this EA.

C. Mandatory Requirements

1. Water Quality Certification

On August 26, 1999, IP applied to the Massachusetts Department of Environmental Protection (MDEP) for Section 401 Water Quality Certification (WQC) for the Woronoco Project. The MDEP received this request on September 8, 1999. The MDEP issued a Section 401 WQC on August 30, 2000, and amended the 401 WQC on

September 29, 2000. The conditions of the Section 401 WQC, as issued by the MDEP, include:

- The project shall be operated in accordance with the conditions contained in the 401 WQC and the provisions included in the license application and any modifications made thereto, to the extent such application provisions and modifications are consistent with the 401 WQC. The facility shall be operated to maintain the designated uses of the Westfield River, as outlined in the Massachusetts Surface Water Quality Standards (314 CMR 4.00) and maintain an integrated and diverse biological community in the Westfield River.

- All activities shall be conducted in compliance with the Massachusetts Wetlands Protection Act. An application for a Section 401 WQC shall be submitted to, and approved by, the MDEP prior to any activity that will cause a discharge subject to Section 404.

- The applicant shall comply with Massachusetts General Laws Chapter 91.

- All maintenance and repair activities, including disposal of debris and removal of sediments in impounded areas, shall be conducted in a manner so as not to impair water quality.

- Changes to the project that would have a significant or material effect on the findings, conclusions, or conditions of this 401 WQC, including project operation, must be submitted to the MDEP for prior review and approval, where appropriate and authorized by law.

- The MDEP may request, at any time the 401 WQC is in effect, that the Commission reopen the license to make modifications necessary to maintain compliance with the Massachusetts Surface Water Quality Standards or other appropriate requirements of state law.

- The MDEP reserves the right to add and alter the terms and conditions of the 401 WQC, when authorized by law and as appropriate to carry out its responsibilities during the life of the project with respect to water quality.

- Operate the project in a run-of-river mode at an elevation of 229.0 feet. Submit an operations and monitoring plan, for MDFW review and MDEP approval, within 6 months of license issuance. The plan should address

provisions for maintaining pond height at 229.0 feet, a means of recording (hourly) and reporting (yearly) pond elevations, and notification of the MDEP when the impoundment falls below 229.0 feet.

- Develop and implement a drawdown management plan, in consultation with (and approval by) the MDEP, to protect mussels and prevent fish stranding within 1 year of license issuance. The plan should address: (a) performing maintenance activities with no drawdowns; (b) limiting the number of drawdowns; and (c) notification of MDEP when a drawdown is planned. No drawdown is permitted prior to approval the plan.

- Provide upstream passage for American eel within 1 year of license issuance. Dates of operation, as well as fishway design and locations shall be determined in consultation with the MDFW and approved by MDEP.

- Evaluate the effectiveness of the existing downstream fish passage facility during the first fish passage season following issuance of a license for the project. The study plan and results shall be reviewed by the MDFW and approved by the MDEP.

- Upon license issuance, release a continuous minimum flow of 57 cfs, or inflow, whichever is less, to the bypassed reach; 35 cfs to the south channel and 22 cfs to the north channel. The applicant shall consult with the MDFW and obtain approval from the MDEP regarding the time frame, location, and design of notches to be installed.

2. Section 18 Fishway Prescription

Section 18 of the FPA states that the Commission shall require the construction, maintenance, and operation by a licensee of such fishways as may be prescribed by the Secretary of the Interior. By letter dated February 9, 2001, the U.S. Department of the Interior (Interior) reserved its authority to prescribe, through the U.S. Fish and Wildlife Service (USFWS), the construction, operation, and maintenance of fishways at the Woronoco Project, as necessary, including measures to evaluate the need for fishways, and to determine, ensure, or improve the effectiveness of such fishways. Interior states that the fishways would be for existing anadromous, catadromous and riverine fish species, and any fish species (including American eel) to be managed, enhanced, protected, or restored in the basin during the term of the license.

The Commission recognizes that future fish passage needs and management objectives cannot always be determined at the time of project licensing. Under these circumstances, and upon receiving a specific prescription from Interior, we recommend the Commission follow its practice of reserving the Commission's authority to require such fishways as may be prescribed by the Secretary of the Interior.

3. Coastal Zone Management Act

Woronoco Hydro submitted a consistency certificate to the Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Office of Coastal Zone Management for compliance with the Coastal Zone Management Act (CZMA). In its reply letter dated October 3, 2001, the Massachusetts Office of Coastal Zone Management concluded that: (1) the activities associated with the proposed project fall outside the geographical boundaries of the Massachusetts Coastal Zone; and (2) the proposed relicensing of the Woronoco Project is not subject to Federal Consistency Review by the Coastal Zone Management Office. Therefore, we conclude that the Woronoco Project is not subject to CZMA review.

V. ENVIRONMENTAL ANALYSIS

In this section, we describe the Westfield River Basin, including the project drainage area and other man-made and natural features that could affect the resources analyzed. We also discuss the environmental resources subject to cumulative effects from the project when considered in combination with other actions affecting the resources. Then, for each resource, we describe the affected environment, the environmental effects and recommendations, cumulative effects (where applicable), and the unavoidable adverse effects of the proposed action with additional staff-recommended measures.

We address, in detail, only those resources affected by the operation of the Woronoco Project, and include analysis of comments by interested parties on the project's proposed operation. Unless otherwise indicated, the sources of our information include the license application (Kleinschmidt, 1999), IP's Additional Information Request response (Kleinschmidt, 2000a), and supplemental filings made by the applicant, Interior, MDFW and TU.

A. General Description of the Westfield River Basin [9]

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[9]Information in this section taken from the *Anadromous Fish Management Plan for the Westfield River, 2001-2010* (MDFW, 2000), unless otherwise indicated.

The Westfield River basin is located in west-central Massachusetts, the river originating in the eastern foothills of the Berkshire Mountains. The basin drains an area of 517 square miles (mi^2) and includes potions of Franklin, Hampshire, Hamden, and Berkshire counties (Kleinschmidt, 1999). From its origination, the river travels south, southeast for about 60 miles before reaching its confluence with the Connecticut River.

The average annual precipitation in the drainage is about 48 inches, which, for the most part, is equally distributed over the course of the year. More than half of this total (25 inches) results in runoff, making the average runoff nearly equal to 2 cfs/mi^2 for the entire basin. The mean annual flow of the Westfield River at the U.S. Geological Survey (USGS) gaging station near the city of Westfield (Gage # 01183500; 1914 to present), which encompasses 497 mi^2 of drainage area, is 930 cfs. The high flow for this station was 70,300 cfs (August 1955) and the minimum flow was 9 cfs (October 2, 1921).

The basin is heavily vegetated with natural second and third growth forests. The damp, cool mountainous western section is characterized by northern hardwood forests. The central portion of the basin has a variety of vegetation, and is commonly considered transitional forest. The warmer eastern section of the basin consists mainly of an Oak-Chestnut climax community.

The extreme western portion of the basin is in the Berkshire Plateau region, with elevations of over 2,000 feet above mean sea level (msl). A good majority of the remainder of the basin exhibits the Southern New England Upland physiography, with only a small portion (downstream of the city of Westfield) in the Connecticut Valley Lowlands. The floodplain elevation drops to 50 feet msl at the confluence of the Westfield and Connecticut Rivers. With the drop in elevation, the mean annual temperature rises from 44 degrees Fahrenheit (°F) in the western mountain to 50°F on the eastern plain.

The Westfield River drops a total of 2,000 feet over its entire 60 mile journey to Connecticut River. The major tributaries of the Westfield River include the Middle Branch, the West Branch, and the Little River, all contributing significantly to the basin's flow and drainage area.

The mainstem Westfield River originates in the town of Savoy and flows through steep sided valleys in a rugged terrain. [10] The river is shallow and flow is rapid, with the

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[10]The headwater reach, or up-river reach, of the mainstem Westfield River is commonly referred to as the East Branch.

elevation dropping about 1,000 feet in the river's first 14 miles. The U.S. Corps of Engineers (Corps) owns and operates a flood control reservoir at Knightville, which is located about 3 miles upstream of the river's confluence with the Middle Branch (table 1). The drainage area at this point is 162 mi^2, with an average flow of 318 cfs.

The Middle Branch of the Westfield River has its source in the town of Peru. The Middle Branch joins the mainstem Westfield River about 27 miles upstream of the river's confluence with the Connecticut River. The Middle Branch runs for about 18 miles through hilly, forested terrain and drops 1,250 feet over its length. Near its confluence with the mainstem, the Middle Branch is impounded by a Corps dam at Littleville (table 1). This reservoir is operated by the Corps for flood control and water supply. The Middle Branch contributes an average annual flow of 102 cfs from a drainage area of 52.6 mi^2.

The West Branch of the Westfield River is formed by the confluence of Depot and Yokum Brooks. The river flows about 17.5 miles and falls 840 feet before joining the mainstem at Huntington, 25 miles upstream of the river's confluence with the Connecticut River. The West Branch has an average annual discharge of 182 cfs and a drainage area of 93.7 mi^2.

The West Branch, Middle Branch, and mainstem Westfield (or East Branch), upstream of their confluence, comprise 60 percent of the basin's total drainage area and contribute about 2/3 of the basin's average annual flow. Downstream from the confluence of these three reaches, the Westfield River is characterized by three impoundments in a 7-mile stretch (table 1), including the impoundment formed by the Woronoco Project (drainage area of 346 mi^2). The river bottom is generally rocky, with widths from 150 to over 200 feet. Through this stretch, the river has a high width to depth ratio and follows a shifting channel through islets and point bars.

Downstream from the Woronoco Project, the Westfield River flows unimpeded to the city of Westfield, where it is joined by the Little River. The source of the Little River is the outlet of Cobble Mountain Reservoir (table 1). From this outlet, the Little River flows for 13 miles before joining the Westfield River, 11 miles upstream of the Westfield River's confluence with the Connecticut River. The Little River drains 45.8 mi^2 of area, drops 280 feet along its course, and has an average annual flow of about 88 cfs.

As it flows through the city of Westfield, the Westfield River cuts through the alluvial deposits of the Connecticut River flood plain. In this stretch, the river's slope is more gradual, dropping only 60 feet in the last 11 miles, and the river forms several

meanders. The Westfield River joins the Connecticut River about 76 miles upstream of Long Island Sound and the Atlantic Ocean.

Table 1. Hydroelectric projects and other barriers in the Westfield River Basin (Source: MDFW, 2000).

Dam Name	FERC No.	River Mile	Height (ft)
Mainstem Westfield			
1. Rexam-DSI	2608	4.1	18
2. Woronoco Falls (natural)	n/a	18.3	6
Woronoco dams (South & North)	2631	18.5	25
3. Russel Falls	n/a	21.2	10
4. Texon	2986	24.1	17
Little River			
1. Lower Steven	n/a	3.5	12
2. Upper Steven	n/a	4.8	15
3. Cobble Mountain	n/a	10.4	151
East Branch (or upper Mainstem)			
1. Knightville	n/a	4.6	160
Middle Branch			
1. Littleville	n/a	2.1	165
West Branch			
1. Hamilton	n/a	8.0	8

B. Scope of Cumulative Effects Analysis

According to the Council on Environmental Quality's regulations for implementing the National Environmental Protection Act (NEPA) (§ 1508.7), an action may cause cumulative effects on the environment if its effects overlap in time and/or space with the effects of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

We reviewed all the environmental resources to determine whether they could be affected in a cumulative manner by hydroelectric development and other non-hydroelectric activities. We used this review of the resource areas to help define the geographic and temporal scopes of the environmental analysis.

Based on our review of Woronoco Hydro's license application, agency comments, and other filings in the proceeding, we identified the Atlantic salmon and American eel fisheries as having the greatest potential to be affected in a cumulative manner by the Woronoco Project, in combination with other past, present, and future activities in the Westfield River Basin and lower Connecticut River. Atlantic salmon and American eel were selected because hydroelectric developments along the waterway, as well as flood control reservoirs in the upper basin, have affected these fisheries and their habitat by altering the flow regime in the river, blocking or delaying fish movement, and entraining fish into intakes (*i.e.*, turbine-related mortality).

1. Geographic Scope

The geographic scope of analysis for cumulatively affected resources is defined by the physical limits or boundaries of: (1) the proposed action's effect on the resources; and (2) contributing effects from other hydroelectric and non-hydroelectric activities within the Westfield River Basin and lower Connecticut River. Based on our review of the record, we identified the scope of analysis for Atlantic salmon and American eel to be the entire Westfield River Basin and lower Connecticut River, below the confluence of the two rivers. We chose this geographic scope because of direct and indirect effects of project operations and facilities, and the contributing effects from other dams, [11] as well as industrial and suburban development and wastewater discharges, on migratory fish habitat and passage in the basin.

2. Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on Atlantic salmon and American eel. Based on the term of the proposed license, we will look 30 to 50 years into the future, concentrating of the effects on Atlantic salmon and American eel from reasonably

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[11]The Woronoco dam complex is the second mainstem obstruction on the Westfield River. Upstream and downstream fish passage facilities are currently operating at the lower-most dam in West Springfield, providing migratory fish species access to the Woronoco Project (see table 1).

foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information for each fish species. We identified the present resource conditions based on the license application and supplemental filings, agency comments, and comprehensive plans.

C. Analysis of Site-Specific Resources

We have reviewed the proposed project in relation to the environmental resources in the project area and have concluded that there would be no direct or indirect environmental effects on federally threatened and endangered species, aesthetics, and socioeconomic resources. We have excluded these resources from our detailed analysis for the reasons identified below. Since the primary effects associated with geology and soils pertain to sedimentation and erosion control from installing eel ladders and constructing recreation access improvements, we address this issue in sections V.C.2. (Fisheries Resources) and V.C.5. (Recreation and Land Use).

Threatened and Endangered Species – There are no known federally listed threatened or endangered species in the project vicinity (Interior, 2001).

Aesthetic and Socioeconomic Resources – The proposed action would not involve any major new construction activity, nor change in project operations.

1. Water Quantity and Quality

a. Affected Environment:

Water Use and Quantity

Water uses of the Westfield River by the general public, in the vicinity of the project, consist mainly of occasional recreational fishing and boating. The primary uses of river water in the immediate project vicinity are hydroelectric generation and waste assimilation. Historically, river water also was used for paper processing at the Strathmore Paper Mill. [12] Currently, the village of Woronoco discharges domestic

[12]Strathmore Paper Company, a subsidiary of IP, historically withdrew about 10 cfs from the Woronoco impoundment for paper processing at the Strathmore Paper Plant. Following pre-treatment, wastewater was discharged downstream of the project tailrace pursuant to IP's National Pollution Discharge Elimination System (NPDES) Permit No. MA0004995. Further, non-contact condenser cooling water was discharged directly to

(continued...)

wastewater to municipal sewers, which, until 1991, discharged the raw sanitary wastes directly to the Westfield River downstream from the project tailrace pool. In 1991, the village of Woronoco completed the installation of a transfer station to pump wastewater to a wastewater treatment facility located in the town of Russell. This treatment facility applies a primary treatment process, including sand filtration and disinfection, to the wastewater before discharging into the river downstream from the project dam.

The Woronoco Project is located at RM 18.5 on the Westfield River, and has a total contributing drainage area of 346 mi^2. The mean annual flow for the Westfield River, in the vicinity of the project, is 718 cfs. The 7Q10 flow for the river at the Woronoco dam complex is 53 cfs. [13]

The annual flow duration curve for the Westfield River at the Woronoco Project is shown in figure 3. The curve was derived using the mean daily flow data from three upstream USGS gaging stations, including: (1) Westfield River at Knightville (No. 01179500); (2) Middle Branch of the Westfield River at Goss Heights (No. 0110500); and (3) the West Branch of the Westfield River at Huntington (No. 01181000). These three gages monitor and account for a total of 308.3 of the 346 mi^2 of drainage area upstream of the Woronoco Project. The daily flows from each gage were added together and prorated by the ratio of remaining drainage area. The period of record is from 1965 to 1990.

The current license for the Woronoco Project does not include a minimum flow requirement for the bypassed reach. However, the previous 401 WQC was issued by the MDEP contingent upon a minimum flow release of 28 cfs during impoundment re-filing operations (see 15 FERC ¶ 62,243). Per requirements of Article 24 of the project's original license, the license was subsequently modified to include a minimum flow release of 48.1 cfs to the Westfield River downstream from the project during impoundment re-fill periods (see 30 FERC ¶ 62,186). This represents the only flow requirement for the project.

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[12](...continued)
the river downstream from the tailrace pool. The paper plant was closed in 1997 and the discharge is no longer occurring.

[13]Represents the 7-day, 10-year low flow for the river.

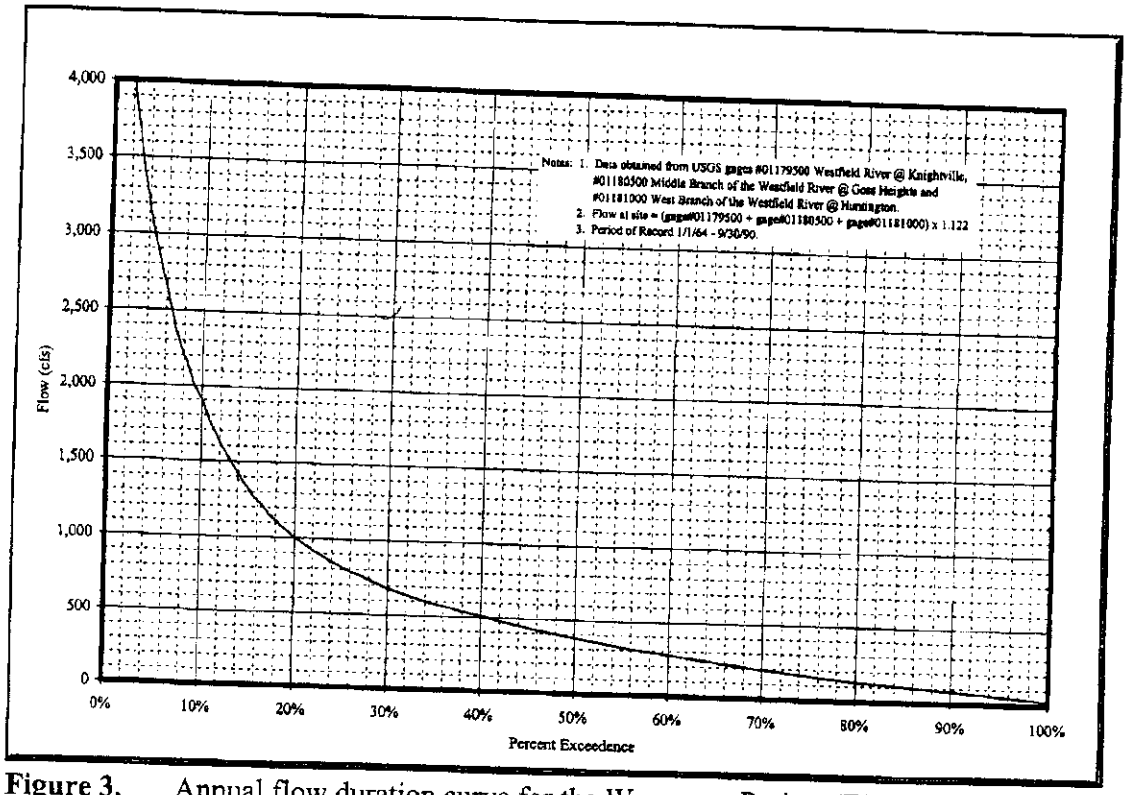

Figure 3. Annual flow duration curve for the Woronoco Project (FERC No. 2631) (Source: Kleinschmidt Associates, 1999).

Water Quality

The MDEP, Division of Water Pollution Control (MDEP-DWPC) has designated the Westfield River as Class B waters. Class B waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated, Class B waters shall also be suitable for public water supply with appropriate treatment, as well as be suitable for irrigation and other agricultural uses and for compatible industrial cooling and processing uses. Class B waters shall have good aesthetic value. From its confluence of the East and West Branches at RM 25.1 to its confluence with the Connecticut River, the Westfield River is designated as Class B Warmwater Fishery and Recreation.

In relevant part, water quality standards for Class B waters include: (1) minimum dissolved oxygen (DO) levels of no less than 5.0 milligrams per liter (mg/l) for

warmwater fisheries, unless background conditions are lower; [14] (2) a maximum temperature of 83°F (28.3°C) for warmwater fisheries, and the rise in temperature due to a discharge shall not exceed 5°F (2.8°C) in rivers and streams designated as warmwater fisheries; and (3) an acceptable pH range of 6.5 to 8.3 and not more than 0.5 units outside of the background range. In addition, the standard for fecal coliform is a geometric mean of 200 organisms per 100 milliliter (ml) in any representative set of samples, and no more than 10 percent of the samples shall exceed 400 organisms per 100 ml.

According to the U.S. Environmental Protection Agency (USEPA) Fact Sheet for the 1983 renewal of the NPDES discharge permit for Strathmore Paper Company, in 1975 the segment of the river where the project is located was designated by the MDEP-DWPC as a Water Quality Limited segment. This designation means that the quantity of wastewater discharged exceeds the river's waste assimilative capacity, which may result in violations of water quality standards. Since 1975 a number of new wastewater treatment facilities have been constructed, and water quality in the Westfield River has significantly improved.

In May and July 1985 the MDEP-DWPC conducted a water quality survey, with samples collected from the mainstem, the three upriver branches, and the Little River in Westfield. Results of this survey indicated that water quality was "good" throughout much of the basin, though most water quality problems existed in the lower portions of the drainage (MDFW, 2000). However, water quality in the lower portion of the river had improved considerably from conditions in the 1950's through the 1970s.

Based on the survey results, water quality in the upper three branches was very good; DO ranged from 8.0 to 9.7 mg/l and percent saturation values ranged from 90 to 100 percent. The water quality from the confluence of the East and West Branches to the Westfield city line was considered good. DO levels were high (9.4 to 9.6 mg/l) and biological oxygen demand (BOD) and solids were low. Bacteria levels in this river segment decreased from a previous survey in 1978. Despite an increased pollution load in the river segment between Westfield to the confluence with the Connecticut River, relative to the upstream segments, DO concentrations in the lower segment were above the standard of 5.0 mg/l, ranging from 8.4 to 8.7 mg/l. BOD, suspended solids, and total solids were found to be higher in the upriver segments.

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[14]Natural seasonal and daily variations above these levels shall be maintained; levels shall not be lowered below 60 percent saturation in warmwater fisheries due to a discharge.

The MDEP-DWPC collected water quality data on the lower Westfield River during the summer of 1990 (June, August, September, and October). Data were collected from 11 stations along the Westfield River and four tributaries in the lower drainage. Visual observations found no algal blooms, and DO levels were consistently above the Class B standard of 5.0 mg/l (MDEP, 1991). Analysis of the data indicated little change from the 1985 study. More specifically, the Westfield River meets Class B water quality standards as far downstream as RM 12.3, except for continuing fecal coliform problems on the lower portion of the river (last 5 miles). Between 1985 and 1991, BOD loading, nutrient levels, suspended solids, and fecal coliform declined by 1, 1-39, 12, and 44 percent, respectively.

To support relicensing the project, the applicant conducted site-specific water quality sampling in August 1997. The goal of this sampling was to characterize the existing water quality (temperature, DO, pH, and secchi disc transparency) at the project under warm weather conditions in order to determine compliance with applicable water quality standards. Sampling for temperature and DO occurred at six stations in the morning and in the evening on three consecutive days. Stations were located upstream of the project, in the impoundment, at the project intake, and in the project tailrace.

The monitoring data show that water quality conditions exceed the state standards for Class B warmwater fisheries. River flow during the sampling period varied from about 131 to 139 cfs. Water temperature ranged from 67.6°F (19.8°C) to 73.4°F (23.0°C) throughout the study period, and varied little among stations during any given sampling series. Similarly, there was little spatial or temporal change in DO from day to day at (or among) sampling stations. DO values ranged from 7.7 mg/l (85.5 percent saturation) to 9.1 mg/l (101.7 percent saturation) and typically never varied more than a few tenths of a mg/l among stations during a given sampling series. pH ranged from 6.4 to 7.6 over the course of the sampling event. Finally, secchi disk transparency in the impoundment ranged from 8.2 to 16.4 feet; in the impoundment at the intake the value was 1.48 feet.

b. Environmental Effects and Recommendations:

Water Use and Quantity

The applicant proposes to continue operating the Woronoco Project in a run-of-river mode, whereby outflow from the project would approximate inflow to the project. The impoundment elevation would be maintained at 229.0 feet, with minimal fluctuations. The applicant also proposes to release a continuous, year-round minimum flow of 57 cfs to the bypassed reach and develop a drawdown management plan, but does

not propose any specific measures to monitor compliance with run-of-river operation and the bypass minimum flow.

The applicant's proposals for run-of-river operation, bypass minimum flow, and a drawdown management plan are consistent with measures recommended by Interior and TU. Additionally, Interior recommends that the applicant develop a plan to maintain run-of-river operations and the bypass minimum flow. [15]

Because bypass minimum flows and impoundment drawdowns primarily affect fisheries resources, we provide our detailed analyses of these measures in section V.C.2., Fishery Resources.

Our Analysis

The Woronoco Project would continue to be operated in a run-of-river mode. Run-of-river operation would maintain existing hydraulic conditions and simulate natural conditions in the Westfield River, to the extent flow is controlled by the Corps' upstream flood control operations. Run-of-river operation would: (1) minimize daily water level fluctuations in the Woronoco impoundment, thus maintaining aquatic resources in the impoundment; and (2) maintain downstream habitat availability for fish and other aquatic organisms by mimicking natural flows. The project has no storage capacity and, when coupled with the proposed run-of-river operation, would have no influence on the seasonal quantity of water discharged into the Westfield River downstream from the project. Run-of-river operation would minimize shoreline erosion, and would limit adverse effects on adjacent wetland communities and wildlife species that use shoreline habitats (see section V.C.3.). The bypassed reach would receive a minimum flow of 57 cfs, which would restore some natural flow and ecosystem stability to the reach.

Based on the aforementioned findings, we conclude there is little potential for the Woronoco Project to adversely affect aquatic resources in the Westfield River stemming from the project's use and allocation of Westfield River flows. The applicant's proposed

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[15]Interior's recommended plan would include a description and design of the mechanisms and structures that are used. The plan would also include provisions for recording data on project operations to verify proper operations and minimum flow releases, and for maintaining these data for inspection by the Commission and resource agencies. The plan would be developed in consultation with the USFWS and the MDFW, and 30 days would be provided for agency comment on the draft plan before it is filed with the Commission for approval.

run-of-river operation, coupled with the provision to provide minimum flows in the bypassed reach, would ensure habitat conditions remain suitable for aquatic resources in the Westfield River.

The applicant does not propose specific measures for monitoring run-of-river operation or any bypass minimum flow that may be required as part of a new license. Thus, we agree with Interior's recommendation for a project operation and flow monitoring plan. Such a measure is necessary to ensure compliance with run-of-river operation and any bypass minimum flow requirement. Moreover, implementing such a measure would afford interested parties a greater understanding of project operations and allow them to independently verify compliance. Therefore, we conclude that a plan for monitoring project operations, including any bypass minimum flow, is warranted.

The project operation and flow monitoring plan should include a description of: (1) the mechanisms and/or structures that would be used to release any required bypass minimum flow; and (2) all gages (including staff gages) and other equipment necessary to monitor run-of-river operation (*e.g.*, headpond and tailrace water surface elevations, generation flow) and any bypass minimum flow. The plan should also include: (1) procedures for recording and maintaining data on project operations and bypass minimum flows; (2) provisions for reporting appropriate project operations and bypass minimum flow data to the resource agencies and the Commission; (3) if necessary, a remote alarm system that can be used to notify an off-site operator in case of emergencies; and (4) a schedule for implementing the plan. The monitoring plan should be developed in consultation with the MDFW, the USFWS, and the USGS.

Water Quality

The applicant proposes to continue run-of-river operations at the Woronoco Project, and to provide a 57 cfs minimum flow to the project's bypassed reach. The applicant proposes no further measures to protect or enhance water quality in the Westfield River. Nor do the resource agencies recommend any specific measures to protect or enhance water quality.

Our Analysis

The Westfield River, in the vicinity of the project, has been designated as Class B waters for warmwater fisheries and recreation. The state standard for DO is no less than 5.0 mg/l and 60 percent saturation. The state standard for water temperature is 83°F, with a 5°F difference associated with water discharges. Historical water quality data for the Westfield River indicates that the river, in the vicinity of the project, fully meets these

standards as far downstream as RM 12.3, well below the Woronoco Project. [16] Further, the results of the applicant's 1997 survey showed that water quality conditions in the project area attained or exceeded Class B warmwater standards for water temperature, DO, and pH during the critical, low-flow/high-temperature summer period.

Under the applicant's run-of-river proposal, we expect water temperature and DO to remain within the acceptable range for supporting a warmwater fishery in the river. Uninterrupted river flows provided by operating in a run-of-river mode minimizes water retention time in the project impoundment, thereby lessening the potential for reduced DO levels and stratification. In addition, continued project operation in a run-of-river mode would protect existing water quality in the river by maintaining natural flow volumes downstream from the project, which would promote circulation through the project impoundment, minimize solar warming, and assist with flushing of accumulated sediments potentially trapped behind the project's two dams and earthen dike.

The applicant's proposed bypass flow of 57 cfs, released from several locations along the north and south dams, would provide certain long-term benefits to water quality in the bypassed reach. We would expect the proposed minimum flow for the bypassed reach to help provide continuity of flows, enhance mixing and aeration of river water, and effectively increase the water quality and waste assimilation capacity of the river.

As discussed further in section V.C.2., the resource management goals for the bypassed reach include, among other things, providing nursery habitat for juvenile Atlantic salmon and incidental habitat for transient brown and rainbow trout. Water temperature and DO levels would be important to achieving these goals. During the 1997 water quality study, [17] water temperature ranged from about 69°F (20.0°C) in the morning to about 72°F (22°C) in the afternoon. DO levels varied little, averaging about 8.4 mg/l, with percent saturation in the 96 percent range. In addition, as part of the instream flow study, water temperature and DO were collected in the south channel pool. On July 31,

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[16]According to the 1990 MDEP water quality survey for the Westfield River, the lower 5 miles of the river experiences violations of state standards for fecal coliform. Fecal coliform is associated with domestic wastewater discharges, as opposed to the Woronoco Project. However, the project's proposed run-of-river operation and minimum bypass flow would help ensure some level of flushing in the system.

[17]Flow conditions in the river represented a 50 percent exceedence flow for the month of August. Weather conditions were mild, with day-time temperatures ranging from the mid-70s to high 80's and night-time temperatures in the mid-60s. Rain occurred on the third day.

1998, water temperature in the pool was 76°F, and DO was 5.7 mg/l. The maximum temperature recorded during the study period (July 31 to August 28, 1998) was about 78°F.

The temperature and DO data cited above meet Class B warmwater fishery standards. However, these data represent marginal conditions for coldwater fisheries, particularly where it concerns water temperature. The temperature tolerance range for rainbow trout is 0 - 77°F (Raleigh *et al.*, 1984) and for brown trout is 0 - 81.6°F (Raleigh *et al.*, 1986). Minimum flows provided to the bypassed reach would improve habitat, aeration, and temperature conditions for coldwater fisheries and other aquatic organisms during the summer months.

In conclusion, no water quality issues have been raised by federal or state resource agencies or other entities in this relicensing process. The continued operation of the project, as proposed, would not adversely affect, but rather would enhance, the ability of the existing project to comply with Class B water quality standards. Further, the proposed project would not contribute to, but could enhance the impaired water quality identified by the MDFW for the lower-most 5 miles of the Westfield River. Therefore, we conclude that relicensing the Woronoco Project would not have significant adverse effects on water quality in the Westfield River.

c. Unavoidable Adverse Effects: None.

2. Fishery Resources

a. Affected Environment:

The Westfield River upstream of the project drains the east slope of the Berkshire Mountains in western Massachusetts. Generally, the headwater tributaries in the drainage support coldwater fisheries, while the mainstem and lower river reaches support marginal coldwater and warmwater fisheries. The river basin upstream of the project, including numerous small tributaries, contributes rearing habitat for Atlantic salmon restoration.

Aquatic Habitat

The Woronoco Project includes: (1) a shallow impoundment of about 43 acres, which provides suitable habitat for warmwater fishes; (2) a deep tailwater pool, which is capable of supporting adult fish; and (3) a bypassed reach consisting of three channels that provide some fish habitat (figure 4). These habitat areas are described more fully below.

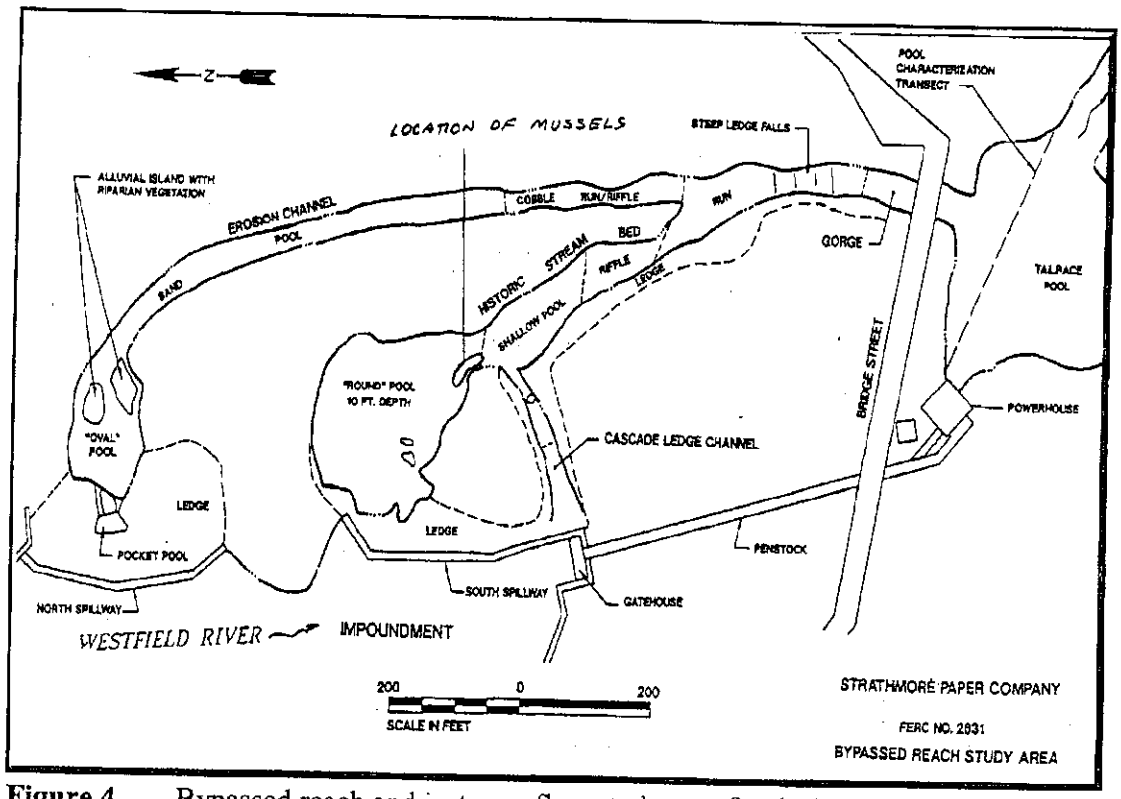

Figure 4. Bypassed reach and instream flow study area for the Woronoco Project (FERC No. 2631) (Source: Kleinschmidt Associates, 1999).

The Woronoco impoundment is relatively narrow and riverine in character, extending upstream of the dam complex for about 6,800 feet (or just over 1.25 miles). Channel depth is about 8 feet, with shoal areas ranging from 2 to 4 feet deep. The shoreline generally consists of steep banks, and is fringed with natural wetland, riparian, and upland vegetation. Substrate throughout the impoundment is predominately a mix of sand and silt. Cover types present in and around the impoundment include areas with overhanging terrestrial vegetation, brush, downed trees, and rooted aquatic vegetation.

The project's bypassed reach extends from the toe of the north and south dams downstream to the confluence with the project tailrace. [18] The habitat consists of three

[18]The bypassed reach was the subject of habitat mapping and a flow demonstration study in 1990 and 1991. Recreational access to the reach is limited by steep, hazardous approaches, which surround the entire reach.

channels, separated by ledge outcrops and/or vegetated alluvium. The three channels converge immediately upstream of a 14.6-foot-high natural ledge drop, which is located in a steep-walled gorge. This ledge drop forms a barrier to upstream fish movement at most flows. The bypassed reach currently supports fish, mussels, and macro-invertebrates, though habitat in the reach is limited by a lack of any minimum flow release.

The original river channel, which extends about 700 feet from the ledge base of the south dam's spillway to the project tailrace, is composed of pool, shallow run and shallow riffle habitat areas. Substrate in this reach is composed of either sand/silt or highly impeded gravel/cobble. There are few hydraulic controls and essentially no cover or velocity shelters. The original river channel is joined, about 600 feet from its origin, by a secondary "erosion" channel, which was formed by a 1938 flood event. This secondary channel begins at the base of the north dam's spillway and extends about 1,000 feet downstream to its confluence with the original channel. Habitat types in this channel consist of shallow pool and shallow run/riffle areas, with substrates of either sand or cobble embedded in sand. Microhabitat features in this channel (*e.g.*, cover, channel form) are poorly developed and ephemeral in nature, due to substrate instability. Velocity shelters are scarce, though the riffle areas provide some macroinvertebrate habitat. A third channel, located adjacent to the project intake, cascades some 200 feet over bedrock terrace ledges to its confluence with the original river channel. Habitat in this channel is limited to small, shallow scour pools in bedrock pockets, with little or no available cover.

The bypassed reach converges with the project tailrace in a circular pool of about 250 feet in diameter. The tailrace pool is generally 11 to 15 feet deep, with a maximum depth of about 19 feet. Substrate is a combination of boulder, ledge, and sand. The water elevation of the pool is controlled by a cobble island and ledge outcrop located at the pool's outlet.

Resident Fish Community

The MDFW has periodically surveyed the fish fauna of the Westfield River since the 1940s, including surveys conducted in 1942, 1952, and 1977 (MDFW, 2000). Some 65 locations throughout the drainage were sampled in 1977 using electrofishing equipment. A total of 25 species were collected (table 2). The five most frequently encountered species during the surveys were white sucker, blacknose dace, brook trout, brown trout, and longnose dace.

Table 2. Fish species known to occur in the Westfield River Basin (Source: MDFW, 2000; Kleinschmidt Associates, 1999).

Name of Species		
American eel	Black Crappie	Blacknose dace
Bluegill	Brook Trout	Brown Trout
Brown Bullhead	Chain Pickerel	Common Shiner
Creek Chub	Fallfish	Golden Shiner
Largemouth Bass	Longnose Dace	Mimic Shiner
Pumpkinseed	Rainbow Trout	Redbreast Sunfish
Rock Bass	Slimy Sculpin	Smallmouth Bass
Spottail Shiner	Tesselated Darter	White Sucker
Yellow Perch		

Based on the 1977 survey, the Westfield River was, and is currently, divided into three Fishery Management Units. Unit A includes the large, low gradient portions of the lower mainstem Westfield River, as well as the Little River in Westfield and sections of the East and Middle branches below Knightsville and Littleville reservoirs. The fish fauna in this unit is composed of mainly of American eel, white sucker, common shiner, and spottail shiner. Warmwater game fish (*e.g.*, smallmouth bass, chain pickerel, rock bass, brown bullhead, and pumpkinseed) made up less than 10 percent of the biomass. Unit B includes the mainstem sections of the East, Middle, and West Branches. Game fish, mainly trout, comprise 27 percent of the fish biomass in this unit. [19] A limited amount of coldwater habitat in this unit supports a stocked rainbow trout fishery throughout the year. Unit C includes the tributaries to the mainstem and the branches of the Westfield River. Brook and brown trout are found in abundance in this unit, making up nearly 36 percent of the total fish biomass collected.

According to the MDFW, the fish fauna in the Westfield River changed little between the 1952 survey and the 1977 survey. The frequency of occurrence within the basin were similar. Also, the relative size and occurrence of game species, other than trout, were similar.

[19]The majority of trout collected were 5.5 inches or greater in length.

The applicant did not conduct a specific fishery survey to support relicensing the Woronoco Project. However, inferences can be drawn from the past MDFW surveys. Based on habitat conditions in the project area and the species included in table 2, it is reasonable to conclude that the Woronoco impoundment supports game fish populations of smallmouth and largemouth bass, chain pickerel, sunfish, and brown bullhead. Though this river reach supports warmwater fish species, it also provides some coldwater habitat that supports a seasonal (spring and fall) stocked trout fishery. [20] The MDFW currently does not actively manage the fishery in the project area, nor is such management contemplated for the future.

Anadromous and Catadromous Fishes

Beginning around the start of the 19th century, the industrial revolution in New England resulted in construction of dams for the purpose of running mills and hydroelectric stations being built along the Connecticut River and its tributaries (Buck, 1993). The first dams were built on tributaries to power sawmills and gristmills (Connecticut River Atlantic Salmon Commission; CRASC, 1998).

Flow regulation, as a result of the operation of hydroelectric generating facilities, has greatly influenced the flow regime, water quality, aquatic habitat, and movement of anadromous, catadromous, and riverine fish in the Connecticut River and its tributaries. Also, dams built in the Connecticut River and its tributaries have blocked access to critical spawning habitat for migratory fish species (CRASC, 1998).

Several native migratory fishes, of particular ecological, economic, and social importance, occur in the Connecticut River basin, including in the Westfield River. These species include Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*), blueback herring (*A. aestivalis*), alewife (*A. pseudoharengus*), gizzard shad (*Dorosoma cepedianum*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*A. oxyrhynchus*), striped bass (*Morone saxatilis*), American eel (*Anguilla rostrata*), and sea lamprey (*Petromyzon marinus*). Runs of these anadromous and catadromous fish populations declined with the industrial development of the Connecticut River basin in

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[20]The MDFW currently does not stock, nor has any records of stocking, the waters in the project area with trout or other species. Rainbow and brown trout are currently stocked in upstream habitats. Trout that seasonally reside in the project reach are drop downs from this stocked fishery. Additionally, IP, the previous project owner, and a local sporting goods operator annually stocked the river upstream of, and downstream from, the project with about 200 rainbow and brown trout each spring since 1990.

the 1800s. The original timber crib dam, when constructed across the Westfield River in 1879 at the site of the present-day Woronoco Project, obstructed fish passage on the mainstem Westfield River 18.5 miles from its mouth.

Since the mid- to late 1800s, a number of attempts were made to restore runs of anadromous fish to the Connecticut River basin. However, these efforts were unsuccessful and subsequently abandoned. In 1965, the U.S. Congress enacted the federal Anadromous Fish Conservation Act (Buck, 1993), which subsequently led to the formation of the CRASC. This set the stage for increased support and funding by the federal government, which again fueled interest in restoring anadromous fish in the Connecticut River and throughout New England. As a result fish ladders and lifts have opened up more than 1,000 miles of migratory fish habitat in the Connecticut River watershed (Interior, 2001).

Operating upstream and downstream fish passage facilities currently exist at the five lower-most mainstream dams on the Connecticut River, as well as at key dams on the Salmon, Farmington, and Westfield Rivers, all tributaries of the Connecticut River (CRASC, 1998). In 1996, fish passage facilities were constructed at the DSI dam, the lowermost dam on the Westfield River (RM 4.0). This opens up about 14 miles of river and provides opportunities for passage up to Woronoco Falls, the site of the Woronoco Project and the historic natural barrier to all anadromous species except Atlantic salmon. In 1998, the licensee for the Woronoco Project installed interim downstream fish passage facilities at the project.

Restoration of anadromous and catadromous fish, including Atlantic salmon, American shad, blueback herring, and American eel, is currently underway on the Westfield River as part of a larger restoration program for the Connecticut River basin (USFWS, 2001a). This cooperative effort is administered by the CRASC. [21] Current restoration activities on the Westfield River, in the project area, are guided by the *Strategic Plan for the Restoration of Atlantic salmon to the Connecticut River* (CRASC, 1998) and the *Anadromous Fish Management Plan for the Westfield River, 2001-2010* (MDFW, 2000). Eel passage goals on the Westfield River are supported by the *Fishery Management Plan for American Eel* (Atlantic States Marine Fisheries Commission; ASMFC, 2000).

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[21]Members of the CRASC include the USFWS, National Marine Fisheries Service, the MDFW, Connecticut Department of Environmental Protection, New Hampshire Fish and Game Department, and Vermont Department of Fish and Wildlife.

The following sections provide a more species-specific account of the efforts to restore fish runs to the Connecticut and Westfield Rivers, as well as a brief summary of the biology, habitat requirements, and population trends of Atlantic salmon and American eel. Species-specific accounts for the other anadromous fish that exist in the Westfield River are not provided, herein, because restoration efforts for species other than salmon and eel are not, and would not be, influenced by the operation and maintenance of the Woronoco Project.

Atlantic Salmon

BIOLOGY

Atlantic salmon spawn in October and November (CRASC, 1998), but often enter freshwater during the preceding spring and remain downstream of spawning areas until fall. Upstream movement is often triggered by increases in river discharge. Salmon spawn in gravel-cobble substrates (0.5 to 4 inches in diameter; USFWS, 1989) in headwater areas of tributaries, where the female digs a nest. [22] Most females lay a total of 7,000 to 8,000 eggs in two or most nests.

The eggs develop in the nest over winter, and the fry hatch the following spring. Fry emerge from the nest primarily from April to June (CRASC, 1998). Fry occupy stream habitats lined with cobble-sized stone and clean, cool (60-70°F) water that is free of sediment. Fry are found around riffles and along the interface of fast moving water, under overhanging cover and generally toward the bottom of the water column.

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[22]In the Westfield River, one in every ten salmon trapped at the fish passage facility at the DSI dam is transported to areas upstream of the Crescent Project (FERC No. 2986) and the Corps' dams (Interior, 2001). The trap and truck program is currently funded by the owner of the DSI dam, the MDFW, and the USFWS. Fish trapped but not released are transported to holding facilities at the Richard Cronin National Salmon Station, where they are kept until fall (USFWS, 2001b). In October/November adult salmon are genetically paired and eggs fertilized (USFWS, 2001c). The fertilized eggs are sent to rearing facilities. The newly-hatched fry are put into suitable habitat before they reach the feeding stage. The fry develop in natural habitat until they reach the smolt stage and emigrate. A portion of the fry produced at the rearing facilities are maintained as part of a brood stock program designed to maintain distinct stocks of marked fish (USFWS, 2001c).

By the end of their first summer, salmon fry develop into parr, which are 3 to 4 inches long (CRASC, 1998). Parr remain in freshwater for a period of 1 to 3 years. Most parr in the Connecticut River spend 2 years in freshwater. During their first fall, parr may disperse widely from their natal stream area to find new habitat (CRASC, 1998). Parr that leave the freshwater environment the following spring begin a process of smoltification, which is a series of behavioral, physiological, and morphological changes that transforms young salmon from freshwater fish to saltwater fish (MDFW, 2000). The smolt's migration to Long Island Sound usually takes place between April and June, when water temperatures reach about 50°F during or immediately after spring run-off. Parr may begin pre-smolt movement in the fall to start their seaward journey.

Seaward-migrating smolts are vulnerable to avian and piscine predation, and they must pass whatever natural and man-made obstacles exist downstream of the rearing habitat. Potential piscine predators in the Westfield River and lower Connecticut River include chain pickerel, northern pike, smallmouth and largemouth bass, walleye, American eel, and striped bass. Obstacles to salmon migration include tributary and mainstem dams, and associated impoundments.

Once in saltwater, salmon migrate northward along the coast to waters in the North Atlantic. Most Connecticut River salmon return to spawn after two years in the ocean, but may return after 1 to 3 years at sea. Adult salmon return to the Connecticut River primarily in May and June (CRASC, 1998). Salmon attempt to reach their natal streams, where they spend the summer holding in deep, cold pools before spawning in the fall. [23] Salmon do not feed during this time. Atlantic salmon may survive to spawn more than one time. Salmon that do survive return to the ocean in late fall (November 1 to December 31) or early spring, during spring off (Interior, 2001).

STATUS & MANAGEMENT

The Connecticut River supported a natural, self-sustaining population of Atlantic salmon prior to the 1800s (Meyers, 1994). Atlantic salmon probably used all major tributaries not blocked by natural barriers, including the Westfield River. However, by the 1820s, Atlantic salmon had disappeared from the Connecticut River basin (Jones,

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[23]Holding pools are typically located close to the spawning grounds (USFWS, 1989). Holding pools have a gravel substrate with large boulders, logs, or ledge out-croppings providing cover. Water depths exceeding 6 feet and velocities under 1.6 fps are preferred. Optimum water temperatures are 50 to 54°F.

1994), largely the result of dam construction, habitat degradation, and overfishing (Meyers, 1994).

In 1867, the Fish Commissioners of Connecticut, Massachusetts, New Hampshire, and Vermont initiated the first program to restore salmon to the Connecticut River (Jones, 1994). The effort involved stocking fry that were hatched from eggs taken from Penobscot River salmon in Maine. The effort was initially successful, as over 800 salmon returned to the Connecticut River into the 1880s. However, the effort was abandoned because the lack of control over harvest, the failure of newly constructed fish passage facilities, and the continued decline of water quality prevented recovery of salmon spawning runs (Ross, 1991; Meyers, 1994).

The second major restoration effort became feasible with the Federal Anadromous Fish Conservation Act of 1965 (Meyers, 1994). The basic goal of the program was to restore American shad to their historical spawning grounds, and, secondarily, to restore Atlantic salmon to some portion of heir historical range (Jones, 1994). In 1982, a Revised Strategic Plan for the Restoration of Atlantic Salmon in the Connecticut River Basin (Stolte, 1982), clarified the goal of the restoration program for Atlantic salmon: "To provide and maintain a sport fishery for Atlantic salmon in the Connecticut River basin and to restore and maintain a spawning population in selected tributaries." The objectives associated with this goal were to attain a population of 19,265 adult salmon returning to the river annually, 7,470 from natural reproduction and 11,795 from hatchery releases. These numbers were expected to produce a sport harvest and a spawning population of 4,000 and 5,570 fish, respectively.

The 1982 Strategic Plan envisioned the stocking of 600,000 salmon smolts and 4.5 million fry to achieve the aforementioned salmon returns. Since 1982, the number of smolts stocked to Connecticut River tributaries has averaged about 231,000 fish per year, and has declined significantly from a high of 476,300 fish in 1990 to a low of 1,300 fish in 1995 (CRASC, 1998). The number of fry stocked has averaged about 2,665,640 fish per year, and has steadily increased from 175,900 in 1986 to about 8.5 million in 1997. No stocking information is available in the record for 1998 through 2001.

The program has been successful in restoring an annual run of several hundred salmon to the Connecticut River and its tributaries (CRASC, 1998; USFWS, 2001d & 2001e). The first salmon returned to the Connecticut River in 1974 and the first documented catch in the Westfield River was in 1992. Between 1974 and 1999, a total of 4,832 adult salmon returned to the Connecticut River, and between 1992 and 1999, a total of 150 adult salmon returned to the Westfield River (table 3).

In 1998, the 1982 Strategic Plan was revised (CRASC, 1998). The mission of the current Atlantic salmon restoration program is "to protect, conserve, restore and enhance the Atlantic salmon population in the Connecticut River basin for public benefit, including recreational fishing." The 1998 Strategic Plan sets seven goals to be achieved, which include, among others: (1) managing salmon production to produce sea-run salmon; (2) enhancing and maintaining the quantity, quality and accessibility of salmon habitat necessary to support re-established spawning population; (3) protecting Connecticut River salmon from exploitation; and (4) assessing the effectiveness of the program.

The Connecticut River Basin has an estimated 243,000 rearing habitat units for Atlantic salmon in the mainstem and 38 tributaries (CRASC,

Table 3. Atlantic salmon returns to the Connecticut and Westfield Rivers, 1974 through 1999 (Source: CRASC, 1998; USFWS, 2001d & 2001e).

YEAR	CONNECTICUT RIVER	WESTFIELD RIVER
1974	1	–
1975	3	–
1976	2	–
1977	7	–
1978	90	–
1979	58	–
1980	175	–
1981	529	–
1982	70	–
1983	39	–
1984	92	–
1985	310	–
1986	318	–
1987	353	–
1988	95	–
1989	109	–
1990	263	–
1991	203	–
1992	490	2
1993	198	10
1994	326	7
1995	188	6
1996	260	21
1997	199	39
1998	300	47
1999	154	18
Total	**4,832**	**150**

1998). [24] To utilize this habitat, the Strategic Plan's objectives are to produce 15 million eggs, 10 million fry, and a minimum of 100,000 hatchery smolts annually.

The Westfield River has an estimated 22,000 rearing habitat units, or about 9 percent of the total rearing habitat in the basin. Assuming a stocking rate of 20-60 fry/100m^2, the annual number of fry stocked in the Westfield River could range from 440,000 to 1,320,000 fish. An estimated 750,000 fry are annually stocked in the Westfield River drainage (34 fry/100m^2), with more than 90 percent stocked upstream of the Woronoco Project (Trout Unlimited, 2001). Assuming all habitat is stocked, the Westfield River could produce 44,000 smolts (2 smolts/unit; CRASC, 1998). Accounting for year-to-year production variability of at least 25 percent (CRASC, 1998), the plan projects potential adult salmon returns of 83 to 138 fish with a smolt-to-adult survival rate of 0.25 percent. With a smolt-to-adult survival rate of 2.5 percent, between 825 and 1,375 adult salmon could return to the river. [25]

The Atlantic salmon restoration program has not been successful in achieving the goal of a natural spawning population and a sport fishery. Though some natural spawning and instream production of fry has been demonstrated, the program has not yet achieved the goal of a recreational fishery. Challenges and threats to the program include marine survival of adults, development of stocks that are genetically suited to the Connecticut River watershed, and predation by striped bass.

American Eel

BIOLOGY

The American eel is a catadromous species whose young enter the Connecticut River watershed to feed and mature, then return to the Atlantic Ocean to spawn. [26] After spending 3 to 18 years in freshwater, eels migrate to spawning grounds located in the Sargasso Sea, in the south Atlantic.

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[24]One habitat unit equals 100 square meters, or about 120 square yards, of habitat.

[25]The goal of the MDFW's *Anadromous Fish Management Plan for the Westfield River, 2001-2010* is to "establish and maintain an annual spawning population of 500 adult Atlantic salmon to the Westfield River for natural production, sport fishing, and aesthetic purposes by the year 2010."

[26]The American eel is panmictic (single spawning site and complete mixing of the gene pool at each spawning event).

Eggs are fertilized and released in the water column. The eggs hatch into a transparent larval stage, which are known as leptocephali. The larvae are pelagic, drifting via the Florida Current and the Gulf Stream to coastal North America and Europe. Before entering freshwater, the larvae turn into elvers, or glass eels. Elvers enter estuaries in the spring, and begin their upstream ascent of Atlantic coast rivers. The upstream ascent in these rivers may last for many months or years (Haro, 1996), with active migration generally coinciding with warmer temperatures (peak activity occurring in July and August). Juveniles, known as yellow eels, may remain in freshwater for up to 24 years. [27]

As sexual maturity begins, yellow eels change into the sub-adult form known as silver eels. Silver eels begin their out-migration back to the Sargasso Sea, where maturity is achieved prior to spawning (ASMFC, 2000; Haro, 1996). Adults are not known to survive after spawning. Downstream movement generally starts for the silver eels with the onset of the fall rainy season and escalates with the onset of colder temperatures.

American eel ascending the Connecticut River are not counted at existing fish passage facilities, though they are known to use fish passage structures. With its ability to ascend damp surfaces, American eels are capable of passing barriers, such as dams, without the aid of fish passage facilities. This behavior, combined with the eel's generalistic food and habitat preferences, has allowed the species to inhabit certain areas upstream of dams. In the Westfield River, American eel exist both upstream of, and downstream from, the Woronoco Project (Interior, 2001).

American eels accessing habitat in the Connecticut River watershed during their long freshwater residency, as well as the silver eel during its out-migration are subject to hydropower turbine mortality. Turbine-related mortality of American eel has been documented to range from 6 to 37 percent (Richkus and Whalen, 1999)

STATUS & MANAGEMENT

All along the Atlantic coast, fishing has traditionally supplied American eels for regional, ethnic, and European food markets, domestic trot line bait, and sport fishing (Richkus and Whalen, 1999). The North American eel fishery is considered small but valuable, geared toward supplying relatively narrow niche markets (Richkus and Whalen,

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[27]In freshwater streams, eel occupy many different habitats, from ponds and lakes to relatively small streams. They are predators, feeding on invertebrates and other fish species. Juvenile eels, in turn, are prey for large predators such as striped bass, northern pike, and blackbass.

1999). Such markets exist for nearly every life stage, from adults to juveniles. In the Connecticut River system, no substantial commercial fishery exists for the species.

Harvests of resident yellow and migrant silver eels, in most areas of North America and Europe, have historically been for human consumption (Richkus and Whalen, 1999). Sub-adult yellow eels are also harvested along the east coast of the United States and sold as trot line bait in commercial and recreational fisheries (*e.g.*, blue crabs, striped bass). In the late 1970s and in the 1990s, a substantial fishery for glass eels entering coastal waters and elvers entering freshwater developed in the United States to satisfy an Asian aquaculture market. [28]

Commercial fishing records indicate that the American eel population has declined dramatically. Declining trends in abundance of American eel were first reported for the St. Lawrence River, where the average daily counts of yellow eels passing the ladder at the R.H. Saunders Generating Station have declined over 100-fold between 1982 and 1993 (*e.g.*, 1.3 million eels in 1983 to 8,289 eels in 1993). Similar declines have been reported for the New Hampshire and Potomac River commercial eel pot fisheries, the Hudson River, and the North Anna River in Virginia (Richkus and Whalen, 1999). The declines in the American eel population are attributed to a variety of causes, including commercial fishing, pollution, changes in oceanic currents, habitat fragmentation, and the negative effects of dams and hydropower projects (Richkus and Whalen, 1999).

The current downward trend in the American eel population prompted the ASMFC to prepare the Fishery Management Plan for American Eel (ASMFC, 2000). The management plan identifies a dramatic reduction in American eel abundance throughout its range, and a pressing need for immediate action. The stated goal of the eel management plan is to conserve and protect the American eel resource to ensure its continued role in the ecology of ecosystems, while providing the opportunity for its commercial, recreational, scientific, and educational use. [29] Two of the five primary objectives are: (1) to protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, to restore American eel to those waters

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[28]In 1994 and 1995, the average price paid for elvers in Maine was $110 and $500 per kilogram, respectively (Richkus and Whalen, 1999). The total value of the fishery was estimated at $5.5 million in 1995.

[29]The goal aims to: (1) protect and enhance the abundance of American eel in inland and territorial waters of the U.S. and jurisdictions, and contribute to the viability of the American eel spawning population; and (2) provide for sustainable commercial, subsistence, and recreational fisheries by preventing over harvest of any eel life stage.

where they were historically abundant, but now may be absent, by providing access to inland waters for glass eel, elvers, and yellow eel, as well as by providing adequate escapement to the ocean for pre-spawning adult eel.

Freshwater Mussels

Recent surveys of the mussel fauna in the project area identified four species of mussels, including populations of squawfoot (*Strophitus undulatus*), eastern elliptio (*Elliptio complanata*), alewife floater (*Anodonta implicata*), and the eastern pearl mussel (*Margaritifera margaritifera*) (Kleinschmidt Associates, 1999). The Woronoco impoundment was surveyed on July 12 and 13, 1999. The bypassed reach was surveyed on September 1, 1998.

Woronoco Impoundment – The purpose of the survey in the Woronoco impoundment was to locate freshwater mussels in the area affected by drawdown of the impoundment. Once the two-day search was complete, all collected specimens were identified, counted and measured. No gravid (reproductively ripe) specimens were found.

Three mussel species were recovered from the impoundment, including the squawfoot, [30] eastern elliptio, and alewife floater. The squawfoot was the most common of the three species, with 108 specimens recovered. Eight eastern elliptio and one alewife floater were found. Squawfoot is a species of Special Concern in Massachusetts, and survives only in the Connecticut and Housatonic River systems.

Within the drawdone zone, two general distribution patterns were observed. First, a broad size range of adults and juvenile specimens were widely distributed in the upper impoundment. They occurred in areas characterized by sand/silt substrates, with little current. The second area of occurrence was in a small area about 150 feet upstream of the South dam, between the dam and the mouth of a small brook. The area is characterized by a mud substrate, with an extensive bed of emergent vegetation

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[30]Squawfoot has been recorded historically from the Westfield River, and populations are known to exist in the Middle Branch, as well as in the mainstem Westfield. Recent research indicates that the species utilizes several host species to complete its life history, including golden and common shiners, tesselated darter, long-nose dace, slimy sculpin, and larval two-lined salamander. Reproduction is thought to be occurring in the Westfield River, as evidenced by the presence of many juvenile individuals. [NOTE: shiners and darters were observed during the survey, indicating that the parasitic phase of reproduction was possible in the project area]

(dominated by pickerel weed). Many juvenile squawfoot (25) were found in this area. Both the headwater area and the area located upstream of the south dam are subject to de-watering during impoundment drawdowns.

Woronoco Bypassed Reach – Two species of mussels were found in the bypassed reach; the squawfoot (two specimens) and the eastern pearly mussel (one specimen). None of these specimens were gravid. During the survey, mussel habitat was observed in only certain stretches of the reach, with much of substrate being composed of boulders and cobble, or silt. The three specimens collected during the survey were collected from a small riffle at the outlet of a pool in the historic stream channel. No individuals were collected from the erosion channel.

A variety of fish species were observed during the survey, including blacknose dace, an unidentified cyprinid, brook trout, American eel, smallmouth bass, and yellow bullhead. While many of these fish are known to be mussel host species, there is no evidence that any serve as host species for mussels living in the bypassed reach. The survey did not document a reproducing mussel population in the reach. [31]

During the survey, there was little evidence of a permanent benthic community. This suggests that the bypassed reach is periodically scoured or disturbed by high flow events. The report concluded that, under existing conditions, there is little opportunity for a permanent, resident mussel population to become established.

b. Environmental Effects and Recommendations:

Project Operations & Impoundment Drawdowns

Project Operations – Woronoco hydro proposes to operate the Woronoco Project in a run-of-river mode by maintaining the impoundment at a target elevation of 229.0 feet, with minimal fluctuations. This proposal is consistent with the run-of-river operational recommendations made by Interior and TU.

Our Analysis

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[31]The mussel report concluded that little habitat existed in the bypassed reach to support self-sustaining populations of mussels. The report further concluded that the mussels found in the bypassed reach were most likely transplants from an upstream location, either by host fish or flood.

Continued run-of-river operation would maintain the riverine fish and freshwater mussel populations occurring in the Woronoco impoundment and in the Westfield River downstream from the project by mimicking natural streamflows. To the extent that project inflow approximates natural hydrologic conditions in the river, run-of-river operation would: (1) minimize daily water level fluctuations and stabilize day-to-day habitat availability for fish, mussels, and other aquatic organisms in the Woronoco impoundment and the downstream river reach; and (2) protect wetlands that rely on saturated soils (Rochester *et al.*, 1994). Also, run-of-river operations would stabilize flows, minimizing the potential for stranding fish and other aquatic organisms, as well as their developing eggs and young.

We conclude that run-of-river operation would help maintain impoundment fisheries and downstream riverine resources of the Westfield River. Therefore, we recommend that Woronoco Hydro operate the project in a run-of-river mode. We define run-of-river operation as minimizing impoundment water level and downstream flow fluctuations by discharging a flow from the project that approximates the sum of inflows to the project on an instantaneous basis. We further recommend that Woronoco Hydro maintain a target operating level of 229.0 feet, with minimal fluctuations.

The existing license for the Woronoco Project does not include any requirements for flow control at the project. However, the existing project is required to release a minimum flow of 48.1 cfs during refill periods. [32] The existing 401 WQC does not include such a requirement. The applicant has not proposed such a measure, nor have any agency or other entity recommended such a measure.

Historically, impoundment drawdowns occurred on nearly an annual basis and were timed to coincide with the annual outage at IP's Strathmore Paper Mill. The drawdowns were generally in the 8- to 10-foot range, which typically lasted for 1 to 3 days. With the closure of the paper mill, the near annual drawdowns no longer occur. However, less frequent maintenance drawdowns may occur (3 to 10 year intervals), over the term of any new license issued for the project. Such drawdowns, without adequate refill procedures, would likely disrupt downstream flows for short durations. Depending on the timing and duration of refill periods, aquatic life in the Westfield River, downstream from the project, could be negatively affected.

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[32]A flow of 48.1 cfs is slightly less than the 7Q10 flow of 53 cfs, and is well below the 10 percent of the mean annual flow figure (71.8 cfs), which is generally considered adequate to sustain short-term survival of riverine aquatic resources (Tennant, 1976).

To maintain aquatic habitat necessary to protect downstream aquatic resources in the Westfield River, we recommend that Woronoco Hydro consult with state and federal resource agencies concerning impoundment refill procedures, and that such procedures be addressed as part of an impoundment drawdown management plan (see below). We recognize that measures may be developed, as part of the aforementioned plan, to eliminate the need for impoundment drawdowns at the Woronoco Project. Nonetheless, at this time, we can not rule out the possibility of maintenance drawdowns occurring at the project over the course of a new license term.

Impoundment Drawdowns – The applicant proposes to develop an impoundment drawdown management plan. The plan would outline measures to protect mussel species and recover stranded fish from de-watered areas in the impoundment, as well as include an evaluation of alternatives to drawing down the impoundment for extended periods of time. This proposal is consistent with recommendations made by Interior and TU.

Our Analysis

Species that inhabit the littoral zone of the impoundment typically are displaced when their preferred habitat is de-watered. Other species that normally occupy deeper, mid-channel, areas may spawn in shallow water. Maintenance drawdowns, depending on their timing and magnitude, can adversely affect fish populations by decreasing spawning success and reducing juvenile survival. Drawdowns can expose spawning nests and de-water eggs and larvae, or cause shallow spawning fish to abandon nests, resulting in higher predation on the eggs and larvae that remain in the nest. Drawdowns can be detrimental to wetland plant species that depend on saturated soil (Rochester *et al.*, 1994). These wetland areas may be important to the reproductive success of certain fish species; displacing juvenile fish from shallow vegetated areas that provide refuge from predators.

In addition to the aforementioned effects, drawdowns may reduce prey for juvenile fish by stranding and de-watering benthic macroinvertebrates and decreasing prey production. Also, impoundment drawdowns pose a significant threat to benthic organisms, including benthic macroinvertebrates and mussels. Unlike fish species and many macroinvertebrates, mussels are mostly sedentary organisms that exhibit little mobility and burrow into a stream channel's substrate. This character trait makes them particularly susceptible to effects of de-watering.

IP historically managed the project impoundment to include near-annual drawdowns of 8 to 10 feet. For the Woronoco impoundment, drawdowns of this

magnitude would be considered relatively significant, considering that the impoundment has extensive shoal areas that are 2 to 4 feet deep.

On July 12 and 13, 1999, the Woronoco impoundment was drawn down 8 to 10 feet from its normal elevation of 229.0 feet. The drawdown exposed substrates in various locations in the impoundment. The most extensive area was a shoal located along the western shoreline adjacent to Strathmore Park (see figure 3 in Kleinschmidt Associates, 1999). The second most extensive area was located along both shores of the impoundment, between the temporary bridge and the project spillway. Of significance, both these areas support mussel beds, as evidenced by the mussel survey conducted along with the drawdown. In fact, the survey results indicate these areas contain significant numbers of the squawfoot mussel, a species of Special Concern in Massachusetts. The bottom profile of these exposed areas is essentially horizontal and flat. Relatively little substrate is exposed in the upper, more narrow, portion of the project impoundment.

The 1999 drawdown exposed between 33 to 50 percent of the impoundment's substrate. A well-defined thalweg, of 2 to 6 feet in depth, remained wetted. Most all substrate exposed during the drawdown consisted of fine sands and/or silts, with some cobble. No significant object cover or woody debris was found in the exposed areas. Very little aquatic vegetation was present. The only exception was the area at the mouth of Potash Brook, which is predominately muddy, with a bed of emergent vegetation.

Based on the information in the record, it seems clear that individual mussels can be, and are, exposed during maintenance drawdowns, particularly of the magnitude that occurred historically at the project. What effect such drawdowns have on the mussel populations in the Woronoco impoundment is not known. However, the potential certainly exists that the impoundment's mussel population could be detrimentally affected by large-scale drawdowns.

We concur that an impoundment drawdown management plan is warranted, and recommend that Woronoco Hydro prepare and implement such a plan in consultation with the resource agencies. At a minimum the plan should outline measures to protect mussel species and recover stranded fish from de-watered areas. [33] As part of the plan, the

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[33]Fish stranding is generally considered a problem in riverine reaches that are characterized by shallow backwater areas, or small pocket water areas created by instream obstructions. Based on observations made during the 1999 drawdown and mussel survey, there appears to be only a few shoreline areas, and no submerged obstructions, which could potentially lead to fish stranding. Therefore, we conclude that, while some fish

(continued...)

applicant should evaluate alternatives to impoundment drawdowns; [34] the evaluation including a discussion of the environmental benefits, as well as the technical and economic feasibility of each alternative evaluated. Should periodic maintenance drawdowns be deemed a necessary component of project operations, the plan should include a provision for minimizing the frequency, duration, and magnitude of drawdown events, as well as minimizing the effect on aquatic resources in the impoundment.

Bypass Minimum Flows

Woronoco Hydro proposes to release a year-round minimum flow of 57 cfs to the project's bypassed reach; 22 cfs to the north channel and 35 cfs to the south channel. The flow to the north channel would be released through a notch cut in the north dam. The flow to the south channel would be released through the existing downstream fish passage facility (20 cfs), with the remainder (15 cfs) released through a notch cut in the center of the south dam. The applicant's proposal is consistent with the recommendations made by Interior and TU.

Our Analysis

The Woronoco powerhouse is located downstream from the project's dams, and the maximum hydraulic capacity of the facility is 710 cfs. Excess flows are spilled into a bypassed reach that measures from 200 to 1,000 feet in length, depending on the channel. The bypassed reach at Woronoco is composed of three separate channels, each with pool, riffle, and run sections. Habitat conditions in the bypassed reach are dependent on the volume of spill occurring at the two Woronoco dams.

The bypassed reach is isolated from surrounding river reaches by the project dams, as well as steep ledge falls at the outlet of the reach. There is limited connectivity of this

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[33](...continued)
stranding may occur, the degree to which stranding occurs is not likely to be significant and of negligible consequence to the impoundment fishery.

[34]Relocation of stranded mussels should be an option. However, this approach may not ensure adequate protection to individual mussels. Some mussels burrow in the mud and cannot be seen (Samad and Stanley, 1986), while smaller individuals are difficult to detect (Hornback and Deneka, 1996; Obermeyer, 1998). Also, relocation, itself is not 100 percent effective, as significant numbers of relocated individuals may perish (Cope and Waller, 1995). Notwithstanding its effectiveness, mussel restoration and conservation often involves the practice of relocation (Parmalee and Bogan, 1998).

reach is limited. Consequently, the reach has limited fishery resource management potential, and there are no MDFW active management initiatives for the reach. However, three passive resource management objectives were identified, which include:

- ! provide aquatic forage production for benthic invertebrates;
- ! provide nursery habitat for juvenile Atlantic salmon that may wash into, and occupy, the bypassed reach; and
- ! provide incidental habitat for transient brown and rainbow trout that are stocked upstream and are washed into the bypassed reach.

The primary management goal of the MDFW and the USFWS for the Westfield River is restoration of Atlantic salmon. To this end, large numbers of salmon fry are stocked by the MDFW upstream of the project. The bypassed reach is not a strategic salmon management area, although salmon recruited to, and reared in, the reach likely make a small contribution to the salmon run in the Westfield River. In keeping with the aforementioned stated objectives, the minimum flow study plan designed for the project's bypassed reach addressed habitat-based instream flow issues related to the production of macroinvertebrates and juvenile salmon. The study plan also considered how flows for the main objectives support brown and rainbow trout.

To evaluate the effects of various flows on aquatic habitat in the bypassed reach (see section V.C.2.a.), Kleinschmidt Associates (IP's consultant) assessed aquatic habitat and flow in the relatively short bypassed reach using a modified Instream Flow Incremental Methodology (IFIM) approach (Bovee, 1982), in which micro-habitat data were gathered in the area of interest at incremental flow releases. The flow study employed standardized field methods, habitat data inputs, and habitat suitability criteria to calculate and interpolate habitat availability. [35] Details of the methodology used is contained in the instream flow study report, located in Appendix C of the license application (Kleinschmidt Associates, 1999).

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[35]The Woronoco flow study differed from a conventional IFIM in that it does not utilize the computerized Physical Habitat Simulation Model (PHABSIM) to extrapolate habitat-discharge relationships.

reach to other riverine fish populations. Also, human access is limited, due to the steep embankments surrounding the reach. As a result, the fishery potential in the bypassed reach is limited. Consequently, the

Field data were collected at leakage (1.5 cfs; existing condition), 20, 40, and 80 cfs, with flow being evenly split between the two bypass channels (table 4). All transect data (*e.g.*, bed elevation, substrate data, water elevation, and velocity) for each discharge were entered into a spreadsheet and quality checked. Habitat Suitability Index (HSI) values used in the analysis were derived from previous flow study applications in New England. Habitat area for a species was calculated for all wetted stream cells at each field-measured flow by computing the total wetted area, then adjusting the wetted area based on the species' HSI values. Usable habitat was interpolated at other flows; there was no projection beyond the flow range of interest. [36] The results of the flow study are summarized below.

Table 4. Summary of discharges measured in two bypass channels at the Woronoco Project (Source: Kleinschmidt Associates, 1999).

Target Flow	Actual flow	N. Channel	S. Channel
Leakage	1.5 cfs	0.5 cfs	1 cfs
20 cfs	27 cfs	12 cfs	15 cfs
40 cfs	44 cfs	22 cfs	22 cfs
80 cfs	81 cfs	46 cfs	35 cfs

South Channel

Wetted area in the south channel is maximized at the highest flow studied (35 cfs; figure 5), nearly double that which occurs under the existing condition of leakage (8,890 vs. 4,820 sq. ft.). For the entire channel, wetted area increased rapidly up to 15 cfs (65 percent increase), with further increases being more gradual (12 percent from 15 cfs to 35 cfs).

[36]Habitat output was expressed in units of Usable Area (UA). One UA unit corresponds to 1 square foot of optimal habitat.

Usable habitat for macroinvertebrates is maximized at 35 cfs, with the increase in habitat being relatively uniform over the range of flows studied and representing a nearly 15 fold increase over leakage flow (figure 5). Habitat area increased nearly 460 percent between leakage and 15 cfs. Usable habitat increased an additional 56 percent between 15 and 22 cfs, with an another 30 percent increase between 22 and 35 cfs. The majority of macroinvertebrate habitat, in the south channel, occurs in the riffle section. Low velocities limits the amount of usable habitat in the run reach. Overall, 15 cfs provides about 50 percent of the habitat available at 35 cfs, while 22 cfs provides about 75 percent of the habitat available at the maximum flow.

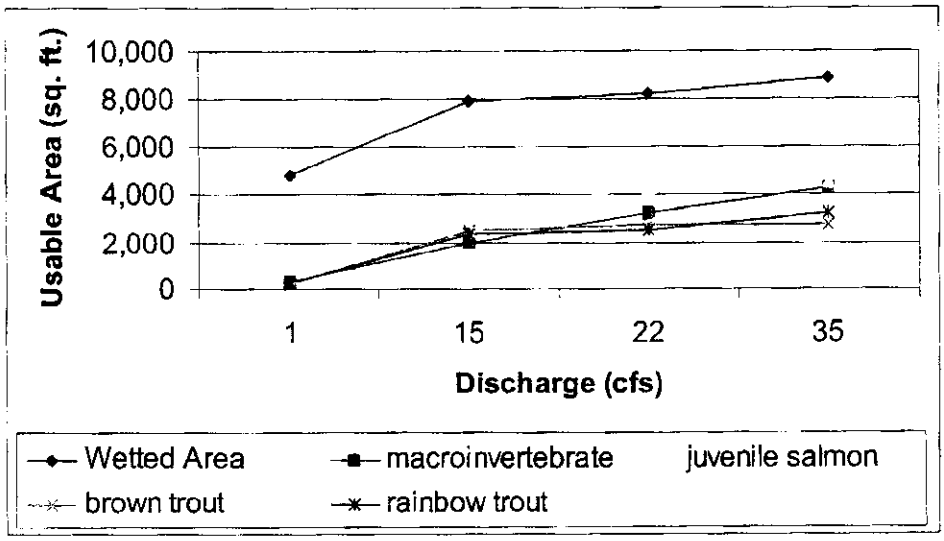

Figure 5. South channel habitat and wetted area as a function of flow (Source: Kleinschmidt Associates, 1999).

For juvenile Atlantic salmon, usable habitat is maximized at 35 cfs (figure 5). Habitat increases moderately across the range of flows studied, with an inflection point at 22 cfs. The majority of habitat for juvenile salmon occurred in the run reach, as habitat in the riffle reach peaked at 22 cfs then declined due to an increase in velocities that exceeded the suitability standards of this life stage. Overall, 15 cfs provides about 75 percent, and 22 cfs provides 94 percent, of the habitat available at 35 cfs.

Usable habitat for catchable-size brown trout is maximized at 35 cfs (figure 5). Habitat increases rapidly between leakage and 15 cfs, the inflection point. Habitat in the riffle section peaked at 22 cfs then declined, as velocities increased to a level that

suitability declined. The majority of habitat available for brown trout occurred in the run area. In the run, habitat suitability reached its inflection point at 15 cfs, with only a marginal increase from 15 cfs through 35 cfs. Overall, flows of 15 and 22 cfs provide 90 and 99 percent, respectively, of the habitat available at 35 cfs.

For catchable-size rainbow trout, usable habitat increases at a moderate rate over the range of flows studied, with habitat being maximized at 35 cfs (figure 5). As is the case for brown trout, the majority of habitat for rainbow trout occurs in the run area, with a rapid increase from leakage up to an inflection point at 15 cfs. This represents a nearly 9-fold increase between leakage and 15 cfs. Overall, flows of 15 and 22 cfs provide roughly 73 and 79 percent, respectively, of the habitat available at 35 cfs.

North Channel

Wetted area in the north channel is maximized at the highest flow studied (46 cfs; figure 6). Similar to the south channel, the amount of wetted area provided by 46 cfs is nearly double that which occurs under existing leakage flows (7,705 vs. 4,463 sq. ft.). However, unlike the south channel, the increase in wetted area in the north channel was relatively uniform over the range of study flows; about 31 percent from 0.5 to 12 cfs, no change from 12 to 22 cfs, and about 32 percent from 22 to 46 cfs.

Usable habitat for macroinvertebrates is maximized at 46 cfs, which represents about a 5 fold increase in habitat over that provided by the leakage flow (figure 6). Habitat area increases by 50 percent between leakage and 12 cfs, then sharply between 12 and 22 cfs (290 percent). A flow of 22 cfs provides about 99 percent of the habitat available at 46 cfs. The majority of habitat for macroinvertebrates occurs in the riffle area, while the run section offers little potential habitat due to low velocities.

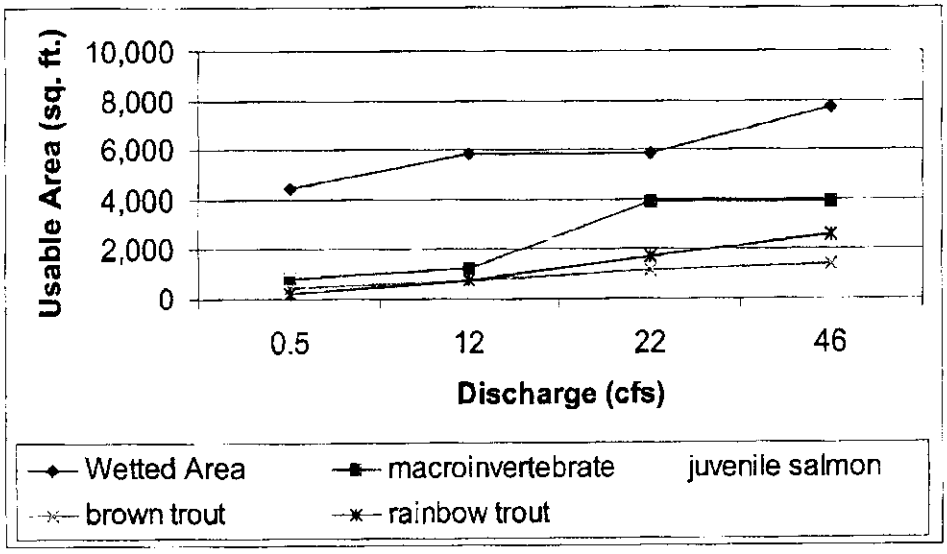

Figure 6. North channel habitat and wetted area as a function of flow (Source: Kleinschmidt Associates, 1999).

For juvenile salmon, usable habitat is maximized at 22 cfs (figure 6). Habitat area roughly doubles between leakage and 22 cfs, reflecting a gradual increase in habitat area. No pronounced inflection point exists. Habitat peaked in the riffle section at 12 cfs, then declined at higher flows due to excessive velocities; whereas habitat in the run area peaked at 22 cfs then declined. Overall, 12 cfs provides about 92 percent of the habitat available at 22 cfs, while 46 cfs provides roughly the same amount of habitat as at 22 cfs.

Usable habitat for catchable-size brown trout is maximized at 46 cfs, reflecting roughly a 4-fold increase in habitat over that provided by leakage (figure 6). Habitat increases fairly uniformly over the range of flows studied, with no clear inflection point. Habitat area roughly doubles between leakage and 12 cfs (due primarily to increases in depth in the run), with modest additional increases up to 46 cfs. Overall, flows of 12 and 22 cfs provide 55 and 84 percent, respectively, of the habitat available at 46 cfs.

For catchable-size rainbow trout, usable habitat increases gradually and linearly over the range of flows studied, with habitat being maximized at 46 cfs (figure 6). This represents about a 10 fold increase in habitat when compared to the amount of habitat provided by the leakage flow. The majority of habitat is located in the riffle area at lower flows, but was about equally abundant in the run and riffle sections at 22 and 46 cfs. Overall, flows of 12 and 22 cfs provide roughly 30 and 67 percent, respectively, of the habitat available at 46 cfs.

Conclusions

The minimum flow for the Woronoco bypassed reach should take into account the priority of habitat management objectives set by the resource agencies for each species, available flow, and the ability of the project to provide the flows (Kleinschmidt Associates, 1999). Moreover, because the bypassed reach consists of two separate channels that are hydraulically distinct, it is appropriate to consider individual flows for each channel. With this said, any flow recommendation for the bypassed reach should consider the management objectives and habitat needs for the primary species of concern.

As previously mentioned, the bypassed reach possesses relatively limited habitat management possibilities due to certain physical attributes of the area (*e.g.*, connectivity with other stream segments, recreational access). As a result, the resource agencies concluded that the primary values of the Woronoco bypassed reach are (1) its ability to support the production of macroinvertebrates, [37] and (2) its capability to serve as refuge for any transient salmonids that wash into the reach from upstream. [38] Based on the passive resource management objectives identified during pre-filing consultation, macroinvertebrate production and juvenile salmon habitat are the greatest priorities for the bypassed reach. Thus, it is reasonable to focus our habitat assessment on the habitat needs of macroinvertebrates and juvenile salmon.

The applicant proposed, and the resource agencies and TU recommend, a minimum flow of 57 cfs, split between the south and north channels. This minimum flow regime would provide 89 percent of the total available wetted area, 98 percent of the total available macroinvertebrate habitat, 100 percent of the total available juvenile salmon habitat, 95 percent of the total available brown trout habitat, and 86 percent of the total

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[37]There is no specific habitat-based management objective for macroinvertebrates in the bypassed reach, although the reach does contribute forage to the aquatic community in the study area and other contiguous stream reaches.

[38]The bypassed reach is not directly stocked with salmon fry or parr, but habitat in the reach could support juvenile (parr) salmon. There is no specific production target for the bypassed reach, nor is the reach strategic for salmon spawning or adult holding. With regard to trout, the bypassed reach is not strategic for reproduction or angling, and no specific management target has been identified. Instream object cover is limited, with the greatest shelter for large trout existing in the deep pool at the toe of the south channel spillway. Use of the riffle/run habitats would likely be limited to foraging opportunities and downstream passage. Thus, the bypassed reach would serve mainly as a refuge area for transient fish between contiguous stream reaches.

available rainbow trout habitat. The 57-cfs minimum flow regime would also help protect mussel habitat in the bypassed reach.

In the south channel, the proposed and recommended flow of 35 cfs would provide 100 percent of the total available wetted area and 100 percent of the total available aquatic habitat for the species evaluated. This flow would also provide an adequate circulation flow for the large, relatively deep plunge pool that exists downstream from the south dam spillway. In the north channel, the proposed and recommended flow of 22 cfs would provide 76 percent of the total available wetted area, nearly 100 percent of the total available macroinvertebrate habitat, 100 percent of the total available juvenile salmon habitat, about 84 percent of the total available brown trout habitat, and about 67 percent of the total available rainbow trout habitat.

We conclude that a 57 cfs minimum flow would adequately protect and enhance aquatic habitat in the Woronoco bypassed reach. This flow is consistent with the applicant's flow proposal and that recommended by Interior and TU.

Upstream Fish Passage

Anadromous Fish – Woronoco Hydro proposes to work with the MDFW to develop an agreement to participate in the MDFW's trap-and-truck program for Atlantic salmon on the Westfield River. As part of this agreement, Woronoco Hydro would fund 1/3 of the trap-and-truck program's annual cost, or about $4,700/year. This proposal is consistent with recommendations made by the resource agencies during pre-filing consultation. [39] The trap-and-truck program would operate, for upstream passage of anadromous fish, from mid-April through July and mid-September through October (MDFW, 2000).

Our Analysis

The Woronoco dam complex is the second mainstem obstruction on the Westfield River, upstream of the river's confluence with the Connecticut River. Upstream and downstream fish passage facilities are currently operating at the lower-most dam on the

[39]Interior recommends that the license be conditioned to require development of an agreement for sharing in the cost of the trap-and-truck program (see page 3 of Interior's February 8, 2001, terms and conditions letter). However, Interior does not identify this recommendation as a 10(j) recommendation.

river (DSI dam in West Springfield). This provides for passage up to the Woronoco Project, which currently does not have upstream fish passage facilities.

Based on current agency management objectives for the Westfield River, there are no plans to require upstream passage for Atlantic salmon, American shad, or river herring at the Woronoco Project at this time (Interior, 2001). Adult shad and river herring are currently targeted for restoration only to river reaches downstream from the Woronoco Project. However, adult salmon are targeted for restoration to the basin upstream of the project. To achieve the salmon restoration goals, salmon are currently trapped at the downstream DSI dam and either transported to the Cronin National Salmon Station for spawning and subsequent production of eggs and fry, or transported to suitable habitat upstream of the Crescent Project and the Corps's two flood control reservoirs. Thus, the Woronoco dam complex acts as a barrier to upstream salmon passage.

Current salmon management calls for continuing the aforementioned trap-and-truck program into the foreseeable future. [40] Due to the presence of several dams upstream, the resource agencies have determined that the trap-and-truck program is the most cost-effective fish passage alternative at this time. As such, construction of fish passage facilities at each dam on the Westfield River has been deferred. Currently, the trap-and-truck program is supported by the owner of the downstream DSI dam, as well as the MDFW and the USFWS. The owner of the Woronoco Project does not provide support to this program at this time.

Implementation of a trap-and-truck program on the Westfield River precludes the need for upstream fish passage facilities at the Woronoco Project. In the absence of the trap-and-truck program, the project would constitute an absolute barrier to salmon passage on the Westfield River. It is therefore reasonable that the licensee for the Woronoco Project bear its share of the costs to implement the existing trap-and-truck program. To this end, the applicant has agreed to work with the MDFW towards developing a cost-sharing agreement for its participation in the trap-and-truck program.

We conclude that Woronoco Hydro should incorporate a cost-sharing provision as part of a comprehensive fish passage plan for the Woronoco Project. The amount included as part of the project's fish passage plan should be consistent with that

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[40]The MDFW concludes that the current system will have adequate capacity to facilitate passage of the adult salmon run on the Westfield River. The USFWS states that "the system will be functional for the foreseeable future in moving salmon past the project." (see response to AIR #5 in Kleinschmidt Associates, 1999).

previously agreed to by the applicant and resources agencies ($4,700 escalated to year 2001$, or $4,970).

American Eel – American eel currently occur upstream of, and downstream from, the Woronoco Project (Interior, 2001). The project's two dams, however, do not provide formal upstream fish passage for eel seeking to move upstream. In response to concerns raised by the resource agencies and TU, the applicant proposes to install an upstream eel ladder at the south dam, adjacent to the existing downstream fish passage facility, and provide upstream passage routes at two additional locations in the north and south channels. [41] The applicant proposes to locate and construct the eel ladder and passage routes in consultation with the resource agencies, and would investigate alternatives should the proposed design prove ineffective at passing eels. The passage system would be operated from May 1 through September 1.

Interior comments that on-site observations confirm that eels are trapped below the project dam with no discernable upstream passage route. Interior also states that three eel ladders are needed at the project, given that there are three discrete flow channels. Interior also commented that the license should be conditioned to require the development of a plan for installation of eel ladders at the project. Interior recommends that the eel ladders be designed in consultation with the USFWS and the MDFW, and once complete, the facilities be assessed to assure that they efficiently pass eels. Despite Interior's comments regarding the need for eel ladders, Interior does not make these recommendations pursuant to Section 10(j) of the FPA.

Trout Unlimited states that upstream passage for American eels is required at each of the three bypass channels. Trout Unlimited contends that eel movement over bedrock, temporarily or irregularly wetted, does not, in and of itself, constitute satisfactory passage facilities. Trout Unlimited recommends that the three eel ladders should be designed to

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[41]Passage at the downstream fish passage facility would be provided by use of a pre-fabricated aluminum ladder, while passage over the north and south dams would be accomplished by using the natural rock ledges. The eel ladder would consist of a 30-cm wide aluminum trough installed at a 12 percent slope. The floor would be lined with synthetic bristles, and a small pump will be used to provide about 25 gallons per minute transport flow (or about 0.06 cfs). Submerged piping would be installed along the upstream face of the north and south dam sections, and around the rock outcrop that separates the two dam sections. This piping would supply riser sections that would discharge onto the existing rock ledges to provide a wetted surface for passage. Alternately, water may be supplied by the minimum flow release mechanisms.

operate at all flows, and during the period of upstream eel movement, the facilities should be operated 24 hours a day. Finally, TU recommends that the license include a provision that allows for changes to the operational parameters of the eel ladders as new information becomes available.

Our Analysis

Research on American eel has been conducted for decades. However, there are little data available on the exact habitat requirements, behavior, and migratory patterns of this species. In the past 10 years there has been an increased focus on American eel for two main reasons: (1) significant declines in elver recruitment to the St. Lawrence and other rivers along the eastern United States (Castonguay *et al.*, 1994a, 1994b; Lary *et al.*, 1998; Haro *et al.*, 2000); and (2) large increases in demand for all eel stages (except for the leptocephalus stage) as grow-out stock for aquaculture, food, or bait (CAEMM, 1996).

The factors most often cited for the decline in populations include anthropogenic effects such as: (1) loss of available habitat from the construction of dams; (2) entrainment or impingement at hydroelectric facilities; (3) water quality or toxicity issues; (4) fishing pressure; and (5) commercial harvesting of sargassum, which affects the larval life stage. In addition to the aforementioned anthropogenic effects, oceanographic influences, such as changes in the Gulf Stream current patterns or other climate changes, have been cited as reasons for the decline in American eel populations.

As previously noted, no substantial commercial fishery exists for eel in the Connecticut River system. Moreover, there is no evidence in the record to suggest that a fishery for eel existed historically in the Connecticut River basin. Thus, the data set available for eel collections or harvest on the Connecticut and Westfield Rivers is scant, at best, and insufficient to determine whether there have been significant declines in American eel numbers similar to those found by other researchers. There is, however, some evidence of upstream migration delay caused by hydroelectric dams.

The success rate of upstream migration over or past dams without eel ladders is unknown. Dam height, roughness of the spillway material, angle of the spillway surface, flashboard height, flow levels and potential pathways around a dam are all confounding factors in determining success rates for migrating elvers and yellow eels.

Results from a 1997 baseline fisheries study on the Presumpscot River in Maine indicated that catch per unit effort (CPUE) for the most upstream impoundment sampled was much lower than the CPUE for the next downstream impoundment (5.5 eels per hour

versus 15.3 eels per hour; Kleinschmidt, 1998, 2000b). Similarly, on-site observations made in 1998 at the Woronoco Project suggest that the project dam may hinder eel movement in the river system. During the 1998 flow study, elvers were observed in bedrock pools near the downstream fish passage plunge pool, which is located above the river channel base level. This suggests that eels can climb the rock ledges, at least to the base of the dam. However, there were no observations of eels scaling the face of the dam or otherwise migrating past the project. Notwithstanding these observations, we know that American eels are known to exist throughout the Westfield River. Their relative distribution, however, is unknown.

With upstream eel passage facilities in place, upstream passage efficiency improves. In a study of a pipe style upstream eel passage device by Mitchell (1985, as cited in Clay, 1995), 150 eels per hour were found to pass through the pipe and over the dam. Two other studies examining upstream passage efficiency variously describe upstream migration success as 57 percent (Dumont *et al.*, 2000) and 85 to 90 percent (Verdon, 1998). These studies suggest that success rates for eels using upstream passage facilities can be higher when compared to unaided eels. These studies also suggest that (a) overlapping size class ranges between year classes and sexes, (b) multiple year migrations, and (c) extended residency times can complicate our understanding of, and the process of estimating, passage efficiency.

Based on the aforementioned information, we conclude that, although some eels are successfully migrating upstream past the Woronoco Project, the lack of efficient eel passage routes at the north and south dams is likely hindering the upstream movement of eels. At the same time, fishery management agencies are making significant commitments to protecting and restoring the species. Providing upstream passage at Woronoco would enhance access to several miles of the mainstem Westfield River, as well as enhance access to tributary habitat. In addition, while some out-migrating eels would be lost to turbine entrainment, we conclude that providing upstream passage for American eel at Woronoco would provide a net benefit to the species, due to the enhanced access to upstream habitats. [42]

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[42]Haro *et al.* (2000) states that in the case of hydroelectric dams, the benefit of upstream eel passage must be weighed against the cost of turbine mortality when eels later migrate downstream. Haro *et al.* (2000) further states that the increase in production by simply moving eels into underutilized habitats upstream of barriers may outweigh decreases in reproductive contribution caused by turbine mortality.

Upstream passage for American eel is relatively easy to accomplish because of the eel's ability to scale significant inclines using small quantities of water. Generally, a shallow, gently-inclined (12° slope) trough with some type of roughened surface (*e.g.*, small branches, wood shavings, aquatic vegetation) provides an adequate passageway (Clay, 1995). In recent years, eel ladders have been improved by including nylon bristles, brushes, and plastic tubing in the facilities design. A flume, 12 inches wide by 10 inches deep, is capable of passing a run of 500,000 elvers annually.

Clay (1995) states that all modern fish ladders for eels take advantage of the eel's natural climbing ability. Also, Clay (1995) states that the entrance conditions for an eel ladder are similar to those for salmon or trout. Generally, the entrance should be placed near the migration point farthest upstream. Some turbulence should be created near the point of entry to attract the eels, which can consist of a separate attraction flow at the ladder's point of entry, sprayed over the entrance, or a combination of both.

Woronoco Hydro's proposed design for an upstream eel ladder, located adjacent to the downstream fish passage facility, is consistent with designs that have proven effective. The eel ladder would include a 30-cm (12-inch) prefabricated aluminum ladder, installed at a 12° slope. The floor of the ladder would be lined with synthetic bristles. The entrance of the eel ladder would be located in an area where significant numbers of elvers have been observed congregating.

With regard to eel passage in the north and south channels, we make the following observations. First, providing continuous minimum flows to these two channels would likely promote eel movement into the two channels. Thus, providing passage opportunities over the north and south dams, via the two channels, is warranted. Second, eels do not require elaborate upstream passage facilities to facilitate passage, as they are known to crawl up/over damp surfaces. To this end, the summary of the March 25, 1999, meeting among the applicant, resource agencies, and other interested parties, notes that elvers, under appropriate conditions, could use the vegetated rock ledges separating the north and south dams as a natural ramp (see figure 2). Thus, upstream passage could be accomplished by wetting the vegetated rock ledges and/or making other changes to this ledge area to facilitate passage. Third, American eels are adept at working their way upstream around low-head barriers and across headwater divides. Thus, when you consider the presence of the rock ledges, the potential benefits of installing two additional eel ladders in the north and south channels are unclear. Finally, no studies, other than the observations made during the 1998 instream flow study, have been conducted addressing upstream eel movements in the project area. Therefore, the existing information in the record does not support the two additional eel ladders.

Based on the above discussion, we conclude that Woronoco Hydro's proposed eel ladder design for the downstream fish passage channel, as well as its additional proposed measures to facilitate upstream passage at the north and south dams, would effectively pass elvers at the project. However, we do agree that monitoring use of eel ladder and the vegetated rock ledges, once these measures have been installed and/or implemented is warranted. Therefore, we recommend that such a monitoring provision be included as part of the project's comprehensive fish passage plan.

Downstream Fish Protection & Passage

Anadromous Fish – In 1998, IP installed an interim downstream fish passage facility at the Woronoco Project. The applicant proposes no changes to this facility, nor does the applicant propose specific dates for operating the facilities. [43] Because the facility has never been studied, the applicant proposes to evaluate the effectiveness of the existing downstream fish passage facility during the first downstream passage season, for Atlantic salmon, following issuance of a new license for the project. The study would include: (1) an evaluation of the attraction efficiency; (2) time of travel; (3) safety of salmon smolts and adult salmon; and (4) zone-of-passage in the downstream channel. The plan would be developed in consultation with the resource agencies.

Interior recommends that the downstream fish passage facility be operated from April 1 through June 15 and November 1 through December 31. Interior also recommends that the applicant prepare and file, for Commission approval, a plan and schedule for evaluating the efficiency of the existing downstream fish passage facility for safely passing salmon smolts and adult salmon. The plan would also address adult American eel. The monitoring plan would assess the effectiveness of the bypass facility and conveyance channel to the bypassed reach, as well as the injury and mortality associated with use of the facility.

Trout Unlimited recommends that downstream fish passage be required year-round, not only for Atlantic salmon, but also for American eel and resident fish (trout , smallmouth bass, and white sucker). Trout Unlimited also recommends that: (1)

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[43]At a March 25, 1999, meeting, the parties agreed that the downstream fish passage facility would be annually operating from April 1 through June 15 for smolt and adult out-migration, and November 1 through December 31 for post-spawn adult out-migration. See March 25, 1999, meeting minutes in Appendix A of License Application.

channels be cut or the water channelized at critical passage areas to ensure an adequate water depth throughout the channel for fish passage; and (2) the depth of the exit plunge pool be increased from about 3 feet to 5 feet (or two adult salmon body lengths) and rock outcroppings in the plunge pool be removed to reduce the likelihood of impact and to increase the volume of the plunge pool. Finally, TU recommends that the effectiveness of the downstream fish passage facility be evaluated. [44]

Our Analysis

Safe downstream passage is critical to the success of the Atlantic salmon restoration effort in the Connecticut River basin, and more specifically on the Westfield River. The MDFW has been actively involved with juvenile Atlantic salmon stocking in the Westfield River since 1988. The Westfield River provides about 9 percent of the juvenile rearing habitat found in the Connecticut River basin. Currently, over 750,000 fry are stocked annually in the Westfield River basin, with over 90 percent stocked upstream of the Woronoco Project. Moreover, adult pre-spawned salmon are targeted for release into spawning habitat upstream of the project when return numbers are sufficient to meet hatchery needs for sea-run broodstock. Therefore, out-migrating salmon smolts and post-spawned adult salmon need a safe downstream passage route past the project to prevent turbine injury, mortality, or migration delay at the project.

Based on our experience assessing downstream fish passage effects at similar hydropower projects, downstream passage measures at the Woronoco Project would improve passage conditions for fish migrating downstream past the project. Downstream fish passage facilities can significantly reduce turbine-related mortality for downstream migrants and other fish species (Francfort *et al.*, 1994). Given the management priority for the Westfield River, we consider downstream passage for resident fish an ancillary benefit of operating downstream fish passage facilities at the Woronoco Project.

The existing, interim downstream fish passage facility was installed at the project, based on consultation with the MDFW and the USFWS. The existing system includes a trashrack with clear bar spacing of 1¼ inches, attraction flow of about 2 percent of the project's hydraulic capacity, intake velocities that do not exceed 2 fps, and an angled

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[44]The evaluation would address downstream passage for salmon, eel, white sucker, and other resident fish, and would include an evaluation of the effectiveness of mechanical protection and the reduction or cessation of turbine flows. Also, the downstream passage evaluation would account for the timing of repairs to the non-functional turbines.

approach relative to the trashrack. This design is consistent with the USFWS's design criteria for downstream fish passage. Moreover, the design of the existing facility has been shown to be an effective means of passing downstream migrating fish at similar projects. Thus, we foresee no reasons why the continued use of the existing facility would not provide adequate downstream fish passage. Therefore, we recommend that a provision be included in the comprehensive fish passage plan for the project that provides for the continued use of the interim facility on a permanent basis. The final design would be subject to the outcome of monitoring, as discussed below.

The downstream fish passage facility was originally designed to pass Atlantic salmon, and was confirmed to be passing salmon downstream in 1998. To date, qualitative field observations indicate that salmon smolts do use the downstream fish passage facility. Moreover, in 1998, a member of TU tracked the movements of nine adult salmon through the project area using radio-telemetry. All nine of these fish successfully navigated the fishway, as all were subsequently located moving downstream well downstream from the project. The condition of these fish could not be verified, though they exhibited normal migratory behavior before and after encountering the downstream fish passage facility at the Woronoco Project.

Despite the observations made to date, the efficiency of the facility, particularly for salmon smolts, remains unclear, because it has not been the subject of any formal effectiveness monitoring. Therefore, we conclude that an effectiveness study of the existing downstream fish passage facility at the Woronoco Project is warranted. At a minimum, the study should be designed to address attraction efficiency, travel time, safety of fish using the fish passage facility, and zone-of-passage characteristics in the downstream channel. We recommend that this study, as well as a provision for making changes, as necessary, in the design and/or operation of the facility to facilitate safe downstream passage of Atlantic salmon, be included as part of the overall comprehensive fish passage plan for the project.

With regard to operational timing of the downstream fish passage facility, we note that the applicant currently operates the facility during the spring out-migration season (April 1 through June 15). Under the new license, the applicant has agreed to operate the facility during the spring migration season, as well as during late fall and early winter (November 1 through December 31). The operational periods of April 1 through June 15 and November 1 through December 31 are consistent with those recommended in the Anadromous Fish Management Plan for the Westfield River (MDFW, 2000). Also, the proposed schedule is consistent with known migration periods for Atlantic salmon in the Westfield and Connecticut River systems (Interior, 2001).

We agree that the downstream fish passage facility at the Woronoco Project should be operated, at a minimum, according to the spring and fall migration schedule outlined by Interior and in the Anadromous Fish Management Plan for the Westfield River (MDFW, 2000). We recommend that this operational schedule be included as a provision in the comprehensive fish passage plan for the project.

Trout Unlimited recommends that the downstream fish passage facility be operated year-round for resident species. However, TU provides no basis for its recommendation. For the reasons outlined below, we consider resident fish passage an ancillary benefit to providing downstream passage for salmon smolts and adult salmon. First, the management priority for the Westfield River is salmon restoration, with management of a resident fishery being a secondary priority. Second, we would agree that operating the downstream fish passage facility during the summer and fall (June 16 through October 31) would likely provide some benefit where it concerns resident fish movement through the project area. However, the degree to which this passage would benefit the resident fishery and other aquatic organisms is unclear. Finally, operating the facility in the winter (January 1 through March 31) is not expected to provide any significant benefit, as fish and other aquatic organisms move little and are mostly dormant during this period.

Based on our review, we conclude that year-round operation of the downstream fish passage facility for resident fish is not warranted. Therefore, we do not recommend year-round operation be a requirement in any new license issued for the project. However, Woronoco Hydro is free to enter into an agreement to operate the downstream fish passage facility year-round, separate from its FERC license. We encourage the applicant and other parties to consider this in the comprehensive fish passage plan for the project. [45]

Trout Unlimited provided a variety of comments concerning the design and functionality of the exit plunge pool and channel for the existing downstream passage

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[45]Trout Unlimited points out in its comments that providing a continuous minimum flow in the bypassed reach would facilitate operation of the downstream fish passage facility on a year-round basis. We concur. A portion of the bypass flow could be used to operate the downstream fish passage facility. Thus, no additional flows would be necessary and no additional loss of generation would occur. However, the applicant would incur some additional expense by operating the downstream fish passage facility year-round. Annual operation and maintenance expenses would increase. [NOTE: year-round operation for in-river resident salmon is recommended in the Anadromous Fish Management Plan for The Westfield River]

facility. With regard to zone-of-passage, TU states that the exit plunge pool and other smaller pools in the bypass channel have no clear and distinct flow exiting the pools with the 20 cfs fish passage flow. Rather, there exists a wide and dissipated flow that is, in places, very thin. Trout Unlimited contends that inadequate zone-of-passage can lead to descaling and migration delays. With regard to the exit plunge pool, TU states that the depth is too shallow for adult salmon, [46] as well as too turbulent and poorly configured for smaller fish. [47] Trout Unlimited contends that head or tail first entry of adult salmon into the exit plunge pool is likely to cause injury and/or mortality. Also, the limited area and shallow depth of the exit plunge pool contribute to extensive turbulence that can effect all species and sizes of fish, making them more vulnerable to injury, predation, and/or migration delays.

Based on our review of the design and configuration of the existing downstream fish passage facility, the cross-sectional transect data of the bypass and conveyance channel, and the USFWS's fish passage design criteria, we concur with TU's concerns. Changes to the facility's exit plunge pool and downstream conveyance channel could significantly improve the effectiveness of the downstream fish passage facility at the project and enhance survival of out-migrating salmon, as well as resident species that use the facility. We recommend that these design considerations be addressed as part of the comprehensive fish passage plan for the project.

American Eel – Woronoco Hydro proposes to monitor the use of the existing interim downstream fish passage facility for passage of Atlantic salmon. Woronoco Hydro, however, proposes no specific measures to address downstream passage of American eel.

Interior, in its letter dated February 8, 2001, does not comment on downstream eel passage. Interior, however, does recommend that the applicant's evaluation of the

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[46]The depth of the exit plunge pool, at its center, is between 2.5 and 3.5 feet (or about one body length of an adult salmon), with a rock structure in the pool close to the immediate plunge flow entry point.

[47]Trout Unlimited states that a significant boil can be observed in the exit plunge pool with the current configuration, indicating that the plunging flow is striking the bottom of the pool then up-welling to form the boil. Plunge flows that strike the bottom of the pool before their energy is dissipated have the potential to carry fish of all sizes to the bottom, increasing the risk of injury and mortality. Moreover, the rock outcroppings that intrude into the pool reduce pool volume and increase the likelihood of strike injuries.

existing interim downstream fish passage facility include American eel, as well as Atlantic salmon. As noted in the previous section, TU contends that downstream passage should be required for American eels, and that the evaluation of the existing downstream passage facility should include American eels, in addition to salmon and resident fish. TU recommends that the evaluation address both mechanical protection devices, as well as the reduction or cessation of turbine flows.

Our Analysis

Downstream passage for American eels is more difficult to design and more costly to implement than upstream passage, mainly due to our limited knowledge of eel behavior during emigration. Currently, there are few, if any, practical designs for downstream eel passage and protection (EPRI, 1998).

Mortality associated with downstream passage through a hydro turbine can be significant, and may be much higher than estimated for salmon smolts. Like many other species, turbine mortality generally increases as the total length of eels increases. This represents a potential significant adverse effect on eels because of their size when they begin to migrate downstream past hydroelectric facilities. Mortality studies on European eel show injury rates from turbine passage as high as 15 to 50 percent. In the case of large eels (greater than 27 inches), mortality ranges from 40 to 100 percent (McGrath, 2000; ASMFC, 2000; Haro *et al.*, 2000; Berg, 1986 as cited in Haro *et al.*, 2000; Monten, 1985 as cited in Haro *et al.*, 2000). At other hydropower sites in North America, American eel turbine mortality estimates range from 6 to 37 percent (table 5).

Table 5. Summary of turbine mortality studies at various North American hydropower projects (Source: the Staff)

	Minetto dam [1]	Luray dam [2]	Beauharnois dam [3]	Beauharnois dam [3]	Raymondville dam [4]
Location	New York	Virgina	Quebec	Quebec	New York
River name	Oswego	Shenandoah	St. Lawrence	St. Lawrence	Raquette
Turbine type	Francis	Francis	Francis	Propeller	Propeller
Hydraulic head	17.5	16	79	79	21.5
≈ 48-hour eel mortality (%)	6	9	16	24	37

[1] Niagara Mohawk Power Corporation, 1995a.
[2] Allegheny Power Service Corporation, 1995.
[3] Richard Verdon, Hydro Quebec, personal communication as cited in FERC, 2001.
[4] Niagara Mohawk Power Corporation, 1995b.

The Woronoco Project has Francis turbines and a hydraulic head of 50 feet. Based on these design features, turbine mortality at the Woronoco Project may be similar to mortality estimates from the projects with the same or similar configuration (*i.e.*, Minetto, Luray, and Beauharnois), which range from 6 to 16 percent, with an apparent increase in mortality with increased head. However, mortality rates would also depend on turbine size, with smaller turbines increasing the potential for blade strikes on the adult eels. The units at Woronoco are smaller than at some of the projects listed in table 5. Thus, based on this information and on the results of European testing, the mortality rate for eels and Woronoco could also be higher than 6 to 16 percent.

Studies from other hydroelectric projects suggest that delayed mortality rates may be high for American eel. At the Luray/Newport Project, FERC No. 2425, on the Shenandoah River, Virginia, researchers reported a 1 percent immediate mortality rate for eels passing through Francis turbines. However, delayed mortality (44 hours) was 8 percent (Allegheny Power Service Corporation, 1995). At the Beauharnois Project on the St. Lawrence River, researchers reported that a substantial number of the eels passing through the Francis turbines received internal injuries and the 48-hour mortality rates was 16 percent, with most of the mortality occurring several hours after passage (Richard Verdon, Hydro Quebec, personal communication as cited in FERC 2001).

The long-term effects of turbine mortality on out-migrating eels from the Woronoco Project are unknown. Some researchers have suggested that the American eel population is declining, although the cause for the decline is unknown (Castonguay *et al.*, 1994a). Castonguay *et al.* (1994b) investigated oceanographic changes, commercial overfishing, chemical contamination, and habitat modifications (*e.g.*, hydro development) as potential causes of the eel decline. Their analysis, however, was inconclusive. Nonetheless, Castonguay *et al.* (1994a) reported that increased eel passage survival at hydropower projects would aid in the recovery of the American eel population.

We conclude that providing measures to facilitate downstream migration of eels at the Woronoco Project could improve the survival rate of adults during their spawning migration. Depending on density-dependent effects and compensatory mechanisms experienced by eels during their time in the ocean, increased survival at Woronoco could also increase the number of Westfield River eels contributing to the American eel spawning populations, and aid in the recovery of the American eel population.

Conflicting data exist on the description of the migratory patterns of silver eels. Current data suggests that the downstream migratory period may encompass two or more months, from the end of August to the end of October (CAEMM, 1996). However, one study on the St. Lawrence River reported that 80 to 85 percent of all migrants were caught during 10 to 15 days in mid-October, even though the migration period occurred from mid-September to early-November. The time and duration of night-time migrations are also not well understood. Studies on the depth of migration have found a general trend for eels to migrate along the bottom at night during the first quarter of a new moon after a rain storm. [48] These results, however, are not consistent either, as some research has shown that eels will change their position in the water column to avoid obstructions while migrating (Haro and Castro-Santos, 1997). Finally, eels may migrate via a variety of avenues past a hydroelectric project (*i.e.*, through the powerhouse, through gates and sluices, over spillways).

With regard to physical protection devices, we offer the following observations. American eels are considered weak swimmers. Consequently, eels may have difficulty avoiding trashracks or screens with sharp angles to the water flow and/or high approach velocities. The response of eels to conventional behavioral barriers (*e.g.*, lights, bubble curtains, louvers) has been variable. All the factors cited above have contributed to the lack of effective downstream passage designs for American eels.

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[48]Initial research has shown a negative association between migrating eels and light.

Given the current state of knowledge on the issue of downstream eel passage, and the fact that little, if anything, is known about out-migrating eel behavior at the Woronoco Project, we conclude that it is premature to require the installation of downstream passage measures for eels at the project. We do, however, agree with Interior and TU that the existing interim downstream fish passage facility should be monitored for use by out-migrating silver eels, and its effectiveness for passing eels determined. Such a measure would provide valuable guidance to Woronoco Hydro and the resource agencies regarding the adequacy of existing fish management measures and facilities, and would help direct decisions regarding the need for any future passage measures to protect and enhance American eel populations in the Westfield River.

Based on the above assessment, we recommend that the comprehensive fish passage plan for the Woronoco Project should include provisions for monitoring eel out-migration movement at the project and determining the effectiveness of the existing downstream fish passage facility for safely passing eels at the project. We also recommend that the fish passage plan address alternative downstream passage measures for eels, and include a provision for making changes to project structures and/or operations should such changes be deemed necessary to adequately protect out-migrating eels at the project. [49]

c. Cumulative Effects:

Numerous dams on the Westfield River affect upstream and downstream migration/passage for Atlantic salmon and American eel. The Woronoco dam(s) is the second obstruction on the Westfield River.

Effects on migration occur at both hydroelectric and non-hydroelectric dams. Atlantic salmon smolts and some post-spawn adults must negotiate three hydroelectric dams and one non-hydroelectric dam on the mainstem of the Westfield River. As discussed throughout the fishery section, there are multiple effects associated with these dams, including, but not limited to (a) delays in migration and (b) turbine-induced injury and mortality. These multiple effects may affect survival of out-migrating salmon and eel.

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[49]Properly timed shutdowns, as identified by TU, would likely benefit downstream eel migrations in the Westfield River. This measure has been used successfully at other hydropower projects in the Northeast and mid-Atlantic states. We recommend that the fish passage plan developed for the project consider this measure as a viable alternative for passing American eel at the project.

The primary management goal for the Westfield River is restoration of Atlantic salmon. The Westfield River is an important component of salmon, as well as American eel, restoration in the Connecticut River basin. This is due, in part, to the fact that the location of the confluence of the Westfield and Connecticut Rivers is below the first mainstem dam on the Connecticut River. Consequently, fish moving or migrating in and out of the Westfield River have unimpeded access between the Westfield River and the Atlantic Ocean.

In 1996, fish passage facilities were constructed at the lower-most dam on the Westfield River. This began the process of defragmenting the Westfield River, and reconnecting the river basin with the Connecticut River. At the Woronoco Project, our recommended measures for bypass minimum flows and fish passage would represent a significant benefit to not only the local, site-specific reaches of the Westfield River, but to the greater Connecticut River basin as well.

Our recommended bypass minimum flows would provide a continuous minimum flow to a reach of river that currently receives only leakage and flow during spill events. This would enhance the aquatic habitat in the bypassed reach, and well as improve conditions necessary to sustain aquatic organisms, including fish and macroinvertebrates. Providing a continuous minimum flow would reduce, if not eliminate, complete de-watering of riverine habitat in the reach. Finally, providing a minimum flow to the bypassed reach would likely enhance access in, and passage through, the reach, particularly for American eel elvers.

We recommend that Woronoco Hydro support, financially or otherwise, the MDFW's trap-and-truck program on the Westfield River. This would help create a cooperative framework and foster cooperative efforts towards implementing an anadromous fish restoration program on the Westfield River, enhancing the prospects of a successful restoration effort.

As part of any new license, Woronoco Hydro would be required to evaluate the effectiveness of the existing downstream fish passage facility for passing salmon smolts and post-spawned adult salmon. Monitoring the facility would provide a means to determine its efficiency and help ensure its effectiveness throughout the term of any new license. While other potential sources of mortality would remain in the basin, relicensing the Woronoco Project, with the proposed and recommended enhancement measures, would improve downstream migratory conditions for salmon at the project and in the Westfield River. Survival of out-migrating salmon smolts and post-spawned adults would be improved. This would have a positive effect on the salmon run in the Westfield River, and the Connecticut River as a whole.

A new eel ladder and other upstream passage improvements for eels would be provided at the project. The incremental benefits of multiple eel ladders are uncertain at this time. Continued operation of the Woronoco Project, with upstream eel passage measures, would have an overall beneficial cumulative effect on the American eel within the Westfield and Connecticut Rivers. Although other obstacles to eel migration and potential sources of mortality (see table 1) would remain on the Westfield River, relicensing of the Woronoco Project, with our recommended enhancement measures would, improve upstream migratory conditions for the eel. Upstream migratory delays associated with passage at the project would be reduced. Finally, the upstream passage measures would promote better distribution of eels within the river by enhancing access to habitat above the Woronoco Project.

Downstream passage measures for American eels are not warranted at this time. Thus, the project would continue to affect downstream passage of eels in the Westfield River in the short-term. In the long-term, however, evaluating the existing downstream fish passage facility, as well as other possible downstream measures, would provide certain future benefits to downstream eel passage at the project (*e.g.*, new passage technologies and/or other operational considerations could be implemented to protect out-migrating eels at the project). Our recommendation to study downstream eel movement at the project, as well as evaluate appropriate downstream protection and passage measures, would enhance the prospects of protecting out-migrating silver eels and some resident yellow eels.

Our recommendations for upstream eel passage and bypass minimum flows would likely increase survival of American eels in the Westfield River. Whether this would result in more ocean spawning and increases in elver recruitment is impossible to predict. Our recommendations, however, are consistent with the Interstate Fishery Management Plan for American Eel (ASMFC, 2000) by protecting existing stocks, increasing habitat accessibility, and helping to maintain balanced populations of anadromous, catadromous, and riverine fish species, consistent with the habitat potential of the Westfield River.

The aforementioned enhancements, and their associated benefits, would enhance the agencies' anadromous and catadromous fish restoration goals for the Westfield River, and more generally the Connecticut River basin. The recommended enhancements would have moderate to significant long-term cumulative benefits on fish passage in the Westfield River.

There is no evidence indicating that disruption of long-distance movements of resident riverine fishes has adversely affected their populations in the Westfield River.

Populations of important resident game fishes presently occur both upstream of, and downstream from, the Woronoco Project.

d. Unavoidable Adverse Effects: Continued operation of the project, with all the recommended enhancement measures would enhance fish populations in the Westfield River. Resident species would continue to be subjected to minor impoundment fluctuations associated with occasional deviations from run-of-river operations. We do not expect these fluctuations, however, to affect fish utilization of shallow, littoral-zone habitat.

Resident fish species would continue to be subjected to entrainment and low levels of turbine mortality. This, however, was not a major concern of the state and federal agencies. We find no evidence in the record to indicate that the fishery is, or would be, significantly affected by the levels of entrainment and turbine mortality that occur today, or would likely occur in the future. Continuing to operate the existing downstream fish passage facility, as well as evaluating its effectiveness, would help ensure that these effects on the resident fishery are minimized.

Atlantic salmon smolts and post-spawned adults would continue to experience some level of downstream migration delay and potential mortality associated with the operation of the projects and the downstream fish passage facilities (few, if any, downstream fish passage facilities have been shown to be 100 percent effective). Similar potential effects would likely occur with the American eel. Compared to existing conditions, though, with no provisions for eel passage, the passage measures recommended by the parties and staff should enhance American eel passage.

3. Terrestrial Resources

a. Affected Environment:

Upland Forest

Over 80 percent of the Westfield River basin is forested, with the remaining portions consisting of developed land, agricultural lands, wetlands, and transitional lands (*e.g.*, abandoned croplands). The forests in the vicinity of the project are composed of mixed hardwoods and softwoods. Typical hardwoods include red oak, red maple, sugar maple, and sycamore. Balsam fir, white pine, white birch, and quaking aspen typify the softwoods.

Wetlands

Three palustrine wetland types, totaling about 31.5 acres, have been identified in the project area, including emergent, scrub-shrub, and forest. There are three separate emergent wetlands, totaling approximately 4 acres, located upstream of the project's two dams, along the shoreline of the project impoundment. These wetlands are characterized by cattail, sedges, rushes, sweet flag, pickerel weed, purple loosestrife, sensitive fern, cinnamon fern, and Joe-pye weed. Each site does not contain all these species. The two scrub-shrub wetlands, totaling 8.5 acres, are characterized by black willow, speckled alder, cinnamon fern, sensitive fern, and pale touch-me-not. The two forested wetlands total about 18.5 acres. These areas are typified by sycamore, green ash, and eastern cottonwood in the overstory, with a ground cover of poison ivy, sensitive fern, cinnamon fern, and pale touch-me-not.

The wetlands in the project area consist mainly of one large site that includes 18 acres of forest, 8.5 acres of scrub-shrub, and 3 acres of emergent wetlands. The remaining wetland sites are all about 0.5 acre in size. The majority of the area covered by the wetlands is located within a floodplain area between Strathmore Park and the Westfield River.

Wildlife

Wildlife resources in the project area are characteristic of rural areas in southern New England. Common mammal species include white-tailed deer, fisher, bobcat, weasel, striped skunk, red and gray squirrel, cottontail rabbit, raccoon, mink, otter, beaver, and muskrat. Most of these species inhabit both uplands and wetlands in the project area. In addition to these mammal species, the project impoundment provides nesting habitat for mallards, black ducks, and Canada geese, and migration habitat for teal and common mergansers. Occasional wild turkey, goshawks, red-tailed hawks, and red-shouldered hawks have been observed in the area.

b. Environmental Effects and Recommendations:

Woronoco Hydro proposes to continue operating the project in a run-of-river mode, and keep the impoundment at its current stable level. This operational mode would help maintain the existing wetlands along the perimeter of the project impoundment, and would have no effect on upland vegetation. Therefore, no effects on vegetation and wildlife species inhabiting the impoundment area are anticipated.

Our Analysis

Under proposed project operation, generation would occur between the range of 157 cfs and 767 cfs with three units operating. Flows less than 157 cfs and more than 767 cfs would be spilled at the project's two dams. Natural flow in the river is such that water would be spilled at the two dams about 50 percent of the time. Therefore, operating the project, as proposed, in a run-of-river mode, with a 57-cfs minimum flow release to the bypassed reach, would help to maintain the existing stream bank vegetation downstream of the project.

Section V.C.2. includes a discussion of impoundment drawdowns. Historic drawdowns have resulted in as much as an 8- to 10-foot lowering of the impoundment. The last known drawdown occurred on July 12 and 13, 1999, resulting in exposure of 33 to 50 percent of the impoundment's substrate. An 8- to 10-foot drawdown has a high potential to adversely affect aquatic resources and wetland plants, particularly herbaceous species. The 1999 event de-watered about 4 acres of emergent wetlands.

De-watering of wetlands, particularly those with herbaceous ground cover, could have a harmful effect. When evaluating such effects, a number of variables should be considered. Among others, these variables include: (1) the duration of the de-watered period; (2) season of occurrence; (3) shading by other plants or structures; and (4) moisture retention time of the growing substrate.

Consider, for example, the approximately 4 acres of emergent wetlands de-watered on July 12 and 13, 1999. This particular drawdown event would likely not have resulted in a measurable harmful effect. This is because (1) the duration of the drawdown was only 2 days, and (2) the substrates affected consist of finer material (*e.g.*, mud, silt), which holds moisture for longer periods of time than courser material (*e.g.*, sand, gravel). In comparison, if the drawdown had lasted for a week or more, during this same time of year (*i.e.*, mid-summer), we would expect to see some measurable harmful effect on the emergent wetlands along the impoundment.

Because of the aforementioned potential effect on wetlands, the impoundment drawdown management plan discussed in section V.C.2. (Fishery Resources) should evaluate and consider measures to protect wetlands under future project operation. As previously stated in section V.C.2., the plan should address measures to minimize the frequency, duration, and magnitude of drawdowns for the purpose of reducing or preventing harmful effects on wetlands.

c. Unavoidable Adverse Effects: Impoundment drawdowns, such as that required for project maintenance, would likely continue to occur periodically. If drawdowns occur during the end of the growing season (*e.g.*, October), but before freezing conditions, and

are of short duration (*e.g.*, for 2 or 3 days), no appreciable harmful effects would be expected. However, should impoundment drawdowns occur during the growing season (*e.g.*, May through September), and for a longer period (*e.g.*, a week of more), we would expect wetlands to experience some adverse effects.

4. Archeological and Historic Resources

a. Affected Environment:

The village of Woronoco was established during the rise of the paper industry when the Woronoco dams and mills were built. The first dam at the site of the existing project was a timber-crib structure constructed in 1879. The existing hydro station was completed in 1913 to supply power to two paper mills, one on either side of the river. The two existing dams were constructed in 1938 and 1950 to replace former structures that needed extensive repair. The project powerhouse and the Strathmore Mill complex is eligible for inclusion in the National Register of Historic Places.

The mill is an extensive complex of brick buildings ranging in height from one to four stories, with numerous parking bays, loading docks, and outbuildings. Also, the mill is liberally fenestrated, with arches over some of the windows, and relieved in various places, with modest embellishments. Neighboring structures are mostly single family, wood-frame dwellings, some of which date from the general period of the mill's construction. Strathmore Paper Mill dates to 1857 when the Jessup and Laflin Company was organized. The principal mill buildings were constructed in 1873.

b. Environmental Effects and Recommendations:

Woronoco Hydro proposes no changes in either the project facilities or project operation that would adversely affect the National Register eligible powerhouse and Strathmore Mill complex. Moreover, the Massachusetts SHPO has, in letters dated May 2, 1997, and May 18, 1999, stated, "After review of the application, I concur that the project will have no effect on the significant architectural and historical characteristics of the National Register-eligible property." In view of the SHPO's recommendation, and because no land disturbing activities are proposed, we find that the project would have no effect on any structure, site, building, district, or object listed on, or eligible for listing on, the National Register.

Despite this however, there remains a possibility for affecting National Register and eligible properties. First, our no effect determination is based on Woronoco Hydro's proposal involving no ground disturbing activities or alterations to the National Register-

eligible property during the term of the license. Thus, before engaging in any ground disturbance, and before engaging in any activity that may result in an alteration of the National Register-eligible property, Woronoco Hydro should take the following actions: (1) consult with the SHPO; (2) based on consultations with the SHPO, prepare a plan describing the appropriate course of action and a schedule for carrying it out; (3) file the plan for Commission approval; and (4) do nothing to affect National Register or eligible properties until notified by the Commission that all these requirements have been satisfied.

Second, there is still the possibility that there could be significant undiscovered properties in the project area that could be adversely affected by project operation. If such properties are found during project operation, Woronoco Hydro should follow the aforementioned procedures

c. Unavoidable Adverse Effects: No unavoidable adverse effects have been identified as resulting from licensing the proposed project.

5. Recreation and Land Use

a. Affected Environment:

The Woronoco Project is situated in the town of Russel, a predominantly rural, forested area containing scattered residential and commercial development. Strathmore Park, a public day-use facility adjacent to the upstream portion of the project impoundment, is the only developed recreation area in the project vicinity.

Before 1998, when IP ceased operating its Strathmore Paper Mill, which is located adjacent to the Woronoco dam complex and powerhouse, the dominant land use in the project area was industrial. Because operation of this mill produced noise, odor, traffic, and industrial wastewater discharge, angling and other recreational uses of the Westfield River in vicinity of the project were rare. Further, the project's impoundment is long and narrow, fairly shallow, situated between Conrail train tracks to the east and U.S. Route 20 to the west, and has fairly steep banks. Also, the impoundment offers limited signed access for boaters and fishermen. Thus, the impoundment has attracted minimal numbers of recreationists.

In contrast, the free-flowing stretches of the Westfield River upstream of the Woronoco Project, particularly the river's East, West, and Middle Branches, provide coldwater habitat and white water opportunities. This attracts considerable numbers of trout anglers and canoeists to those areas.

b. Environmental Effects and Recommendations:

The applicant proposes to improve recreational access at the project by constructing and maintaining the following new facilities: [50]

(1) a parking area for up to 15 vehicles, as well as a put-in/take out for canoes and small, non-motorized boats using the project impoundment and upstream river reaches, which would be located at the southwest portion of the impoundment near U.S. Route 20;

(2) a take-out area for canoes located directly upstream of the project's two dams and on the impoundment's southeast shoreline, which would include a footpath and signs directing paddlers to a downstream put-in; [51] and

(3) a parking area for 15 vehicles and a short trail from Bridge Street to a put-in area for canoeists, which would be located along the east shoreline of the Westfield River, a short distance downstream from the project powerhouse.

Our Analysis

Staff finds that construction of the aforementioned facilities would improve access to the project impoundment for warmwater anglers, as well as recreationists with small boats and canoes. Also, canoe portage around the existing dams would be improved, thereby benefitting canoeists who want to use the Westfield River downstream of the project. However, the applicant has not provided sufficiently detailed drawings to enable staff to determine if the proposed facilities would satisfy the needs of area recreationists. Further, the applicant has not proposed measures to control on-site erosion and any resulting sedimentation that could occur during construction of the proposed facilities. In absence of adequate erosion control measures, the planned construction could result in significant adverse effects to local water quality and fisheries.

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[50]Sites 1 and 3 would be ADA (American with Disabilities Act) compliant, to the extent feasible given the topography of the area.

[51]The portage right-of-way would have designated rest stops and racks.

Therefore, to ensure that the proposed recreational facilities incorporate designs and materials that enhance recreational use and area aesthetics, [52] and that construction activities do not result in significant erosion and sedimentation, we recommend that the applicant file, for Commission approval, a final recreation plan. This plan should include, at a minimum, the following elements: (1) site designs and construction schedule for the proposed facilities; (2) specifications of the materials to be used and any special features that would enhance area aesthetics; (3) site-specific measures to control erosion and sedimentation during and subsequent to construction of the recreational facilities; and (4) comments from concerned entities, including the town of Russel and Hampden County, on the applicant's final plan and schedule.

c. Unavoidable Adverse Effects: Construction of the proposed recreational facilities would produce some minor, short-term erosion and local sedimentation.

D. No-Action

The no-action alternative reflects the continuation of current project operation, with no change in the existing environment at the project. The project would continue to operate under the same terms and conditions of the previous license, and there would be continued energy production. Woronoco Hydro would not be required, nor obligated, to provide any additional environmental measures to enhance environmental, recreation, and cultural resource values.

The project would continue to operate in a run-of-river mode, which would have the same effect on the environment as it does in its current operating state. Rather large drawdowns, for maintenance and other purposes, could continue. These drawdowns subject significant portions of the littoral zone to de-watering, which adversely affects spawning and nursery habitats and results in stranding of aquatic organisms (*e.g.*, freshwater mussels).

Under this scenario, Woronoco Hydro would not be required to provide additional enhancement, in the form of a minimum flow release, to the bypassed reach, beyond the flow required to operate the existing downstream fish passage facility. This would leave two of the three bypass channels without flow, except for leakage and spill flow. Aquatic habitat would not be enhanced, but maintained in its current state.

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[52]Staff currently lacks sufficient information to conclude that the applicant's proposed recreational facilities would blend in with the area's existing features.

No additional fish passage measures would be required at the project. Woronoco Hydro would not be required to cooperate with the downstream hydro owner, the MDFW, and the USFWS towards implementing anadromous and catadromous fish restoration programs for the Westfield River. Downstream fish passage would continue to be provided via the existing interim downstream passage facility, with no understanding of its effectiveness for safely passing salmon smolts and post-spawned adult salmon. No upstream passage would be provided for American eel, thus continuing to hinder access to potential upstream habitat. Nor would any downstream protection and passage measures for out-migrating silver eels and resident yellow eels be provided.

Under this alternative, recreational improvements would not be required, and the existing recreation facilities would remain as they presently exist. Likewise, cultural resource protection measures would not be required. Further, aesthetic quality may be affected during impoundment drawdowns when exposed mud flats and other areas may visually detract from the shoreline appearance.

VI. DEVELOPMENTAL ANALYSIS

In this section, we analyze the project's use of the water resources of the Westfield River to generate hydropower, estimate the economic benefits of the Woronoco Project, and estimate the cost of various environmental protection and enhancement measures and the effects of these measures on project operations.

Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in Mead Corporation, Publishing Paper Division, [53] the Commission employs an analysis that uses current costs to compare the costs of the project and likely alternative power, with no forecasts concerning potential future inflation, escalation, or deflation beyond the license issuance date. The Commission's economic analysis provides a general estimate of the potential power benefits and costs of a project and reasonable alternatives to project power. The estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license.

A. Power and Economic Benefits of the Project

We estimate the economic benefits of the no-action alternative (existing operation), then compare these benefits to two action alternatives: (1) the applicant's

[53] 72 FERC ¶ 61,027 (July 13, 1995).

proposed project; and (2) the proposed project with additional staff-recommended measures. Table 6 shows the assumptions, values, and sources we used in our analysis.

Current and Proposed Energy Generation – In analyzing the project's use of the Westfield River to generate hydropower, we looked at the effects on future generation from rehabilitating the project facilities and from the proposed and recommended environmental enhancements.

The Woronoco Project historically generated about 7,700 MWh of energy annually. However, as the project currently operates (with only one functioning turbine), the project generates only about 6,130 MWh annually. Woronoco Hydro proposes to rehabilitate the two non-functioning turbines, which would allow the project to again generate at its historic level of 7,700 MWh annually.

Woronoco Hydro proposes to release a minimum flow of 57 cfs to the project's bypassed reach. This minimum flow would reduce the total annual generation by about 1,000 MWh. Thus, instead of generating 7,700 MWh annually, the proposed project would generate about 6,700 MWh annually.

Table 6. Staff assumptions for the economic analysis of the Woronoco Project (Source: the Staff).

Assumption	Value
Energy Value (2001) [a]	34.3 mills/kWh
Period of analysis	30 years
Interest rate [b]	8 percent
Cost of money [b]	8 percent
Federal tax rate	34 percent
Local tax rate [c]	$47,590
Insurance rate	0.25 percent of rehabilitation costs
Term of financing	20 years
Operations & maintenance (O&M) costs (2001) [c]	$42,300

[a] We base the value of project power on the Energy Information Administration's Annual Energy Outlook for 2002 (http://www.eia.doe.gove/oiaf/aeo/index.html), which estimates market prices for natural gas in the New England area.

[b] Discount rate of 8 percent reflects the average cost of debt financing.

[c] Woronoco Hydro provided average costs for state taxes and O & M in 1999$, which we escalated to year 2001$ using the Consumer Price Indices from the Bureau of Labor Statistics, U.S. Department of Labor website (http://www.bls.gov/cpi).

B. Cost of Environmental Enhancement and Protection Measures

Power and Economic Benefits of the No-Action Alternative – Our analysis of the no-action alternative shows that the total annual costs for the project would be $130,870 (21.3 mills/kWh). With an average generation of 6,130 MWh per year, the total energy benefits would be about $210,440 (34.3 mills/kWh). The net annual benefit of continuing to operate the project as it presently exists would be about $79,570 (13.0 mills/kWh).

Power and Economic Benefits of Woronoco Hydro's Proposal – Woronoco Hydro proposes to rehabilitate the project facilities and implement environmental and recreation improvements. Table 7 shows the capital, O & M, and energy costs associated with the proposed measures. The costs (1999$) provided by the applicant in its relicense

application were escalated to year 2001$ using the Consumer Price Indices from the U.S. Department of Labor website (see table 6).

As proposed (with generation of 6,700 MWh annually), the project would cost about $181,650 (27.1 mills/KWh) annually. The net annual benefits would be about $48,360 (7.2 mills/kWh).

Table 7. Summary of capital, O & M, energy, and total annual costs of environmental measures for the Woronoco Project, as proposed by Woronoco Hydro (Source: the Staff).

Environmental Measures	Capital Cost (2001$)	Annual O&M (2001$)	Annual Energy Cost (2001$)	Total Annual Cost (2001$)
Minimum Bypass Flow of 57 cfs - (1,000 MWh/year) [a]	($0)	($0)	($34,330)	($0)
Downstream Fish Passage	$52,870	$0	$0	$4,700
Upstream Fish Passage	$0	$4,970	$0	$4,970
Upstream Eel Passage	$31,720	$0	$0	$2,820
Drawdown Management Plan	$5,300	$0	$0	$470
Recreation access	$31,720	$0	$0	$2,820
Total Environmental Costs [a]	$121,610	$4,970	$0	$15,780
Upgrade of Facilities	$489,000	$0	$0	$35,000
Cost of No-Action Alternative	------	------	------	$130,870
Cost of Proposed Project	------	------	------	$181,650

[a] The cost of energy lost from the minimum flow was not added to the environmental costs. Rather, the energy loss was taken into account when calculating the total benefits in the economic analysis.

As previously mentioned, Woronoco Hydro's proposed minimum flow of 57 cfs would reduce the annual generation by 1,000 MWh. In our economic analysis, this generation loss was deducted from the total annual energy generation and not included in

the environmental costs. Nonetheless, as can be seen in Table 7, the 57-cfs minimum flow would reduce the energy benefits by about $34,330 annually.

Power and Economic Benefits of Staff's Recommended Project – To analyze the applicant's proposed project, with staff's recommended measures, we add to the costs of the applicant's proposed project those measure(s) recommended by staff, then estimate the project's total economic benefits. We add to Woronoco Hydro's proposal the cost of staff's project operation and flow monitoring plan.

Table 8 shows the costs of the additional measures and the total cost of staff's recommended project. We estimated that, as recommended by staff, the project would cost about $182,120 (27.2 mills/KWh) annually. The net annual benefits would be about $47,890 (7.1 mills/kWh).

Table 8. Summary of project costs for the proposed project with staff's additional measures (Source: the Staff).

Environmental Measures	Capital Cost (2001$)	Annual O&M (2001$)	Annual Energy Cost (2001$)	Total Annual Cost (2001$)
Project Operation and Flow Monitoring Plan	$5,300	$0	$0	$470
Total Environmental Costs	$5,300	$0	$0	$470
Cost of Applicant's Proposed Project (from table 7)	------	------	------	$181,650
Cost of Staff's Recommended Project	------	------	------	$182,120

Summary of Economic Analysis – Here, we briefly summarize and compare the no-action alternative with the two identified action alternatives; (1) the applicant's proposed project and (2) the applicant's proposed project with additional staff-recommended measures. Table 9 shows the summary of our analysis. Based on our analysis, we find that all three alternatives have positive net benefits.

Table 9. Summary of economic analysis of alternatives (Source: the Staff).

Alternative	Annual Cost	Annual Benefits	Net Annual Benefits
No-Action Alternative (6,130 MWh/year)	$130,870 (21.3 mills/kWh)	$210,440 (34.3 mills/kWh)	$79,570 (13.0 mills/kWh)
Alternative 2 (Table 7) (6,700 MWh/year)	$181,650 (27.1 mills/kWh)	$230,010 (34.3 mills/kWh)	$48,360 (7.2 mills/kWh)
Alternative 3 (Table 8) (6,700 MWh/year)	$182,120 (27.2 mills/kWh)	$230,010 (34.3 mills/kWh)	$47,890 (7.1 mills/kWh)

C. Greenhouse Gas Effects

The Woronoco Project would annually generate about 6,700 MWh of electricity. By producing hydroelectric power, the Woronoco Project displaces the need for other power plants, primarily fossil-fueled facilities, to operate, thereby avoiding some power plant emissions and creating an environmental benefit. If the electric generation capacity of the project were replaced with other fossil fuels, greenhouse gas emissions could potentially increase by 4,120 metric tons of carbon per year (if gas is used as the alternative fuel) to 6,470 metric tons of carbon per year (if coal is used as the alternative fuel).

VII. COMPREHENSIVE DEVELOPMENT & RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which the project is located. When we review a hydropower project, we consider the water quality, fish and wildlife, recreational, cultural, and other non-developmental values of the involved waterway equally with its electric energy and other developmental values. In determining whether, and under what circumstances, to license a project, the Commission must weigh the various economic and environmental tradeoffs involved in the decision.

A. Recommended Alternative

Based on our independent review and evaluation of the proposed action, the proposed action with staff-recommended measures, and no action, we recommend adopting the proposed action with the additional staff-recommended measures as the

preferred alternative. We recommend this alternative because: (1) issuance of the licenses would allow Woronoco Hydro to continue to operate the project as a beneficial, dependable, and inexpensive source of electric energy; (2) continued operation of the project would avoid the need for an equivalent amount of fossil-fueled-fired electric generation and capacity, continuing to help to conserve these non-renewable energy resources and reduce atmospheric pollution; and (3) the recommended environmental measures would adequately protect and/or enhance water quality, fisheries, terrestrial, recreation, and cultural resources.

We recommend the following protection and/or enhancement measures be included in any license issued by the Commission for the Woronoco Project:

- Operate the project in a run-of-river mode, by maintaining the impoundment elevation at 229.0 feet, with minimal fluctuations;

- Provide a year-round minimum flow of 57 cfs to the project's bypassed reach, with 22 cfs in the north channel and 35 cfs in the south channel;

- Prepare and implement a flow release and project operation and flow monitoring plan;

- Prepare and implement a comprehensive fish passage plan that includes provisions for (a) operating the existing downstream fish passage facility, (b) installing an eel ladder at the south dam and providing upstream passage routes at two additional locations in the north and south channels, (c) providing funding support towards implementing the MDFW's upstream trap-and-truck program for Atlantic salmon on the Westfield River, [54] and (d) evaluating the effectiveness of the existing downstream fish passage facility for passing salmon smolts, post-spawning adult salmon, and American eel, as well as develop appropriate protection measures for out-migrating eels;

- Reserve Interior's authority to prescribe fish passage facilities in the future;

- Develop and implement a drawdown management plan that outlines measures to protect mussel species and recover stranded fish, as well as

[54]This amount should be equal to $4,700 escalated to year 2001$, or $4,970.

wetlands, and that includes an evaluation of alternatives to drawing down the impoundment for extended periods of time;

- Consult with the Massachusetts SHPO and implement appropriate measures before (a) engaging in any activity that may result in an alteration of the National Register-eligible properties (*i.e.*, project powerhouse and Strathmore Mill complex) and (b) if significant undiscovered properties are found in the project area during normal project operations; and

- Develop and implement a final recreation enhancement plan for enhancing access in the project area that includes, at a minimum, the three new carry-in boat access sites proposed by the applicant.

B. Conclusion

Among the measures we recommend for inclusion in any license issued for the Woronoco Project, there are several that would affect the project's economics. These measures pertain primarily to bypass minimum flows, fish passage, and recreation access improvements. We evaluate, in detail, the measures pertaining to minimum flows, fish passage, and recreational access in their respective sections of section V.C. We also provide our rationale to support the recommendations we make in sections V.C.1. (Water Quantity and Quality, V.C.2. (Fishery Resources), and V.C.5. (Recreation and Land Use).

We cannot directly quantify the environmental enhancements that would be provided by each of our recommended measures. Collectively, however, these measures would afford greater environmental resource protection and enhancement at the Woronoco Project. We find that the measures would be a worthwhile expenditure when compared to the revenue that Woronoco Hydro would forego. We also note that the applicant and resource agencies are in agreement concerning these measures. Therefore, we conclude that operation of the project, as proposed by Woronoco Hydro and with staff's additional measures, would not only improve the environmental conditions in the project area, but would reduce any cumulative effects associated with the project.

VIII. CONSISTENCY WITH FISH AND WILDLIFE RECOMMENDATIONS

Section 10(j) of the FPA requires the Commission to include license conditions based on recommendations provided by the federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project. We have addressed the concerns of the federal and state fish and wildlife agencies and made recommendations consistent with those of the agencies.

Interior, on behalf of the USFWS, filed terms and conditions under section 10(j) for the Woronoco Project on February 9, 2001. The MDFW did not file 10(j) recommendations for the project.

Under Section 10(j), we are making a preliminary determination that four recommendations made by Interior fall within the scope of section 10(j), and are consistent with the purposes and requirements of the FPA or other applicable law. With regard to the fifth recommendation (a plan to evaluate the effectiveness of the existing downstream fish passage facilities), we have made a preliminary determination that it is an inappropriate fish and wildlife recommendation in that it constitutes a study that could have been done pre-filing. However, we have considered this recommendation under Section 10(a) of the FPA, addressed it in the section V.C.2., and recommend adopting it as part of any new license issued for the Woronoco Project.

Table 10 lists the five recommendations submitted by Interior that are subject to Section 10(j). Table 10 also summarizes our analysis of those recommendations, including whether the recommendations are adopted under the staff alternative.

Table 10. Analysis of fish and wildlife agency recommendations for the Woronoco Project (Source: the Staff).

	Agency	Recommendation	Within Scope of 10(j)	Total Annual Cost (2001 $)	Recommend Adopting?
1	Interior	Operate project in R-O-R mode such that headpond and flow fluctuations are minimized	Yes	none	Yes
2	Interior	Release a continuous minimum flow of 57 cfs, or inflow, to bypassed reach; 22 cfs from North dam, 15 cfs from South dam, and 22 cfs through downstream fish passage facility	Yes	$34,330	Yes
3	Interior	Develop and implement a plan to monitor R-O-R operations and minimum flows	Yes	nominal	Yes
4	Interior	Develop and implement plan to evaluate effectiveness of downstream fish passage facilities	No [a]	nominal	Yes
5	Interior	Develop and implement a mussel and aquatic life protection plan.	Yes	nominal	Yes

[a] This is a study that could have been done before filing the license application.

IX. CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2) of the FPA requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. Under Section 10(a)(2), federal and state agencies filed a total of 16 comprehensive plans that

address various resources in Massachusetts. Of these, we identified and reviewed nine plans relevant to the project.[55] No inconsistencies were found.

We also reviewed one state plan that is relevant to the project, but is not listed as a Commission-approved comprehensive plan, which is the Anadromous Fish Management Plan for the Westfield River, 2001-2010 (MDFW, 2000). No inconsistencies were found.

Based on our review of the agency and public comments filed on the project, and our independent analysis pursuant to Sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, we conclude that the issuance of a new license for the Woronoco Project, with the recommended enhancement measures, would permit the best comprehensive development of the Westfield River.

X. FINDING OF [OR NO] SIGNIFICANT IMPACT

None of the resources we analyzed, including water quantity and quality, fisheries, terrestrial, threatened and endangered species, cultural and historic, and recreational resources would experience significant adverse effects under the proposed action or any of the alternatives considered in this EA. On the basis of this independent analysis, we

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[55]**Massachusetts**: (1) A Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River Basin, Policy Committee for Fisheries Management of the Connecticut River, September 1982 (Revised by the Connecticut River Atlantic Salmon Commission, July 1998); (2) Massachusetts Outdoors for our Common Good: Open Space and Outdoor Recreation in Massachusetts, Massachusetts Department of Environmental Management, Division of Planning and Development, December 1988; and (3) Connecticut River Basin Water Quality Management Plan, Massachusetts Department of Environmental Quality Engineering Division of Water Pollution Control, June 1983.

Federal: (1) Management Plan for American Shad in the Connecticut River Basin, Connecticut River Atlantic Salmon Commission, February 1992; (2) Silvio O. Conte National Fish and Wildlife Refuge, Final Action Plan and Environmental Impact Statement, U.S. Department of the Interior, October 1995; (3) Final Environmental Impact Statement - Restoration of Atlantic Salmon to New England River, U.S. Department of the Interior, May 1989; (4) Fisheries USA: The Recreational Fisheries Policy of the U.S. Fish and Wildlife Service, U.S. Fish and Wildlife Service, undated; (5) The Nationwide Rivers Inventory, National Park Service, 1982; and (6) North American Waterfowl Management Plan, U.S. Fish and Wildlife Service, May 1986.

conclude that issuance of a new license for the Woronoco Project, with our recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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