

Stuyvenberg, Andrew

From: Bo Pham
Sent: Monday, December 22, 2008 2:33 PM
To: Gray, Dara
Cc: Young, Gary; David Wrona; Andrew Stuyvenberg; Lisa Regner; IPRenewal NPEmails
Subject: NRC letter regarding Issuance of DSEIS

Dara,

Attached is the letter & enclosure for issuance of the DSEIS.

Bo Pham

Chief, Environmental Review Branch
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
301-415-8450



Entergy letter
regarding IP DS...



Reduced size IP
DSEIS Vol 1.pd...



Reduced size IP
DSEIS Vol 2.pd...

December 22, 2008

Vice President, Operations
Entergy Nuclear Operations, Inc.
Indian Point Energy Center
450 Broadway, GSB
P.O. Box 249
Buchanan, NY 10511-0249

SUBJECT: NOTICE OF AVAILABILITY OF THE DRAFT PLANT-SPECIFIC
SUPPLEMENT 38 TO THE GENERIC ENVIRONMENTAL IMPACT
STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS REGARDING
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3 (TAC NOS.
MD5411 AND MD5412)

Dear Sir or Madam:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed the draft plant-specific Supplement 38 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)," regarding the renewal of operating licenses DPR-26 and DPR-64 for an additional 20 years of operation for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). Enclosed is a copy of the draft supplement and the associated *Federal Register* Notice of Availability. This notice advises the public that the draft supplement is publicly available at the NRC Public Document Room (PDR) or from the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC website at <http://adamswebsearch.nrc.gov/dologin.htm>. The Accession Numbers for the draft Supplement 38 to the GEIS are ML083540594 (Volume 1, main report) and ML083540614 (Volume 2, appendices). In addition, the White Plains Public Library (White Plains, NY), Hendrick Hudson Free Library (Montrose, NY), and the Field Library (Peekskill, NY), have agreed to make the draft supplement available for public inspection.

As discussed in Section 9.3 of the draft supplement, the preliminary recommendation of the staff is that the Commission determine that the adverse environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on: (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by Entergy Nuclear Operations, Inc. (the licensee); (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments received during the scoping process.

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A separate Notice of Availability of the draft supplemental environmental impact statement will be placed in the *Federal Register* through the U.S. Environmental Protection Agency. If you have any questions regarding this matter, please contact the NRC Environmental Project Manager, Mr. Andrew Stuyvenberg, at 301-415-4006 or by e-mail at Andrew.Stuyvenberg@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Branch Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:
As stated

cc w/encls.: See next page

UNITED STATES NUCLEAR REGULATORY COMMISSION
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
NOTICE OF AVAILABILITY OF THE DRAFT SUPPLEMENT 38 TO THE GENERIC
ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS
AND PUBLIC MEETING FOR THE LICENSE RENEWAL
OF INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
DOCKET NOS. 50-247 and 50-286

Notice is hereby given that the U.S. Nuclear Regulatory Commission (NRC, Commission) has published a draft plant-specific supplement to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, regarding the renewal of operating licenses DPR-26 and DPR-64 for an additional 20 years of operation for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). IP2 and IP3 are located in Westchester County in the village of Buchanan, New York, approximately 24 miles north of New York City. Possible alternatives to the proposed action (license renewal) include no action and reasonable alternative energy sources. Draft Supplement 38 to the GEIS is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at <http://adamswebsearch.nrc.gov/dologin.htm>. The Accession Numbers for draft Supplement 38 to the GEIS are ML083540594 (Volume 1, main report) and ML083540614 (Volume 2, appendices). Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at PDR.Resource@nrc.gov. In addition, the White Plains Public Library (White Plains, NY),

Hendrick Hudson Free Library (Montrose, NY), and the Field Library (Peekskill, NY), have agreed to make the draft supplement to the GEIS available for public inspection.

Any interested party may submit comments on the draft supplement to the GEIS for consideration by the NRC staff. To be considered, comments on the draft supplement to the GEIS and the proposed action must be received by March 18, 2009; the NRC staff is able to ensure consideration only for comments received on or before this date. Comments received after the due date will be considered only if it is practical to do so. Written comments on the draft supplement to the GEIS should be sent to: Chief, Rulemaking, Directives and Editing Branch, Division of Administrative Services, Office of Administration, Mailstop T-6D59, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001.

Comments may be hand-delivered to the NRC at 11545 Rockville Pike, Room T-6D59, Rockville, Maryland 20852, between 7:30 a.m. and 4:15 p.m. on Federal workdays. Electronic comments may be submitted to the NRC by e-mail at IndianPoint.EIS@nrc.gov. All comments received by the Commission, including those made by Federal, State, local agencies, Native American Tribes, or other interested persons, will be made available electronically at the Commission's PDR in Rockville, Maryland, and through ADAMS.

The NRC staff will hold a public meeting to present an overview of the draft plant-specific supplement to the GEIS and to accept public comments on the document. The public meeting will be held on February 12, 2009, at the Colonial Terrace, 119 Oregon Road, Cortlandt Manor, New York 10567. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m. with a repeat of the overview portions of the meeting and will continue until 10:00 p.m., as necessary. Both meetings will be transcribed and will include: (1) a presentation of the contents of the draft plant-specific supplement to the GEIS, and (2) the opportunity for interested government agencies, organizations, and individuals to provide

comments on the draft report. Additionally, the NRC staff will host informal discussions one hour prior to the start of each session at the same location. No comments on the draft supplement to the GEIS will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meeting or in writing. Persons may pre-register to present oral comments at the meeting by contacting Mr. Andrew Stuyvenberg, the NRC Environmental Project Manager at 1-800-368-5642, extension 4006, or by e-mail at IndianPoint.EIS@nrc.gov, no later than January 29, 2009. Members of the public may also register to provide oral comments within 15 minutes of the start of each session. Individual, oral comments may be limited by the time available, depending on the number of persons who register. If special equipment or accommodations are needed to attend or present information at the public meeting, the need should be brought to Mr. Stuyvenberg's attention no later than January 26, 2009, to provide the NRC staff adequate notice to determine whether the request can be accommodated.

FOR FURTHER INFORMATION, CONTACT: Mr. Stuyvenberg, Projects Branch 2, Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Mail Stop O-11F1, Washington, D.C. 20555-0001. Mr. Stuyvenberg may be contacted at the aforementioned telephone number or e-mail address.

Dated at Rockville, Maryland, this 22nd day of December, 2008.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

David J. Wrona, Branch Chief
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Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Draft Report for Comment Main Report

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at NRC's Public Electronic Reading Room at <http://www.nrc.gov/reading-rm.html>.

Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

1. The Superintendent of Documents
U.S. Government Printing Office
Mail Stop SSOP
Washington, DC 20402-0001
Internet: bookstore.gpo.gov
Telephone: 202-512-1800
Fax: 202-512-2250
2. The National Technical Information Service
Springfield, VA 22161-0002
www.ntis.gov
1-800-553-6847 or, locally, 703-605-6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: U.S. Nuclear Regulatory Commission
Office of Administration
Mail, Distribution and Messenger Team
Washington, DC 20555-0001
E-mail: DISTRIBUTION@nrc.gov
Facsimile: 301-415-2289

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Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute
11 West 42nd Street
New York, NY 10036-8002
www.ansi.org
212-642-4900

Legally binding regulatory requirements are stated only in laws; NRC regulations; licenses, including technical specifications; or orders, not in NUREG-series publications. The views expressed in contractor-prepared publications in this series are not necessarily those of the NRC.

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG-XXXX) or agency contractors (NUREG/CR-XXXX), (2) proceedings of conferences (NUREG/CP-XXXX), (3) reports resulting from international agreements (NUREG/IA-XXXX), (4) brochures (NUREG/BR-XXXX), and (5) compilations of legal decisions and orders of the Commission and Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of NRC's regulations (NUREG-0750).

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Draft Report for Comment Main Report

Manuscript Completed: December 2008
Date Published: December 2008

COMMENTS ON DRAFT REPORT

Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number NUREG-1437, Supplement 38, draft, in your comments, and send them by March 11, 2009, to the following address:

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop TWB-05-B01
Washington, DC 20555-0001

Electronic comments may be submitted to the NRC by e-mail at
IndianPoint.EIS@nrc.gov.

For any questions about the material in this report, please contact:

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear power plant operating licenses for a 20-year period in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS),⁽¹⁾ and codified the results in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff identified 92 environmental issues and reached generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to the NRC to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This draft SEIS includes the NRC staff's analysis which considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither Entergy nor the NRC staff has identified information that is both new and significant for any issues that apply to IP2 and/or IP3. In addition, the NRC staff determined that information provided during the scoping process was not new and significant with respect to the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the operating licenses for IP2 and IP3 will not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the NRC staff's conclusion in the GEIS is that the impact is of SMALL⁽²⁾ significance (except for the collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to IP2 and IP3 are addressed in this draft SEIS. The NRC staff determined that several of these issues were not applicable because of the type of facility cooling system or other reasons detailed within this SEIS. For the remaining applicable issues, the NRC staff concludes that the significance of potential environmental impacts related to operating license renewal is SMALL, with four exceptions—entrainment, impingement, heat shock from the facility's heated discharge, and impacts to aquatic endangered species. Overall effects from entrainment and impingement may be SMALL to

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

⁽²⁾ Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

Abstract

LARGE, depending on the species affected. Impacts from heat shock likely range from SMALL to MODERATE depending on the conclusions of thermal studies proposed by the New York State Department of Environmental Conservation (NYSDEC). NRC staff did not find data that suggest the effect of heat shock is likely to rise to LARGE. Given the uncertainties in the data NRC staff reviewed, impacts to the endangered shortnose sturgeon could range from SMALL to LARGE.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewals for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report submitted by Entergy, (3) consultation with other Federal, State, and local agencies; (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process.

Paperwork Reduction Act Statement

This NUREG does not contain information collection requirements and, therefore, is not subject to the requirements of the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). These information collections were approved by the Office of Management and Budget, approval numbers 3150-0004, 3150-0155, 3150-0014, 3150-0011, 3150-0021, 3150-0132, and 3150-0151.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

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EXECUTIVE SUMMARY

By letter dated April 30, 2007, Entergy Nuclear Operations, Inc. (Entergy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20-year period. If the operating licenses are renewed, State regulatory agencies and Entergy will ultimately decide whether the plant will continue to operate based on factors such as the need for power, issues falling under the purview of the owners, or other matters within the State's jurisdiction, including acceptability of water withdrawal, consistency with State water quality standards, and consistency with State coastal zone management plans. If the operating licenses are not renewed, then IP2 and IP3 must be shut down at or before the expiration date of their current operating licenses which expire September 28, 2013, and December 12, 2015, respectively.

The NRC has implemented Section 102 of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321), in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission requires preparation of an environmental impact statement (EIS) or a supplement to an EIS for renewal of a reactor operating license. In addition, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS).⁽¹⁾

Upon acceptance of the IP2 and IP3 application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The NRC staff visited the IP2 and IP3 site in September 2007, held two public scoping meetings on September 19, 2007, and conducted two site audits on September 10–14, 2007, and September 24–27, 2007. In the preparation of this draft supplemental environmental impact statement (SEIS) for IP2 and IP3, the NRC staff reviewed the IP2 and IP3 environmental report (ER) and compared it to the GEIS, consulted with other agencies, conducted an independent review of the issues following the guidance in NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal," issued October 1999, and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within the scope of the environmental review are contained in the Scoping Summary Report for Indian Point Nuclear Generating Unit Nos. 2 and 3, issued by NRC staff in December, 2008. In Appendix A of this SEIS, the NRC staff adopt, by reference, the comments and responses in the Scoping Summary Report and provide information on how to electronically access the scoping summary or view a hard copy.

The NRC staff will hold public meetings in Cortlandt Manor, New York, in February 2009 to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with information to assist them in formulating comments on this

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

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draft SEIS. When the comment period ends, the NRC staff will consider and address all of the comments received. These comments will be addressed in Appendix A, Part 2, to the final SEIS.

This draft SEIS includes the NRC staff's preliminary analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse effects. It also includes the NRC staff's preliminary recommendation regarding the proposed action.

The Commission has adopted the following statement of purpose and need for license renewal from the GEIS:

The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The purpose of the NRC staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine the following:

...whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current operating license (or licenses).

NRC regulations (10 CFR 51.95(c)(2)) contain the following statement regarding the content of SEISs prepared at the license renewal stage:

The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in 10 CFR 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact"] and in accordance with 10 CFR 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an operating license and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines.

The following definitions of the three significance levels are set forth in footnotes to Table B-1 of

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Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," to 10 CFR Part 51, Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)":

SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS reached the following conclusions:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (that is, SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions in the GEIS for issues designated as Category 1 in Table B-1 of Appendix B to 10 CFR Part 51, Subpart A.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This draft SEIS documents the NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the operating licenses for IP2 and IP3), alternative methods of power generation, and conservation. The NRC staff also considered two alternatives that included continued operation of IP2 and IP3 with either a closed-cycle cooling system, or a combination of intake modifications and habitat restoration projects that may achieve similar effects on aquatic organisms as closed cycle cooling because the New York State Department of Environmental Conservation (NYSDEC) issued a preliminary determination, in its 2003 draft State Pollutant Discharge Elimination System (SPDES) permit that closed cycle cooling is the site-specific best technology available to reduce impacts on fish and shellfish. NYSDEC's 2003 draft SPDES permit indicated that Entergy could propose another alternative that would have

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1 similar effects on aquatic species. The 2003 SPDES permit is currently subject to adjudication
2 and has not gone into effect.

3 Entergy and the NRC staff have established independent processes for identifying and
4 evaluating the significance of any new information on the environmental impacts of license
5 renewal. Neither Entergy nor the staff has identified information that is both new and significant
6 related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly,
7 neither the scoping process nor the NRC staff has identified any new issue applicable to IP2
8 and IP3 that has a significant environmental impact. Therefore, the NRC staff relies on the
9 conclusions of the GEIS for all of the Category 1 issues that are applicable to IP2 and IP3.

10 Entergy's license renewal application presents an analysis of the 21 Category 2 issues that are
11 applicable to IP2 and IP3, plus environmental justice and chronic effects from electromagnetic
12 fields, for a total of 23 issues. The NRC staff has reviewed the Entergy analysis and has
13 conducted an independent review of each issue. Six of the Category 2 issues are not
14 applicable because they are related to the type of existing cooling system, water use conflicts,
15 and ground water use not found at IP2 and IP3. Entergy has stated that its evaluation of
16 structures and components, as required by 10 CFR 54.21, "Contents of Application—Technical
17 Information," did not identify any major plant refurbishment activities or modifications as
18 necessary to support the continued operation of IP2 and IP3 for the license renewal period.
19 Entergy did, however, indicate that it may replace reactor vessel heads and control rod drive
20 mechanisms at IP2 and IP3, though it has no firm plans to do so at this time. The NRC staff has
21 evaluated the potential impacts of these activities using the framework provided by the GEIS for
22 addressing refurbishment issues.

23 Seventeen environmental issues related to operational impacts and postulated accidents during
24 the renewal term are discussed in detail in this draft SEIS. These include 15 Category 2 issues
25 and two uncategorized issues, environmental justice and chronic effects of electromagnetic
26 fields. The NRC staff also discusses in detail the potential impacts related to the 10 Category 2
27 issues that apply to refurbishment activities. The NRC staff concludes that the potential
28 environmental effects for most of these issues are of SMALL significance in the context of the
29 standards set forth in the GEIS with four exceptions—entrainment, impingement, heat shock
30 from the facility's heated discharge, and impacts to aquatic endangered species. The NRC staff
31 jointly assessed the impacts of entrainment and impingement to range from SMALL to LARGE
32 (depending on species affected), based on NRC's analysis of representative important species.
33 Impacts from heat shock likely range from SMALL to MODERATE depending on the
34 conclusions of thermal studies proposed by the New York State Department of Environmental
35 Conservation (NYSDEC). NRC staff did not find data that suggest the effect of heat shock is
36 likely to rise to LARGE. Given the uncertainties in the data NRC staff reviewed, impacts to the
37 endangered shortnose sturgeon could range from SMALL to LARGE. The NRC staff
38 considered mitigation measures for each applicable Category 2 issue.

39 The NRC staff also determined that appropriate Federal health agencies have not reached a
40 consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore,
41 no further evaluation of this issue is required.

42 For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable,
43 comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the
44 SAMAs for IP2 and IP3 and the plant improvements already made, the NRC staff concludes that

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1 several SAMAs may be cost-beneficial. However, these SAMAs do not relate to adequate
2 management of the effects of aging during the period of extended operation. Therefore, they do
3 not need to be implemented as part of the license renewal pursuant to 10 CFR Part 54,
4 "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

5 Cumulative impacts of past, present, and reasonably foreseeable future actions were
6 considered, regardless of what agency (Federal or non-Federal) or person undertakes such
7 other actions. For purposes of this analysis, the NRC staff determined that the cumulative
8 impacts to terrestrial and aquatic resources in the IP2 and IP3 environs would be LARGE, due
9 primarily to past development and pollution, much of which preceded IP2 and IP3 or occurred
10 as a result of other actions (for example, suburban development and hardening of the Hudson
11 River shoreline).

12 NRC analysis indicates that the adverse impacts of likely alternatives will differ from those of the
13 proposed action. Most alternatives result in smaller impacts to aquatic life, while creating
14 greater impacts in other resource areas. Often, the most significant environmental impacts of
15 alternatives result from constructing new facilities or infrastructure.

16 The preliminary recommendation of the NRC staff is that the Commission determine that the
17 adverse environmental impacts of license renewals for IP2 and IP3 are not so great that not
18 preserving the option of license renewal for energy planning decisionmakers would be
19 unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS,
20 (2) the ER submitted by Entergy, (3) consultation with other Federal, State, and local agencies,
21 (4) the staff's own independent review, and (5) the staff's consideration of public comments
22 received during the scoping process.

ABBREVIATIONS/ACRONYMS

1		
2	°	degree(s)
3	µm	micron(s)
4	ac	acre(s)
5	AC	alternating current
6	ACC	averted cleanup and decontamination
7	ACEEE	American Council for an Energy Efficient Economy
8	AEC	Atomic Energy Commission
9	AFW	auxiliary feed water
10	AGTC	Algonquin Gas Transmission Company
11	ALARA	as low as reasonably achievable
12	ANOVA	analysis of variance
13	AOC	averted off-site property damage costs
14	AOE	averted occupational exposure costs
15	AOSC	averted on-site costs
16	APE	averted public exposure
17	ASME	American Society of Mechanical Engineers
18	ASMFC	Atlantic States Marine Fisheries Commission
19	ASSS	alternate safe shutdown system
20	ATWS	anticipated transient without scram
21	AUTOSAM	Automated Abundance Sampler
22	BA	biological assessment
23	Bq/L	becquerel per liter
24	Bq/kg	becquerel per kilogram
25	BSS	Beach Seine Survey
26	BTA	best technology available
27	BTU	British thermal unit(s)
28	C	Celsius
29	CAA	Clean Air Act
30	CAFTA	computer aided fault-tree analysis code
31	CAMR	Clean Air Mercury Rule
32	CCF	common cause failure
33	CCMP	Comprehensive Conservation and Management Plan
34	CCW	component cooling water
35	CDF	core damage frequency
36	CDM	Clean Development Mechanism
37	CET	Containment Event Tree
38	CEQ	Council on Environmental Quality
39	CFR	<i>Code of Federal Regulations</i>
40	cfs	cubic foot (feet) per second
41	CHGEC	Central Hudson Gas & Electric Corporation
42	Ci	curie(s)
43	cm	centimeter(s)

Abbreviations and Acronyms

1	CMR	conditional mortality rate
2	CNP	Cook Nuclear Plant
3	CO	carbon monoxide
4	CO ₂	carbon dioxide
5	COE	cost of enhancement
6	COL	Combined License
7	Con Edison	Consolidated Edison Company of New York
8	CORMIX	Cornell University Mixing Zone Model
9	CPUE	catch-per-unit-effort
10	CST	condensate storage tank
11	CSET	Containment Safeguards for Event Tree
12	cu ft	cubic feet
13	CV	coefficient of variation
14	CVCS	Chemical and Volume Control System
15	CWA	Clean Water Act
16	CWIS	Circulating Water Intake System
17	CWS	Circulating Water System
18	CWSH	Circulating Water Screenhouse
19	cy	cubic yards
20	CZMA	Coastal Zone Management Act
21	dB(A)	decibel(s)
22	DBA	Design-basis accident
23	DC	direct current
24	DEIS	Draft Environmental Impact Statement
25	DNA	deoxyribonucleic acid
26	DO	dissolved oxygen
27	DOC	dissolved organic carbon
28	DOE	U.S. Department of Energy
29	DOT	U.S. Department of Transportation
30	DPS	distinct population segment
31	DSM	demand-side management
32	DWR	Division of Water Resources
33	ECL	Environmental Conservation Law
34	EDG	emergency diesel generator
35	EIA	Energy Information Administration
36	EIS	environmental impact statement
37	ELF-EMF	extremely low frequency-electromagnetic field
38	Enercon	Enercon Services, Inc.
39	Entergy	Entergy Nuclear Operations, Inc.
40	EO	Executive Order
41	EOP	emergency operating procedure
42	EPA	U.S. Environmental Protection Agency
43	EPACT2005	Energy Policy Act of 2005
44	EPRI	Electric Power Research Institute
45	ER	Environmental Report

Abbreviations and Acronyms

1	ER-M	effects-range-median
2	ERS	Environmental Radiation Surveillance
3	ESA	Endangered Species Act
4	ESP	Early Site Permit
5	ESWS	Essential Service Water System
6	F	Fahrenheit
7	F&O	Facts and Observations
8	FAA	Federal Aviation Administration
9	FDA	Food and Drug Administration
10	FEIS	Final Environmental Impact Statement
11	FERC	Federal Energy Regulatory Commission
12	FES	Final Environmental Statement
13	FFTM	far field thermal model
14	FIVE	fire-induced vulnerability evaluation
15	FJS	Fall Juvenile Survey
16	F _{MSY}	fishing mortality rate that can produce the maximum sustainable yield
17	FPC	Federal Power Commission
18	fps	feet per second
19	FPS	fire protection system
20	FR	<i>Federal Register</i>
21	FSAR	Final Safety Analysis Report
22	FSS	Fall Shoals Survey
23	ft	foot (feet)
24	ft ²	square feet
25	ft ³	cubic feet
26	ft/mi	feet per mile
27	FWS	U.S. Fish and Wildlife Service
28	g	gram(s)
29	gCeq/kWh	gram(s) of carbon dioxide equivalents per kilowatt-hour
30	GEIS	<i>Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437</i>
31		
32	GHG	greenhouse gas
33	GL	Generic Letter
34	gpm	gallon(s) per minute
35	GW	gigawatt
36	HAP	hazardous air pollutant
37	HCLPF	high confidence of low probability of failure
38	HEPA	high efficiency particulate air
39	HLW	high-level waste
40	hr	hour(s)
41	HRA	Human Reliability Analysis
42	HRERF	Hudson River Estuary Restoration Fund
43	HRF	Hudson River Foundation
44	HRFI	Hudson River Fisheries Investigation

Abbreviations and Acronyms

1	HRIF	Hudson River Improvement Fund
2	HRPC	Hudson River Policy Committee
3	HRSA	Hudson River Settlement Agreement
4	HVAC	heating, ventilation, and air conditioning
5	Hz	hertz
6	in.	inch(es)
7	INEEL	Idaho National Energy and Environmental Laboratory
8	IP1	Indian Point Nuclear Generating Unit No. 1
9	IP2	Indian Point Nuclear Generating Unit No. 2
10	IP3	Indian Point Nuclear Generating Unit No. 3
11	IPE	individual plant examination
12	IPEE	individual plant examination of external events
13	ISFSI	Independent Fuel Storage Installation
14	ISLOCA	Interfacing Systems Loss of Coolant Accidents
15	IWSA	Integrated Waste Services Association
16	kg	kilogram(s)
17	kg/yr	kilograms per year
18	km	kilometer(s)
19	km ²	square kilometer(s)
20	kV	kilovolt(s)
21	kW	kilowatt
22	kWh	kilowatt hour(s)
23	lbs	pounds
24	L	liter(s)
25	LERF	Large Early Release Frequency
26	LLMW	low-level mixed waste
27	LOCA	loss of coolant accident
28	LOE	Line(s) of Evidence
29	LOS	level of service
30	lpm	liters per minute
31	LPSI	low pressure safety injection
32	LRS	Long River Survey
33	LSE	load serving entities
34	m	meter(s)
35	mm	millimeter(s)
36	m ²	square meter(s)
37	m ³	cubic meter(s)
38	m ³ /sec	cubic meter(s) per second
39	mA	milliampere(s)
40	MAAP	Modular Accident Analysis Program
41	MACCS2	MELCOR Accident Consequence Code System 2
42	MBq	megabecquerel
43	MCL	maximum contaminant level

Abbreviations and Acronyms

1	MDS	Minimum Desirable Streamflow
2	mg	milligram(s)
3	mgd	million gallons per day
4	mg/L	milligram(s) per liter
5	mGy	milligray
6	mi	mile(s)
7	min	minute(s)
8	MIT	Massachusetts Institute of Technology
9	mL	milliliter(s)
10	MMACR	Modified Maximum Averted Cost-Risk
11	MMBtu	million British thermal unit(s)
12	mov	motor-operated valve
13	mph	miles per hour
14	mps	meter(s) per second
15	mrad	millirad(s)
16	mrem	millirem(s)
17	MSE	mean squared error
18	MSL	mean sea level
19	MSPI	Mitigating Systems Performance Indicator
20	mSv	millisievert
21	MT	metric ton(s)
22	MTU	metric ton of uranium
23	MUDS	Makeup Discharge Structure
24	MUSH	Makeup Water Screen House
25	MW	megawatt
26	MWd	megawatt-days
27	MW(e)	megawatt(s) electric
28	MW(h)	megawatt hour(s)
29	MW(t)	megawatt(s) thermal
30	MWSF	Mixed Waste Storage Facility
31	NAAQS	National Ambient Air Quality Standards
32	NAS	National Academy of Sciences
33	NCP	normal charging pump
34	NEPA	National Environmental Policy Act of 1969, as amended
35	NESC	National Electric Safety Code
36	NGVD	National Geodetic Vertical Datum
37	NHPA	National Historic Preservation Act
38	NIEHS	National Institute of Environmental Health Sciences
39	NMFS	National Marine Fisheries Service
40	NJDEP	New Jersey Department of Environmental Protection
41	NJPDES	New Jersey Pollutant Discharge Elimination System
42	NO ₂	nitrogen dioxide
43	NO _x	nitrogen oxide(s)
44	NOAA	National Oceanic and Atmospheric Administration
45	NPDES	National Pollutant Discharge Elimination System
46	NRC	U.S. Nuclear Regulatory Commission

Abbreviations and Acronyms

1	NRDC	Natural Resource Defense Council
2	NRHP	National Register of Historic Places
3	NSPS	New Source Performance Standards
4	NSSS	nuclear steam supply system
5	NWJWW	Northern Westchester Joint Water Works
6	NY/NJ/PHL	New York/New Jersey/Philadelphia
7	NYCA	New York Control Area
8	NYCDEP	New York City Department of Environmental Protection
9	NYCEF	New York City Environmental Fund
10	NYCRR	New York Code of Rules and Regulations
11	NYISO	New York Independent System Operator
12	NYNHP	New York Natural Heritage Program
13	NYPA	New York Power Authority
14	NYPSC	New York Public Service Commission
15	NYRI	New York Regional Interconnect, Inc.
16	NYSDEC	New York State Department of Environmental Conservation
17	NYSDOH	New York State Department of Health
18	NYSERDA	New York State Energy Research and Development Authority
19	NYSHPO	New York State Historic Preservation Office
20	O ₃	ozone 8-hour standard
21	OCNGS	Oyster Creek Nuclear Generating Station
22	ODCM	Offsite Dose Calculation Manual
23	OL	operating license
24	PAB	primary auxiliary building
25	PAH	polycyclic aromatic hydrocarbon
26	PAYS	Pay as You Save
27	PCB	polychlorinated biphenyls
28	pCi/L	picoCuries per liter
29	pCi/kg	picoCuries per kilogram
30	PDS	plant damage state
31	PILOT	payment-in-lieu-of-taxes
32	PM _{2.5}	particulate matter, 2.5 microns or less in diameter
33	PM ₁₀	particulate matter, 10 microns or less in diameter
34	POC	particulate organic carbon
35	PORV	power operated relief valve
36	POTW	publicly owned treatment works
37	ppm	parts per million
38	ppt	parts per thousand
39	PRA	probabilistic risk assessment
40	PSA	probabilistic safety assessment
41	PSD	Prevention of Significant Deterioration
42	PV	photovoltaic
43	PWR	pressurized water reactor
44	PWW	Poughkeepsie Water Works
45	PYSL	post yolk-sac larvae

Abbreviations and Acronyms

1	REMP	Radiological Environmental Monitoring Program
2	R-EMP	regional environmental monitoring and assessment program
3	radwaste	radioactive waste
4	RAI	request for additional information
5	RCP	reactor coolant pump
6	RCRA	Resource Conservation and Recovery Act
7	RCS	reactor cooling system
8	REMP	radiological environmental monitoring program
9	RHR	residual heat removal
10	Riverkeeper	Hudson River Fishermen's Association
11	RIS	Representative Important Species
12	RKM	river kilometer(s)
13	RLE	review level earthquake
14	RM	river mile(s)
15	RMP	Risk Management Plan
16	ROD	Record of Decision
17	ROI	region of influence
18	ROW	right-of-way
19	RPC	long-term replacement power costs
20	rpm	revolutions per minute
21	RRW	risk reduction worth
22	RWST	refueling water storage tank
23	s	second(s)
24	SAFSTOR	safe storage condition
25	SAMA	severe accident mitigation alternative
26	SAR	Safety Analysis Report
27	SAV	submerged aquatic vegetation
28	SBO	station blackout
29	Scenic Hudson	Scenic Hudson Preservation Conference
30	SCR	selective catalytic reduction
31	SECPop	sector population, land fraction and economic estimation program
32	SEIS	Supplemental Environmental Impact Statement
33	SER	Safety Evaluation Report
34	SFP	Spent Fuel Pool
35	SGBD	steam generator blowdown
36	SGTR	Steam Generator Tube Ruptures
37	SO ₂	sulfur dioxide
38	SO _x	sulfur oxide(s)
39	SOP	standard operating procedure(s)
40	SPDES	State Pollutant Discharge Elimination System
41	SPU	stretch power update
42	sq mi	square mile(s)
43	SRP	Standard Review Plan
44	SSBR	spawning stock biomass per-recruit
45	SSE	safe shutdown earthquake

Abbreviations and Acronyms

1	Sv	person-sievert
2	SWS	service water system
3	T	temperature
4	TD	turbine driven
5	TDS	total dissolved solids
6	TI-SGTR	thermally-induced Steam Generator Tube Ruptures
7	TL	total length
8	TLD	Thermoluminescent dosimeter
9	TMDL	Total Maximum Daily Load
10	TOC	total organic carbon
11	TRC	TRC Environmental Corporation
12	UHS	ultimate heat sink
13	U.S.	United States
14	USACE	U.S. Army Corps of Engineers
15	USCB	U.S. Census Bureau
16	USD	Unified School District
17	USGS	U.S. Geological Survey
18	UWNY	United Water New York
19	V	volt(s)
20	VALNF	value of non-farm wealth
21	VOC	volatile organic compound
22	WET	whole effluent toxicity
23	WJWW	Westchester Joint Water Works
24	WOE	weight of evidence
25	WOG	Westinghouse Owner's Group
26	YSL	yolk-sac larvae
27	YOY	young of year
28	yr	year(s)

1.0 INTRODUCTION

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51), which implement the National Environmental Policy Act of 1969, as amended (NEPA), renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment and then to issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the NRC staff prepared NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾ The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 by defining the number and scope of issues that need to be addressed by the applicants in plant-by-plant renewal proceedings. Use of the GEIS guides the preparation of complete plant-specific information in support of the operating license renewal process.

Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC, operate the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) nuclear power reactors, respectively, as indirect wholly owned subsidiaries of Entergy Corporation and indirect wholly owned subsidiaries of Entergy Nuclear Operations, Inc. (Entergy). IP2 and IP3 are located in Buchanan, New York.

IP2 has operated under operating license DPR-26, which was issued by the NRC, since August 1974. The IP2 operating license will expire on September 28, 2013. IP3 has operated under operating license DPR-64, which was issued by the NRC, since August 1976. The IP3 operating license will expire on December 12, 2015. Unit No. 1 (IP1) was shut down in 1974.

Entergy, Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC, are joint applicants for the renewal of the operating licenses (the joint applicants will be referred to as Entergy). Entergy submitted an application to the NRC to renew the IP2 and IP3 operating licenses for an additional 20 years each under 10 CFR Part 54 on April 30, 2007 (Entergy 2007a). Pursuant to 10 CFR 54.23, "Contents of Application—Environmental Information," and 10 CFR 51.53(c), Entergy submitted an environmental report (ER) (Entergy 2007b) as part of the license renewal application in which Entergy analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects. Entergy submitted supplemental information clarifying operating licenses and applicant names in a letter on May 3, 2007 (Entergy 2007c).

This report is the draft facility-specific supplement to the GEIS (the supplemental EIS (SEIS)) for the Entergy license renewal application. This draft SEIS is a supplement to the GEIS because it

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

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relies, in part, on the findings of the GEIS. The NRC staff will also prepare a separate safety evaluation report in accordance with 10 CFR Part 54.

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this draft SEIS, including the development of the GEIS and the process used by the NRC staff to assess the environmental impacts associated with license renewal, (2) describe the proposed Federal action to renew the IP2 and IP3 operating licenses, (3) discuss the purpose and need for the proposed action, and (4) present the status of IP2 and IP3 compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

The ensuing chapters of this draft SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid waste management. Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about the adverse impacts that cannot be avoided, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and the irreversible or irretrievable commitment of resources. Chapter 9 also presents the NRC staff's preliminary recommendation with respect to the proposed license renewal action.

Additional information is included in appendices. Appendix A contains public comments related to the environmental review for license renewal and staff responses to those comments.

Appendices B through G include the following:

- the preparers of the supplement (Appendix B)
- the chronology of the NRC staff's environmental review correspondence related to this draft SEIS (Appendix C)
- the organizations contacted during the development of this draft SEIS (Appendix D)
- the IP2 and IP3 compliance status in Table E-1 and copies of consultation correspondence prepared and sent during the evaluation process) (Appendix E)
- GEIS environmental issues that are not applicable to IP2 and IP3 (Appendix F)
- NRC staff evaluation of severe accident mitigation alternatives (Appendix G)

1.2 Background

Use of the GEIS, which examines the possible environmental impacts that could occur as a result of renewing individual nuclear power plant operating licenses under 10 CFR Part 54, and

the established license renewal evaluation process support the thorough evaluation of the impacts of operating license renewal.

1.2.1 Generic Environmental Impact Statement

The NRC initiated a generic assessment of the environmental impacts associated with the license renewal term to improve the efficiency of the license renewal process by documenting the assessment results and codifying the results in the Commission's regulations. This assessment is provided in the GEIS, which serves as the principal reference for all nuclear power plant license renewal EISs.

The GEIS documents the results of the systematic approach that the NRC staff used to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. For each potential environmental issue, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) term "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels—SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," as follows:

SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The GEIS assigns a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has

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been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this draft SEIS unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1; therefore, additional plant-specific review for these issues is required.

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The two issues not categorized are environmental justice and chronic effects of electromagnetic fields. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning, 67 apply only to operation during the renewal term, and 8 apply to both refurbishment and operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its operating license is required to submit an ER as part of its application. The license renewal evaluation process involves careful review of the applicant's ER and assurance that all new and potentially significant information not already addressed in or available during the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of the proposed license renewal.

In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must do the following:

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, in accordance with 10 CFR 51.53(c)(3)(ii)
- discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action

In accordance with 10 CFR 51.53(c)(2), the ER does not need to do the following:

- consider the economic benefits and costs of the proposed action and alternatives to the proposed action except insofar as such benefits and costs are either (1) essential for making a determination regarding the inclusion of an alternative in the range of alternatives considered or (2) relevant to mitigation

- 1 • consider the need for power and other issues not related to the environmental effects of
- 2 the proposed action and the alternatives
- 3 • discuss any aspect of the storage of spent fuel within the scope of the generic
- 4 determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b)
- 5 • pursuant to 10 CFR 51.23(c)(3)(iii) and (iv), contain an analysis of any Category 1 issue
- 6 unless there is significant new information on a specific issue

7 New and significant information is (1) information that identifies a significant environmental issue
8 not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or
9 (2) information that was not considered in the analyses summarized in the GEIS and that leads
10 to an impact finding that is different from the finding presented in the GEIS and codified in
11 10 CFR Part 51.

12 In preparing to submit its application to renew the IP2 and IP3 operating licenses, Entergy
13 developed a process to ensure that (1) information not addressed in or available during the
14 GEIS evaluation regarding the environmental impacts of license renewal for IP2 and IP3 would
15 be properly reviewed before submitting the ER and (2) such new and potentially significant
16 information related to renewal of the licenses for IP2 and IP3 would be identified, reviewed, and
17 assessed during the period of NRC review. Entergy reviewed the Category 1 issues that
18 appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of
19 the GEIS remain valid with respect to IP2 and IP3. This review was performed by personnel
20 from Entergy who were familiar with NEPA issues and the scientific disciplines involved in the
21 preparation of a license renewal ER.

22 The NRC staff also has a process for identifying new and significant information. That process
23 is described in detail in NUREG-1555, "Standard Review Plans for Environmental Reviews for
24 Nuclear Power Plants, Supplement 1: Operating License Renewal," issued March 2000 (NRC
25 2000). The search for new information includes (1) review of an applicant's ER and the process
26 for discovering and evaluating the significance of new information, (2) review of records of
27 public comments, (3) review of environmental quality standards and regulations,
28 (4) coordination with Federal, State, and local environmental protection and resource agencies,
29 and (5) review of the technical literature. New information discovered by the NRC staff is
30 evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where
31 new and significant information is identified, reconsideration of the conclusions for those issues
32 is limited in scope to the assessment of the relevant new and significant information; the scope
33 of the assessment does not include other facets of the issue that are not affected by the new
34 information.

35 Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are
36 applicable to IP2 and IP3. At the beginning of the discussion of each set of issues, there is a
37 table that identifies the issues to be addressed and lists the sections in the GEIS where the
38 issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For
39 Category 1 issues for which there is no new and significant information, the table is followed by
40 a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of
41 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For
42 Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the
43 tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and

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the draft SEIS sections where the analysis is presented. The draft SEIS sections that discuss the Category 2 issues are presented immediately following the table.

The NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts with the environmental impacts of alternatives. The evaluation of the Entergy license renewal application began with the publication of a notice of acceptance for docketing, notice of opportunity for a hearing, and notice of intent to prepare an EIS and conduct scoping in the *Federal Register*, May 11, 2007 (72 FR 26850; NRC 2007). A public scoping meeting was held on June 27, 2007, in Cortlandt Manor, New York. Comments received during the scoping period have been summarized by the NRC in a summary report issued in December of 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML083360115). The NRC staff adopts by reference the scoping summary report in Part 1 of Appendix A to this draft SEIS.

The NRC staff followed the review guidance contained in NUREG-1555, Supplement 1 (NRC 2000). The NRC staff, and the contractor retained to assist the NRC staff, visited the IP2 and IP3 site on September 11 and 12, 2007, and again on September 24 and 25, 2007, to gather information and to become familiar with the site and its environs. The NRC staff also reviewed the comments received during scoping and consulted with Federal, State, regional, and local agencies. A list of the organizations consulted is provided in Appendix D. Other documents related to IP2 and IP3 were reviewed and are referenced within this draft SEIS.

This draft SEIS presents the NRC staff's preliminary analysis that considers and weighs the environmental effects of the proposed renewal of the operating licenses for IP2 and IP3, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's preliminary recommendation to the Commission on whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

A 75-day comment period will begin on the date of publication of the U.S. Environmental Protection Agency Notice of Filing of the draft SEIS to allow members of the public to comment on the preliminary results of the NRC staff's review. During this comment period, a public meeting will be held in Cortlandt Manor, New York, in February 2009. During this meeting, the NRC staff will describe the preliminary results of the NRC environmental review and answer questions related to it to provide members of the public with information to assist them in formulating their comments.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the operating licenses for IP2 and IP3 (IP1 was shut down in 1974). IP2 and IP3 are located on approximately 239 acres of land on the east bank of the Hudson River at Indian Point, Village of Buchanan, in upper Westchester County, New York, approximately 24 miles north of the New York City boundary line. The facility has two Westinghouse pressurized-water reactors. IP2 is currently licensed to generate 3216 megawatts thermal (MW(t)) (core power) with a design net electrical capacity of 1078 megawatts electric (MW(e)). IP3 is currently licensed to generate 3216 MW(t) (core power) with a design net electrical capacity of about 1080 MW(e). IP2 and IP3 cooling is

provided by water from the Hudson River to various heat loads in both the primary and secondary portions of the plants. The current operating license for IP2 expires on September 28, 2013, and the current operating license for IP3 expires on December 12, 2015. By letter dated April 23, 2007, Entergy submitted an application to the NRC (Entergy 2007a) to renew the IP2 and IP3 operating licenses for an additional 20 years.

1.4 The Purpose and Need for the Proposed Action

Although a licensee must have a renewed license to operate a reactor beyond the term of the existing operating license, the possession of that license is just one of a number of conditions that must be met for the licensee to continue plant operation during the term of the renewed license. Once an operating license is renewed, State regulatory agencies and the owners of the plant will ultimately decide whether the plant will continue to operate based on factors such as the need for power or matters within the State's jurisdiction—including acceptability of water withdrawal, consistency with State water quality standards, and consistency with State coastal zone management plans—or the purview of the owners, such as whether continued operation makes economic sense.

Thus, for license renewal reviews, the NRC has adopted the following definition of purpose and need (GEIS Section 1.3):

The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and where authorized, Federal (other than NRC) decision makers.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954, as amended, or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an operating license is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the unit's license.

1.5 Compliance and Consultations

Entergy is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, Entergy provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with the IP2 and IP3 license renewals. Authorizations and consultations relevant to the proposed operating license renewal actions are included in Appendix E.

The NRC staff has reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant

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environmental issues. The ER states that Entergy is in compliance with applicable environmental standards and requirements for IP2 and IP3. The NRC staff has not identified any environmental issues that are both new and significant.

1.6 References

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

40 CFR Part 1508. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 1508, “Terminology and Index.”

Atomic Energy Act of 1954. 42 *United States Code* 2011, *et seq.*

Entergy Nuclear Operations, Inc. (Entergy). 2007a. “Indian Point, Units 2 & 3, License Renewal Application.” April 23, 2007. ADAMS Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. “Applicant’s Environment Report, Operating License Renewal Stage.” (Appendix E to “Indian Point, Units 2 & 3, License Renewal Application”.) April 23, 2007. ADAMS Accession No. ML071210530.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007. ADAMS Accession No. ML071280700.

National Environmental Policy Act of 1969 (NEPA). 42 *United States Code* 4321, *et seq.*

U.S. Nuclear Regulatory Commission (NRC). 1996. “Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants.” NUREG-1437, Volumes 1 and 2, Washington, DC.

U.S. Nuclear Regulatory Commission (NRC). 1999. “Generic Environmental Impact Statement for License Renewal of Nuclear Plants Main Report,” Section 6.3, “Transportation,” Table 9.1, “Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants.” NUREG-1437, Volume 1, Addendum 1, Washington, DC.

U.S. Nuclear Regulatory Commission (NRC). 2000. “Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal.” NUREG-1555, Supplement 1, Washington, DC.

U.S. Nuclear Regulatory Commission (NRC). 2007. “Entergy Nuclear Operations, Inc.; Notice of Receipt and Availability of Application for Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3; Facility Operating License Nos. DPR-26 and DPR-64 for an Additional 20-Year Period.” *Federal Register*, Volume 72, Number 91, p. 26850. May 11, 2007.

2.0 DESCRIPTION OF NUCLEAR POWER PLANT AND SITE AND PLANT INTERACTION WITH THE ENVIRONMENT

Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York. The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 24 mi (39 km) north of New York City.

Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. The plant and its surroundings are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

Indian Point Nuclear Generating Station Unit No. 1 (IP1, now permanently shut down) shares the site with IP2 and IP3. IP1 is located between IP2 and IP3. IP1 was shut down on October 31, 1974, and has been placed in a safe storage condition (SAFSTOR) awaiting final decommissioning.

2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term

The entirety of the Indian Point site is surrounded by a perimeter fence, establishing an area known as the "owner controlled area." Security personnel patrol all roads within the site. Within the fence lies an area of greater security known as the "protected area." The protected area is more heavily guarded and controlled by a second fence and an intrusion detection system. The protected area is accessible only through manned security buildings and gates requiring electronic identification. In addition, spaces within the protected area designated as "vital areas" have additional access controls (Entergy 2006a).

The area within a 6-mi (10-km) radius of the IP2 and IP3 site includes the Village of Buchanan, located about 0.5 mi (0.8 km) southeast of the site, and the City of Peekskill, located 2.5 mi (4.0 km) northeast. In the 2000 U.S. census, populations of these towns were 2,189 and 22,441, respectively. The largest town within a 6-mi (10-km) radius of the site is Haverstraw, New York, with a 2000 population of approximately 33,811 (USCB 2000). Haverstraw is located to the southwest on the western bank of the Hudson River. Several other small villages, including Verplanck and Montrose, lie within a 6-mi (10-km) radius of the IP2 and IP3 site. The area within a 6-mi (10-km) radius of the site also includes several thousand acres of the Bear Mountain State Park located across the Hudson River, the nearly 2000-acre (809-ha) Camp Smith (a New York State military reservation) located 2.3 mi (3.7 km) north of the site, and a portion—about 2000 acres (809 ha)—of the U.S. Military Academy at West Point.

The area within a 50-mi (80-km) radius of the site includes parts of New York, New Jersey, and Connecticut. New York City, located approximately 24 mi (39 km) south of the plant, is the largest city within 50 mi (80 km) with a 2006 population of approximately 8,214,426 (USCB 2006). Other population centers include Danbury and Stamford, Connecticut; Newark, New

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1 Jersey; and Poughkeepsie, New York. The area within a 50-mi (80-km) radius also includes all
2 of the U.S. Military Academy at West Point, located 7.5 mi (12 km) northwest of the site, and the
3 Picatinny Arsenal, located 35.5 mi (57.1 km) southwest of the site in New Jersey (Entergy
4 2007a).

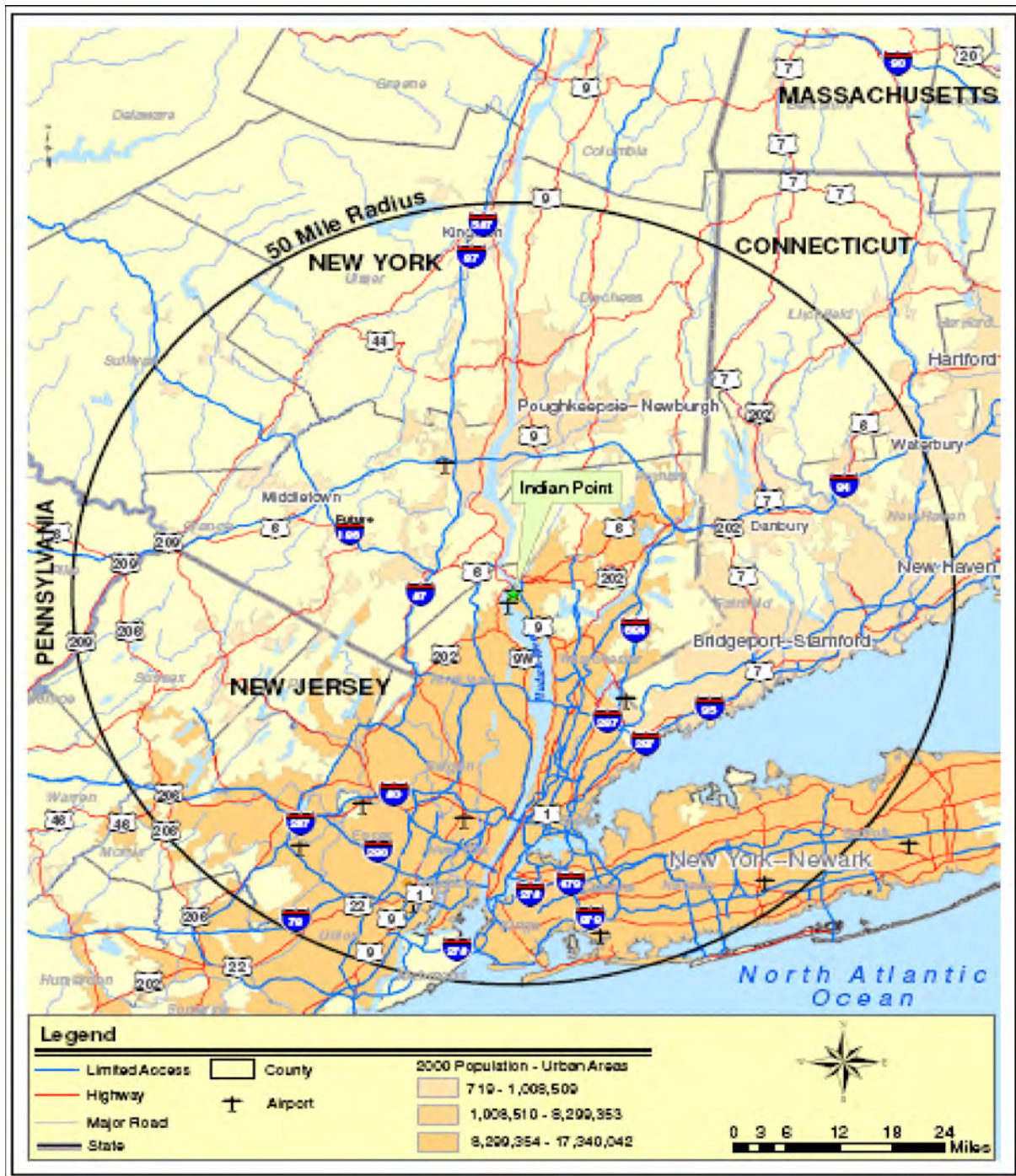
5 The region surrounding the Indian Point site has undulating terrain with many peaks and
6 valleys. Dunderberg Mountain lies on the western side of the Hudson River 1 mi (1.6 km)
7 northwest of the site. North of Dunderberg Mountain, high grounds reach an elevation of
8 800 feet (ft) (244 meters (m)) above the western bank of the Hudson River. To the east of the
9 site lie the Spitzenberg and Blue Mountains. These peaks are about 600 ft (183 m) in height.
10 There is also a weak, poorly defined series of ridges that run in a north-northeast direction east
11 of IP2 and IP3. The Timp Mountains are west of the facility. These mountains rise to a
12 maximum elevation of 846 ft (258 m). Elevations south of the site are 100 ft (30.5 m) or less
13 and gradually slope toward the Village of Verplanck (Entergy 2007a).

14 The site location and features within 50-mi (80-km) and 6-mi (10-km) radii are illustrated in
15 Figures 2-1 and 2-2, respectively.

2.1.1 External Appearance and Setting

17 As discussed in Section 2.1, the immediate area around the Indian Point site is completely
18 enclosed by a security fence. Access to the site is controlled at a security gate on Broadway
19 (main entrance). Controlled access to the site is also available using the existing wharf on the
20 Hudson River. The wharf is used to receive heavy equipment shipped to the site by barge.
21 There are no rail lines that service the site. The nearest residence is less than 0.5 mi (0.8 km)
22 from IP2 and IP3 and about 100 meters (m) (328 ft) beyond the site boundary to the east-
23 southeast (ENN 2007a).

24 The facility can be seen easily from the river. Surrounding high ground and vegetation make it
25 difficult to see the facility from beyond the security fence on land, except from Broadway. The
26 334-ft (102-m) tall superheater stack for IP1, the 134-ft (40.8-m) tall IP2 and IP3 turbine
27 buildings, and the 250-ft (76.2-m) tall reactor containment structures are the tallest structures on
28 the site (Entergy 2007a).



1 Source: Entergy 2007a

2 **Figure 2-1. Location of IP2 and IP3, 50-mi (80-km) radius**



Source: Entergy 2007a

Figure 2-2. Location of IP2 and IP3, 6-mi (10-km) radius

Other visible IP2 and IP3 site features include auxiliary buildings, intake structures, the discharge structure, electrical switchyard, and associated transmission lines (Entergy 2007a). The site boundary and general facility layout are depicted in Figures 2-3 and 2-4, respectively.

The facility contains several stationary bulk petroleum and chemical storage tanks. Bulk chemical storage tanks are registered with the New York State Department of Environmental Conservation (NYSDEC) via Hazardous Substance Bulk Storage Registration Certificates. The tanks and their contents are managed in accordance with the NYSDEC Chemical Bulk Storage Regulations. The IP2 bulk petroleum storage tanks are registered with NYSDEC via a Major Oil Storage Facility License, while the IP3 tanks are registered with the Westchester County Department of Health via a Petroleum Bulk Storage Registration Certificate.

IP2 and IP3 each use two main transformers to increase voltage from their respective turbine generators. The transformers increase generator output from 22 kilovolts (kV) to 345 kV. Power is then delivered to the Consolidated Edison Company (Con Edison) transmission grid by way of two double-circuit 345-kV lines. These lines connect the main onsite transformers to the offsite Buchanan substation which is located across Broadway near the main entrance to the site. The lines that connect the transformers to the substation are about 2000 ft (610 m) in length and, except for the terminal 100 ft where they cross over Broadway (a public road) and enter the substation, lines are located within the site boundary (Entergy 2007a). The 345-kV transmission lines that distribute power from the substation are shown in Figure 2-3.

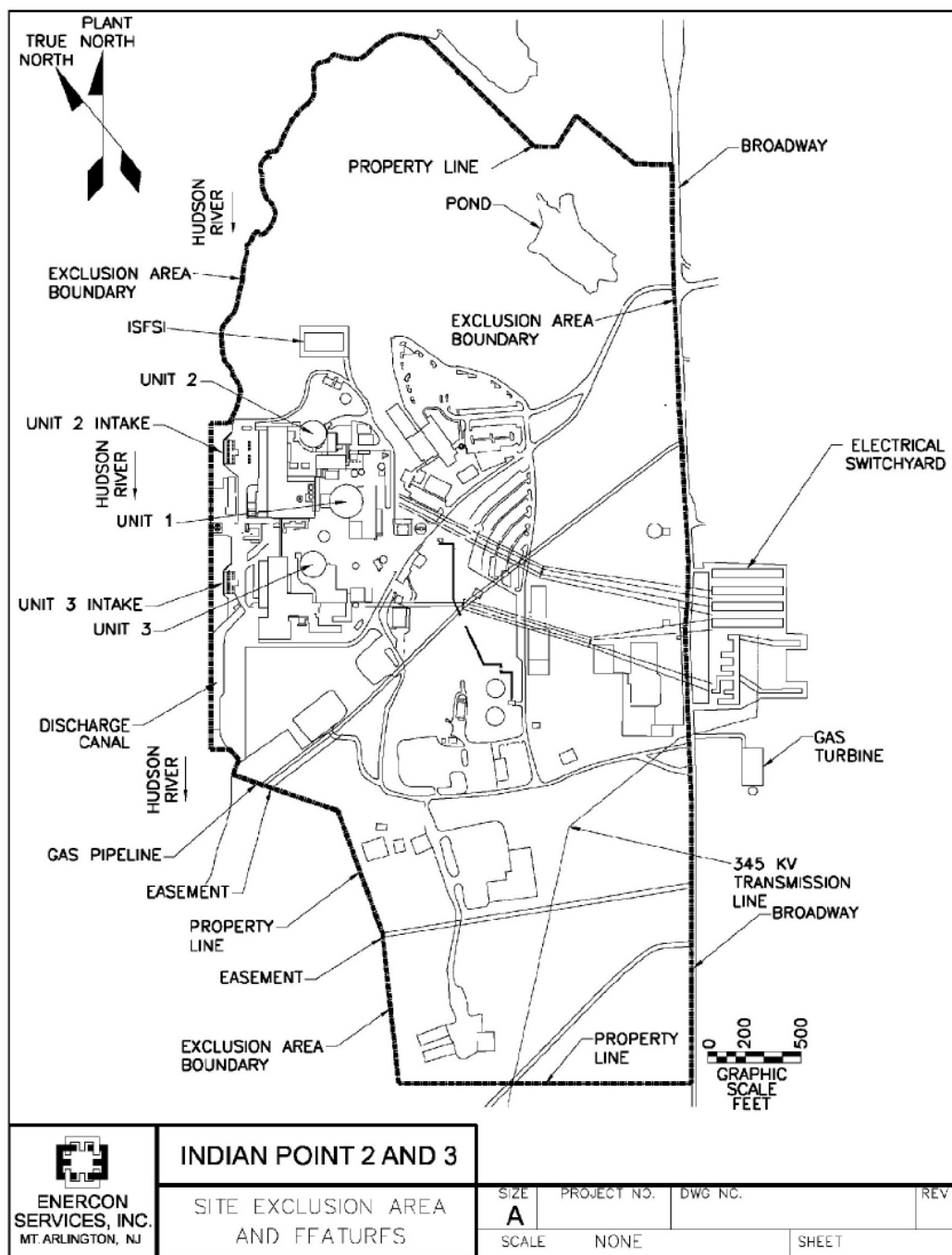
2.1.2 Reactor Systems

As noted in Section 2.0, both IP2 and IP3 employ Westinghouse pressurized-water reactors and four-loop NSSSs. Each NSSS loop contains a reactor coolant pump and a steam generator. The reactor coolant system transfers the heat generated in the reactor core to the steam generators, which produce steam to drive the electrical turbine generators (Entergy 2007b).

IP2 is currently licensed to operate at a core power of 3216 megawatt thermal (MW(t)), which results in a turbine generator output of approximately 1078 megawatt electric (MW(e)). IP3 is currently licensed to operate at 3216 MW(t), which results in a turbine generator output of approximately 1080 MW(e). IP2 and IP3 have similar designs with independent functional and safety systems. The units share the following systems (Entergy 2007b):

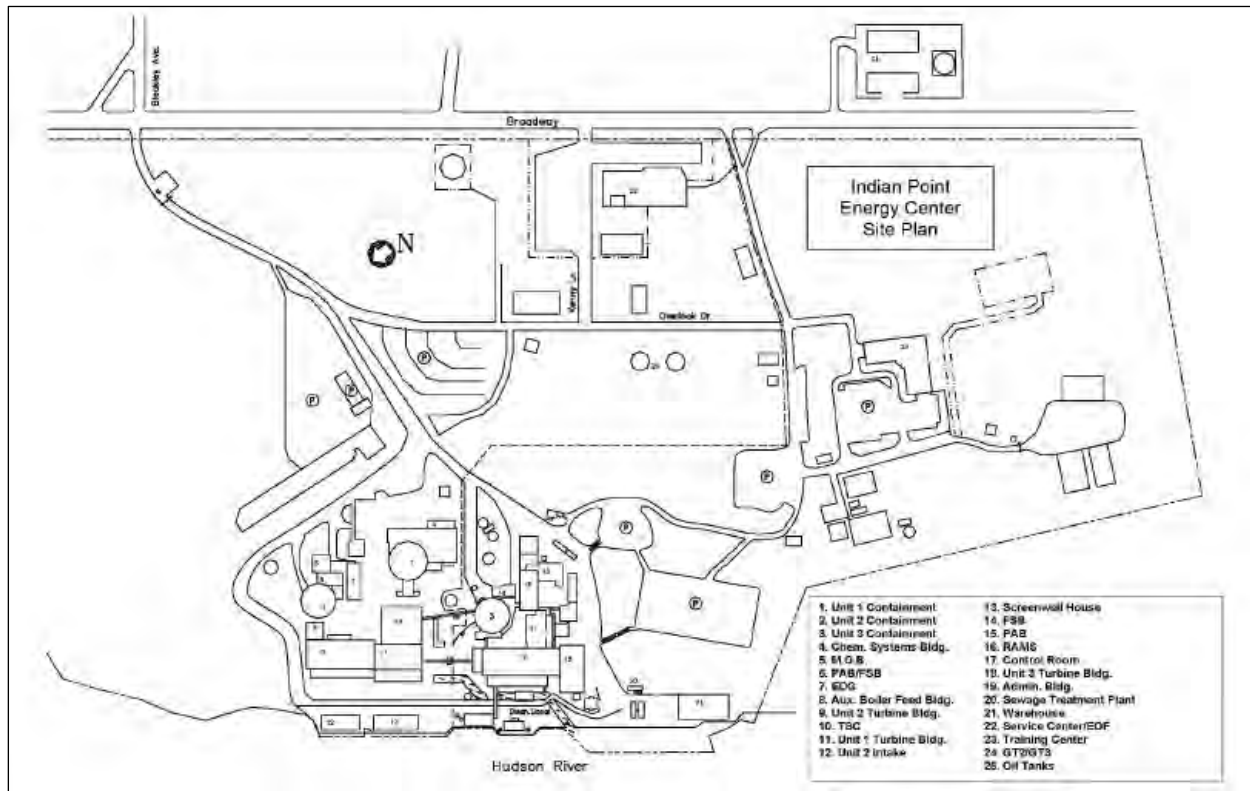
- discharge canal, outfall structure, and associated instrumentation and sampling systems
- electrical supplies and interties
- station air interties
- demineralized water, condensate makeup, and hydrogen interties
- city water and fire protection interties
- dedicated No. 2 fuel oil systems for diesel generators
- sewage treatment facility
- auxiliary steam system intertie

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1 Source: Entergy 2007a

2 **Figure 2-3. IP2 and IP3 property boundaries and environs**



1 Source: Entergy 2007a

2 **Figure 2-4. IP2 and IP3 site layout**

- 3
- 4 • service boiler fuel oil supply system
 - 5 • liquid steam generator blowdown, radioactive waste processing, and discharge (to IP1) facilities

6 The nuclear fuel for IP2 and IP3 is made of low-enrichment (less than 5 percent by weight
 7 uranium-235) uranium dioxide pellets stacked in pre-pressurized tubes made from zircaloy or
 8 ZIRLO. The fuel tube rods have welded end plugs. Based on core design values, IP2 and IP3
 9 operate at an individual rod average fuel burnup of no more than 62,000 megawatt-days per
 10 metric ton of heavy metal. This ensures that peak burnups remain within the acceptable limits
 11 specified in Table B-1 of Appendix B, "Environmental Effect of Renewing the Operating License
 12 of a Nuclear Power Plant," to Subpart A, "National Environmental Policy Act—Regulations
 13 Implementing Section 102(2)," of Title 10, Part 51, "Environmental Protection Regulations for
 14 Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations*
 15 (10 CFR Part 51) (Entergy 2006a). Reactor fuel that has exhausted a certain percentage of its
 16 fissile uranium content so that it is no longer an efficient fissile fuel source is referred to as spent
 17 fuel. The spent fuel is removed from the reactor core and replaced by fresh fuel during routine
 18 refueling outages. Refueling outages at IP2 and IP3 typically occur every 24 months. The
 19 spent fuel assemblies are then stored in the spent fuel pool (SFP) in the fuel storage building.

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1 Located north of IP2 inside the protected area fence, the spent fuel will be transferred to dry
2 storage (Entergy 2007a) at an onsite independent spent fuel storage installation (ISFSI). The
3 first fuel was moved from IP2 to the ISFSI pad, which is approximately 100 ft (30.5 m) wide by
4 200 ft (61.0 m) long, during the first week of January 2008 (Entergy 2008a).

5 IP2 and IP3 containment buildings completely enclose each unit's reactor and the reactor
6 coolant system. The containment buildings are designed to minimize leakage of radioactive
7 materials to the environment if a design-basis loss-of-coolant accident were to occur. The
8 containment structures have an outer shell of reinforced concrete and an inner steel liner
9 (Entergy 2007b).

10 The IP2 containment building contains a containment purge supply and exhaust system and a
11 containment pressure relief system. The purge supply and exhaust system provides fresh air to
12 the containment and filters air released from containment. The containment pressure relief
13 system regulates normal pressure in the containment during reactor power operation (Entergy
14 2007b).

15 The IP3 containment building contains a vapor containment heating and ventilation purge
16 system and a vapor containment pressure relief system. The heating and ventilation system
17 regulates fresh air flow into the containment and filters air before its dispersion to the
18 environment. The vapor containment pressure relief system regulates pressure changes in
19 containment during reactor power operation (Entergy 2007b).

2.1.3 Cooling and Auxiliary Water Systems

21 IP2 and IP3 have once-through condenser cooling systems that withdraw water from and
22 discharge it to the Hudson River. The systems are described in detail in the IP2 and IP3
23 environmental report (ER) (Entergy 2007a). This section provides a general description based
24 on the information provided by Entergy in the ER.

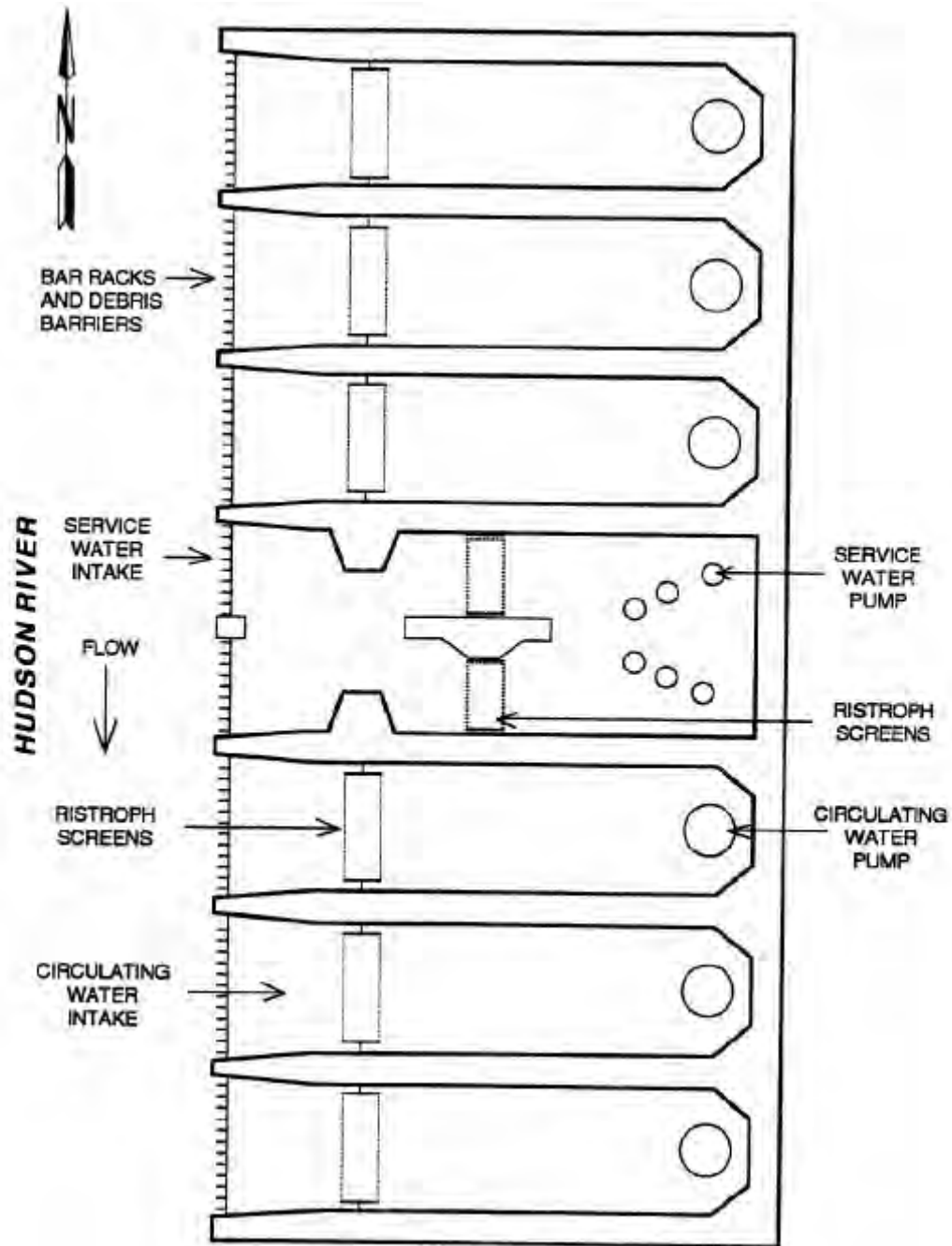
25 The maximum design flow rate for each cooling system is approximately 1870 cubic feet per
26 second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s).

27 Two shoreline intake structures—one for each unit—are located along the Hudson River on the
28 northwestern edge of the site and provide cooling water to the site. Each structure consists of
29 seven bays, six for circulating water and one for service water. The IP2 intake structure has
30 seven independent bays, while the IP3 intake structure has seven bays that are served by a
31 common plenum. In each structure, six of the seven bays contain cooling water pumps, and the
32 seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers,
33 river water passes through traveling screens in the intake structure bays to remove debris and
34 fish.

35 The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high
36 speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm;
37 $8.83 \text{ m}^3/\text{s}$) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides
38 187 cfs (84,000 gpm; $5.30 \text{ m}^3/\text{s}$) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating
39 water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each
40 pump provides 312 cfs (140,000 gpm; $8.83 \text{ m}^3/\text{s}$); at low speed, it provides a dynamic head of
41 29 ft (8.8 m) and 143 cfs (64,000 gpm; $4.05 \text{ m}^3/\text{s}$). In accordance with the October 1997
42 Consent Order (issued pursuant to the Hudson River Settlement Agreement; see

1 Section 2.2.5.3 for more information), the applicant adjusts the speed of the intake pumps to
2 mitigate impacts to the Hudson River.

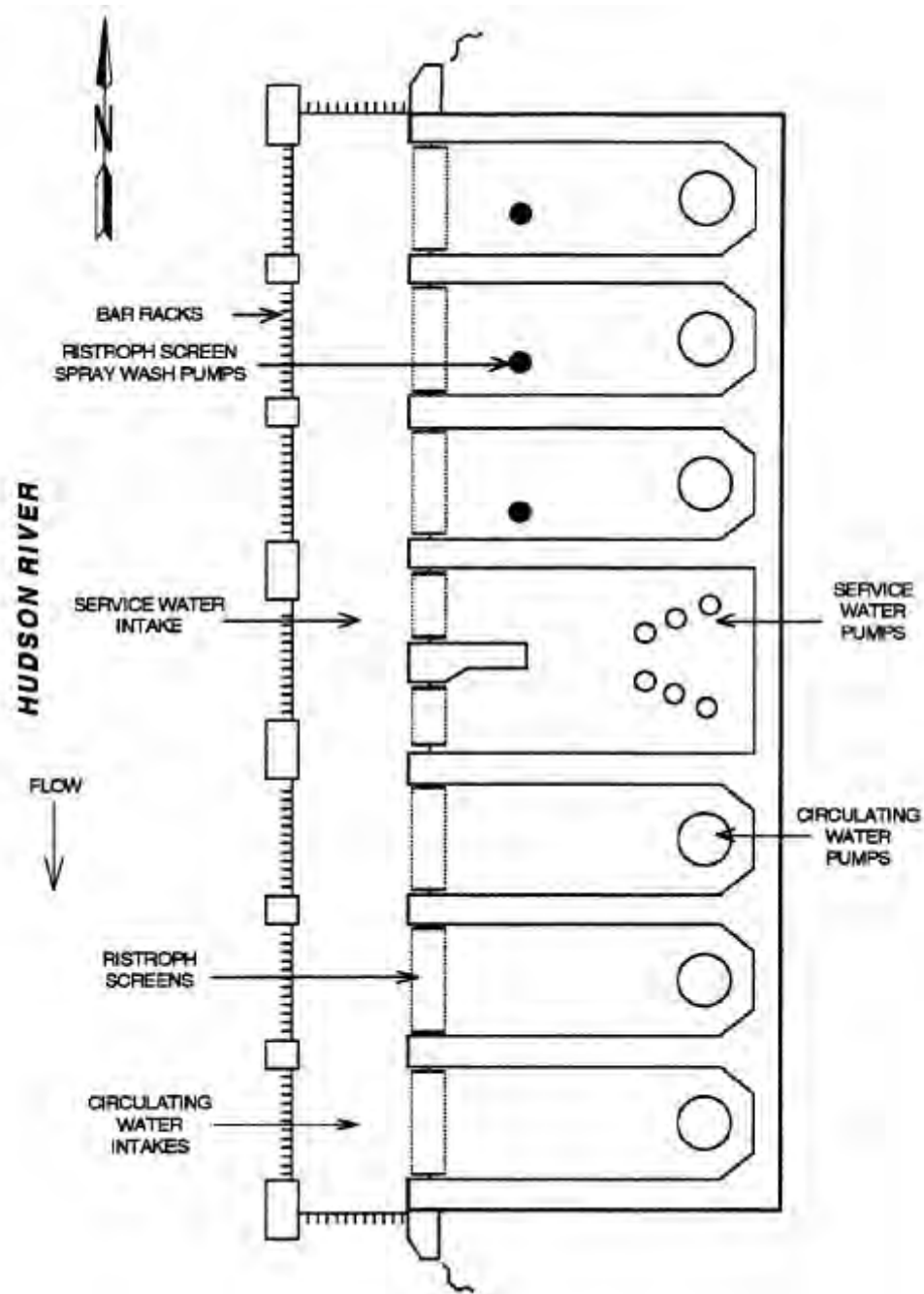
3 Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located
4 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under
5 a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps
6 floating debris and ice from entering the bay. At the entrance to each bay, water also passes
7 through a subsurface bar screen to prevent additional large debris from becoming entrained in
8 the cooling system. Next, smaller debris and fish are screened out using modified Ristroph
9 traveling screens. Figures 2-5 through 2-8 illustrate the IP2 and IP3 intake structures and bays.



1 Source: Entergy 2007a

2

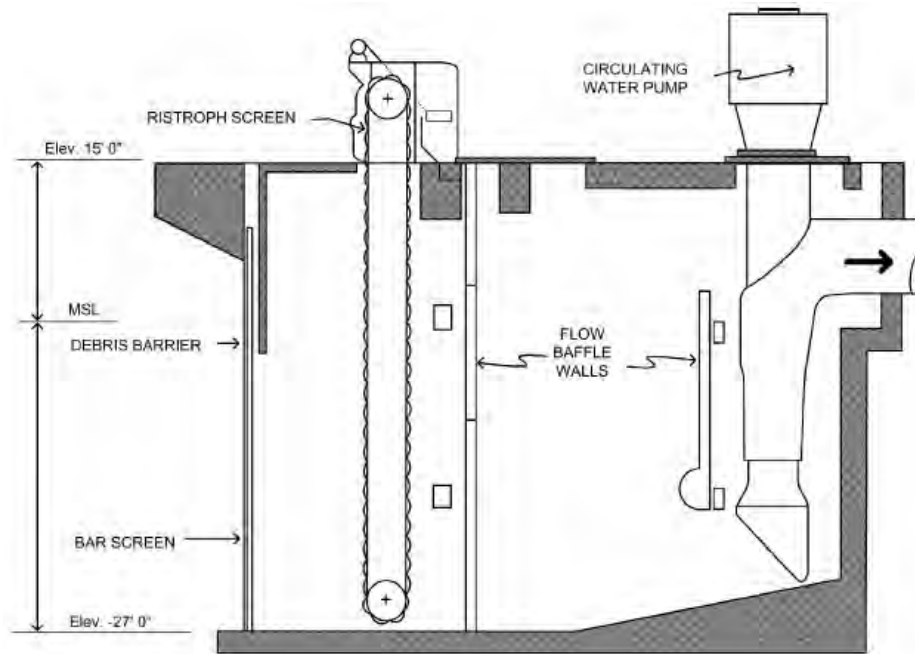
Figure 2-5. IP2 intake structure



1 Source: Entergy 2007a

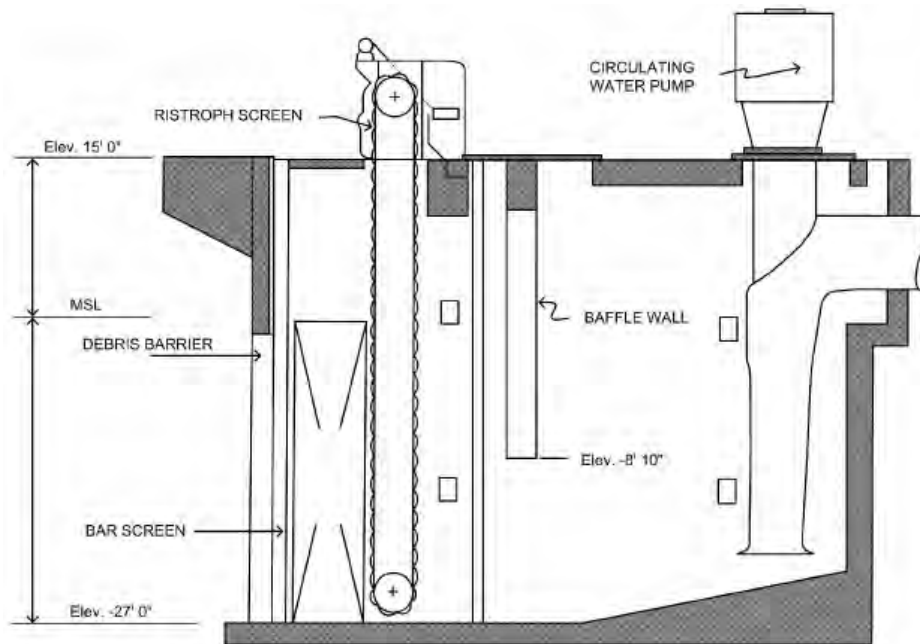
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Figure 2-6. FIP3 intake structure



Source: Entergy 2007a

Figure 2-7. IP2 intake system



Source: Entergy 2007a

Figure 2-8. IP3 intake system

1 The modified Ristroph traveling screens consist of a series of panels that rotate continuously.
2 As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled
3 baskets at the bottom of each panel and are carried over the headshaft, where they are washed
4 out onto a mesh using low-pressure sprays from the rear side of the machine. The 0.25-by-
5 0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the
6 mesh. Two high-pressure sprays remove debris from the front side of the machine after fish
7 removal.

8 From the mesh, fish return to the river via a 12-in. (30-cm) diameter pipe. The pipe extends
9 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft
10 (11 m).

11 After moving through the condensers, cooling water is discharged to the discharge canal via a
12 total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the
13 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure
14 located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full
15 flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by
16 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the
17 surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), enhances mixing
18 to minimize thermal impact.

19 The discharged water is at an elevated temperature, and therefore, some water is lost because
20 of evaporation. Based on conservative estimates, the staff of the U.S. Nuclear Regulatory
21 Commission (NRC) estimates that this induced evaporation resulting from the elevated
22 discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m³/s). This loss is about
23 .5 percent of the annual average downstream flow of the Hudson River, which is more than
24 9000 cfs (4 million gpm or 255 m³/s). The average cooling water transient time ranges from
25 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system.

26 Auxiliary water systems for service water are also provided from the Hudson River via the
27 dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool
28 components (e.g., pumps) that generate heat during operation. Secondary functions of the
29 service water include the following:

- 30 • protect equipment from potential contamination from river water by providing cooling to
31 intermediate freshwater systems
- 32 • provide water for washing the modified Ristroph traveling screens
- 33 • provide seal water for the main circulating water pumps

34 The IP2 service water bay has six identical centrifugal sump-type pumps, each having a
35 capacity of at least 11 cfs (5000 gpm; 0.31 m³/s) at 220-ft (67-m) total design head. The IP3
36 service water bay also has six similar pumps, each rated at 13 cfs (6000 gpm; 170 m³/s) and
37 195-ft (59.4-m) total design head. The average approach velocity at the entrance to each
38 service water bay when all pumps are operating is about 0.2 fps (0.06 mps). Each service
39 water bay also contains two Ristroph screens to reduce fish entrainment.

40 Additional service water is provided to the nonessential service water header for IP2 through the
41 IP1 (which is decommissioned) river water intake structure. The IP1 intake includes four intake
42 bays each with a coarse bar screen and a single 0.125-in. (0.318-cm) mesh screen. The intake

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structure contains two 36-cfs (16,000-gpm; 1.0-m³/s) spray wash pumps. The screens are washed automatically and materials are sluiced to the Hudson River.

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

IP2 and IP3 radioactive waste systems are designed to collect, treat, and dispose of radioactive and potentially radioactive wastes that are byproducts of plant operations. These byproducts include activation products resulting from the irradiation of reactor water and impurities therein (principally metallic corrosion products) and fission products resulting from their migration through the fuel cladding or uranium contamination within the reactor coolant system.

Operating procedures for radioactive waste systems are designed to ensure that radioactive wastes are safely processed and discharged from the plant within the limits set forth in 10 CFR Part 20, "Standards for Protection against Radiation"; Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"; the plant's technical specifications; and the IP2 and IP3 Offsite Dose Calculation Manual (ODCM) (Entergy 2007a).

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, or solid. Liquid radioactive wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Gaseous radioactive wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the reactor coolant system, solids that came into contact with reactor coolant system liquids or gases, or solids used in the reactor coolant system or steam and power conversion system operation or maintenance.

As indicated in Section 2.1.2, reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 24 months. Spent fuel assemblies are then stored for a period of time in the SFP in the fuel storage building and may later be transferred to dry storage at a recently constructed onsite ISFSI. Entergy has constructed an ISFSI in the north end of the IP2 and IP3 site in an area that was previously undeveloped. The facility is planned to hold up to 78 Holtec International HI-STORM 100S(B) casks (Entergy 2007a).

The IP2 and IP3 ODCM contains the methodology and parameters used to calculate offsite doses resulting from radioactive gaseous and liquid effluents and the gaseous and liquid effluent monitoring alarm and trip setpoints used to verify that radioactive discharges meet regulatory limits. The ODCM also contains the radioactive effluent controls and radiological environmental monitoring activities and descriptions of the information that should be included in the annual Radiological Environmental Operating Report and annual Radioactive Effluent Release Report (Entergy 2007a).

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

The liquid waste processing system collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal.

IP2

In IP2, the liquid waste holdup system collects low-level radioactive waste from throughout the facility and holds the waste until it can be processed. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. Liquid waste is divided into two general classifications—high-quality liquid waste from the reactor coolant drain tank and routine liquid waste from the waste holdup tank which contains reactor coolant. The IP2 liquid wastes are transferred from the waste holdup tank to the IP1 waste collection system (described later in this section). The liquid waste can also be transferred from the waste holdup tank to the waste condensate tank, where its radioactivity can be analyzed to determine whether the waste is acceptable for discharge into the condenser circulating water and into the Hudson River.

In the event of primary reactor coolant water (radioactive) leakage into the secondary-side water (nonradioactive) system, potentially contaminated water that collects in the secondary-side drains may be collected and sent to a collection point in the auxiliary boiler feedwater building for eventual processing.

IP3

In IP3, the liquid waste holdup system collects low-level radioactive waste from throughout the facility and holds the waste until it can be processed. During normal plant operations, the system receives input from numerous sources, such as equipment drains and leak lines, radioactive chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak-offs, and floor drains. The system consists of three tanks—a 24,500-gallon (gal) (92,700-liter (L)) waste holdup tank located in the waste holdup pit, and the two 62,000-gal (235,000-L) waste holdup tanks located in the liquid radioactive waste storage facility.

The liquid radioactive waste storage facility, which houses the 62,000-gal (235,000-L) waste tanks, is an underground concrete structure. The 62,000-gal (235,000-L) tanks are supported on concrete piers. The building is supported on hard rock. The foundation consists of a rigid 2-in. (5.0-cm) thick slab that is waterproofed. The reinforced concrete walls of the building are also waterproofed. The roof is made of 3-in. (7.6-cm) reinforced concrete poured on a steel deck and beam system.

When the waste has been sampled and analyzed and found to be acceptable for discharge, it is pumped from the waste holdup tank to the monitor tanks. When one monitor tank is filled, it is isolated, and the waste liquid is recirculated and sampled for radioactive and chemical analysis while the second tank is in service accumulating waste. If the waste material in the filled monitor tank meets release standards, the waste liquid is pumped to the service water discharge for release into the Hudson River. If it does not meet release standards, it is returned to the waste holdup tanks for additional processing. Entergy performs radioactive and chemical analyses to determine the amount of radioactivity released. There is also a radiation monitor which provides surveillance over the operation to ensure that the discharge is within radiation standards. If the radioactivity in the liquid waste being discharged exceeds the radiation standard, the discharge is terminated.

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IP1

Radioactive waste storage and processing facilities located in IP1 provide additional waste processing services for the two operating units. IP1 contains four tanks with a capacity of 75,000 gal (284,000 L) each. From these tanks, the liquid can be processed by use of sluicable demineralizer vessels. There is also a portable demineralization system located in the IP1 Chemical System Building to process liquid waste. This system uses a number of inline ion exchanger resin beds and filters to remove radionuclides and chemicals from the waste stream. Once the contents of the waste tanks meet release criteria, the liquid waste is discharged into the river.

Liquid Releases

Liquid releases to the Hudson River are limited to the extent possible to satisfy the dose design objectives of Appendix I to 10 CFR Part 50. IP2 and IP3 have controls, described in their ODCMs, for limiting the release of radioactive liquid effluents. The controls are based on the concentrations of radioactive materials in liquid effluents and the calculated projected dose to a hypothetical member of the public. Concentrations of radioactive material that may be released in liquid effluents are limited to the concentrations specified by 10 CFR Part 20. For the calendar year, the ODCM limits the dose to a member of the public from liquid effluents to 3 millirems (mrem) (0.03 millisievert (mSv)) to the total body and 10 mrem (0.10 mSv) to any organ (Entergy 2007a).

Entergy maintains radioactive liquid effluent discharges in accordance with the procedures and methodology described in the ODCM. The liquid radioactive waste processing system is effectively used to reduce radioactive materials in liquid effluents before discharge to meet the as-low-as-reasonably-achievable (ALARA) dose objectives in Appendix I to 10 CFR Part 50.

The NRC staff reviewed the IP2 and IP3 radioactive effluent release reports for 2002 through 2006 for liquid effluents (Entergy 2003a, 2003b, 2004, 2005a, 2006b, 2007c) to determine whether releases were reasonable. In 2006, 5.99×10^7 gal (2.27×10^8 L) of radiological liquid effluents diluted with 1.47×10^{12} gal (5.58×10^{12} L) of water were discharged from the IP2 and IP3 site. The amount of radioactivity discharged in the form of fission and activation products from the IP2 and IP3 site in 2006 totaled 5.92×10^{-2} curies (Ci) (2.19×10^3 megabecquerels (MBq)). A total of 1.56×10^3 Ci (5.77×10^7 MBq) of tritium was released from the IP2 and IP3 site in 2006. A total of 3.82×10^{-1} Ci (1.41×10^4 MBq) of dissolved and entrained gases was released in liquid discharges from the IP2 and IP3 site in 2006 (Entergy 2007c). The liquid discharges for 2006 are consistent with the radioactive liquid effluents discharged from 2002 through 2005. The NRC staff expects variations in the amount of radioactive effluents released from year to year by Entergy based on the overall performance of the plant and the number and scope of maintenance and refueling outages. The liquid radioactive wastes reported by Entergy are reasonable, and the NRC staff noted no unusual trends.

Though Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation, such replacement actions are not likely to result in a significant increase of liquid radioactive effluents being discharged compared to the amount discharged during normal plant operations. This is based on consideration that liquids generated, processed, and released during the outage will likely be offset by the amount of liquid waste that would not be generated, processed, and released during normal plant operations during the outage period. Based on the NRC staff's evaluation

of recent historical releases in the previous paragraph and based on the NRC staff's expectation that no significant increase in liquid effluents from the potential replacement of the reactor heads and control rod drive mechanisms is likely to occur, the NRC staff expects similar quantities of radioactive liquid effluents to be generated during normal operation and outages from IP2 and IP3 during the period of extended operation.

Releases to Ground Water

In addition to the planned radioactive liquid discharges made through the liquid waste processing system, Entergy identified a new release pathway as a result of the discovery of tritium contamination in the ground outside the IP2 SFP. This release was listed as an abnormal release in the 2006 radioactive effluent release report. The applicant included a detailed radiological assessment of all the liquid effluent releases and the projected doses in its 2006 annual radioactive effluent release report (Entergy 2007c). The following information is from that report.

The applicant estimated that approximately 0.19 Ci (7.03×10^3 MBq) of tritium migrated directly to the Hudson River by the ground water flow path in 2006, resulting in an approximate total body dose of 2.10×10^{-6} mrem (2.10×10^{-8} mSv). The amount of tritium released through this pathway is approximately 0.015 percent of the tritium released to the river from routine releases. Tritium releases in total (ground water as well as routine liquid effluent) represent less than 0.001 percent of the Federal dose limits for radioactive effluents from the site. Strontium-90, nickel-63, and cesium-137 collectively contributed approximately 5.70×10^{-4} Ci (21.1 MBq) from the ground water pathway, which resulted in a calculated annual dose of approximately 1.78×10^{-3} mrem (1.78×10^{-5} mSv) to the total body, and 7.21×10^{-3} mrem (7.21×10^{-5} mSv) to the critical organ, which was the adult bone (primarily because of strontium-90). Storm drain releases to the discharge canal were conservatively calculated to be approximately 9.40×10^{-2} Ci (3.48×10^3 MBq) of tritium, resulting in an approximate total body dose of 2.00×10^{-8} mrem (2.00×10^{-10} mSv). Entergy asserts that the annual dose to a member of the public from the combined ground water and storm water pathways at IP2 and IP3 remains well below NRC and U.S. Environmental Protection Agency (EPA) radiation protection standards (Entergy 2007c). The NRC staff further discusses releases to groundwater, including recent inspection results, in Section 2.2.7 of this SEIS.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

IP2

The gaseous radioactive waste processing system and the plant ventilation system control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operations. During plant operations, gaseous waste is generated by degassing the reactor coolant and purging the volume control tank, displacing cover gases as liquid accumulates in various tanks, equipment purging, and sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases. The majority of the gas received by the waste disposal system during normal plant operations is cover gas displaced from the chemical and volume control system holdup tanks as they fill with liquid.

Vented gases flow to a waste gas compressor suction header. One of two compressors is in continuous operation with the second unit designed to operate as a backup for peak load conditions. From the compressors, gas flows to one of four large gas decay tanks. The control arrangement on the gas decay tank inlet header allows plant personnel to place one large tank

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1 in service and to select a second large tank for backup. When the tank in service becomes
2 pressurized to a preset level, a pressure transmitter automatically opens the inlet valve to the
3 backup tank, closes the inlet valve to the filled tank, and triggers an alarm to alert personnel to
4 select a new backup tank. Gas held in the decay tanks can either be returned to the chemical
5 and volume control system holdup tanks or be discharged to the environment, provided that the
6 gas meets radiation limits.

7 Six additional small gas decay tanks are available for use during degassing of the reactor
8 coolant system before the reactor is brought to a cold shutdown. The reactor coolant fission
9 gas activity is distributed among the six tanks through a common inlet header. A radiation
10 monitor in the sample line to the gas analyzer checks the gas decay tank radioactivity inventory
11 each time a sample is taken for hydrogen-oxygen analysis. An alarm notifies plant personnel
12 when the inventory limit is approached so that another tank can be placed into service.

13 Before a tank's contents can be discharged into the environment, they must be sampled and
14 analyzed to verify that sufficient decay of the radioactive material has occurred and to document
15 the amount of radioactivity that will be released. If appropriate radioactivity criteria are met, the
16 gas is discharged to a plant vent at a controlled rate and checked by a radiation monitor in the
17 vent. In addition to the radiation monitor, gas samples are manually taken and analyzed to
18 ensure that radiation protection limits are maintained. During a release, a trip valve in the
19 discharge line closes automatically when there is an indication of a high-radioactivity level in the
20 plant vent (Entergy 2007a).

21 IP3

22 The gaseous radioactive waste processing system and the plant ventilation system control,
23 collect, process, store, and dispose of gaseous radioactive wastes generated as a result of
24 normal operations. During plant operations, gaseous waste is generated by degassing the
25 reactor coolant and purging the volume control tank, displacement of cover gases as liquid
26 accumulates in various tanks, equipment purging, sampling operations and automatic gas
27 analysis for hydrogen and oxygen in cover gases, and venting of actuating nitrogen for pressure
28 control valves.

29 The majority of the gas received by the waste disposal system during normal operations is
30 cover gas displaced from the chemical and volume control system holdup tanks as they fill with
31 liquid. Since this gas must be replaced when the tanks are emptied during processing, facilities
32 are provided to return gas from the decay tanks to the holdup tanks. A backup supply from the
33 nitrogen header is provided for makeup if the return flow from the gas decay tanks is not
34 available.

35 Gases vented to the vent header flow to the waste gas compressor header. One of the two
36 compressors is in continuous operation with the second unit as a backup for peak load
37 conditions. From the compressors, gas flows to one of four large gas decay tanks. The control
38 arrangement on the gas decay tanks inlet header allows for the operation of one tank with a
39 second tank as backup. When the tank in service is filled, a pressure transmitter automatically
40 opens the inlet valve to the backup tank and closes the valve of the filled tank and sounds an
41 alarm. Plant personnel then select a new tank to be the backup and repeat the process.

42 Gases are held in the decay tanks to reduce the amount of radioactivity released into the
43 environment. These gases can either be returned to the chemical and volume control system
44 holdup tanks or discharged to the environment if the radioactivity meets radiation standards.

1 There are six additional small gas decay tanks for use during degassing of the reactor coolant
2 before the reactor is brought to a cold shutdown. The reactor coolant fission gas activity
3 inventory is distributed equally among the six tanks through the use of a common header. The
4 total radioactivity in any one gas decay tank is controlled in order to limit the potential
5 radiological consequences if any tank ruptures.

6 Before a tank's contents can be released into the environment, they must be sampled and
7 analyzed to verify that there was sufficient decay and to provide a record of the type and
8 quantity of radioactivity to be released. Once these steps are completed, the gas may be
9 released to the plant vent at a controlled rate and monitored by a radiation monitor. The
10 radiation monitor, upon detecting high radioactivity levels, can automatically close the discharge
11 line to the plant vent. Samples are also taken manually to document releases (Entergy 2007a).

12 Gaseous Releases

13 Entergy maintains radioactive gaseous effluents in accordance with the procedures and
14 methodology described in the ODCM. The gaseous radioactive waste processing system is
15 effectively used to reduce radioactive materials in gaseous effluents before discharge to meet
16 the ALARA dose objectives in Appendix I to 10 CFR Part 50.

17 The NRC staff reviewed the IP2 and IP3 annual radioactive effluent release reports from 2002
18 through 2006 for gaseous effluents (Entergy 2003a, 2003b, 2004a, 2005a, 2006b, 2007c) to
19 determine whether the releases were reasonable. There were no abnormal gaseous releases
20 from IP2 and IP3 in 2006. The amount of radioactivity discharged in the form of fission and
21 activation gases from the operating reactors at the IP2 and IP3 site in 2006 totaled 2.20×10^2 Ci
22 (8.14×10^6 MBq). A total of 20.8 Ci (7.69×10^5 MBq) of tritium was released from the IP2 and IP3
23 site in 2006. A total of 7.87×10^{-4} Ci (29.1 MBq) of radioiodines and 4.76×10^{-5} Ci (1.76 MBq) of
24 particulates was released from the IP2 and IP3 site in 2006 (Entergy 2007c). The gaseous
25 discharges for 2006 are consistent with the radioactive gaseous effluents discharged from 2002
26 through 2005. The NRC staff expects variations in the amount of radioactive effluents released
27 from year to year based on the overall performance of the plant and the number and scope of
28 maintenance and refueling outages. The gaseous radioactive wastes reported by Entergy are
29 reasonable, and the NRC staff noted no unusual trends.

30 Though Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control
31 rod drive mechanisms during the period of extended operation, such replacement actions are
32 not likely to result in a significant increase in discharges of gaseous radioactive effluents above
33 the amount discharged during normal plant operations. This is based on consideration that any
34 gaseous effluents released during the outage will be offset by the amount of gaseous effluents
35 that would not be generated, processed, and released during normal plant operations. Based on
36 the NRC staff's evaluation of recent historical releases in the previous paragraph and based on
37 the NRC staff's expectation that no significant increase in gaseous effluents from the potential
38 replacement of the reactor heads and control rod drive mechanisms will occur, the NRC staff
39 expects that similar quantities of radioactive gaseous effluents will be generated during normal
40 operations and outages at IP2 and IP3 during the period of extended operation.

41 **2.1.4.3 Solid Waste Processing**

42 IP2 and IP3 solid radioactive wastes include solidified waste derived from processed liquid and
43 sludge products; spent resins, filters, and paper; and glassware used in the radiation-controlled
44 areas of the plant. Waste resin is stored in the spent resin storage tank to allow radioactive

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1 decay. When a sufficient volume of resin is accumulated, it is moved from storage and placed
2 into a high-integrity container. The wet waste is then dewatered and prepared for transportation
3 in accordance with the plant's process control program. The process control program contains
4 the criteria and requirements that the waste must meet to comply with NRC and U.S.
5 Department of Transportation (DOT) requirements for transportation of radioactive waste on the
6 public roads. The other solid radioactive wastes, such as paper, rags, and glassware, are also
7 processed for shipping in accordance with the process control program. Entergy, when
8 possible, sends the solid radioactive waste to a material recovery center or to a facility licensed
9 to incinerate and perform other techniques to reduce the waste volume before disposal.
10 Additional interim radioactive waste storage space is located in the IP1 containment.

11 IP2

12 At IP2, the original four steam generators are stored in the Original Steam Generator Storage
13 Facility. The facility is made of reinforced concrete and is designed to contain contaminated
14 materials and allow for decontamination of materials if necessary. The structure is built to
15 prevent both the intrusion of water into the facility and the leakage of contaminated water from
16 the facility. The floor of the facility is sloped to direct any liquids to a sump. The floor slab and
17 lower portion of the walls have a protective coating to facilitate decontamination, if required. A
18 passive high-efficiency filter is used to prevent airborne contamination from being vented
19 outside the facility. This facility is located within the owner-controlled area outside of the
20 protected area.

21 IP3

22 At IP3, solid radioactive waste (dry activated waste or solidified resins) may be stored in the IP3
23 Interim Radioactive Waste Storage Facility before being shipped off site. The facility is a
24 concrete structure designed to minimize the impact of stored materials on the public and the
25 environment. It is shielded to limit the offsite annual radiation dose to less than 5 mrem
26 (0.05 mSv). As at IP2, a reinforced concrete structure is used to store the original four steam
27 generators, which were removed in 1989. This structure, called the Replaced Steam Generator
28 Storage Facility, is shielded to reduce radiation exposure, and all openings are sealed with no
29 provision for ventilation. There is a locked and locally alarmed labyrinth entrance that allows for
30 periodic surveillance of the steam generators. There are no gaseous or liquid releases from this
31 facility.

32 Solid Waste Shipment

33 IP2 and IP3 radioactive waste shipments are packaged in accordance with NRC and DOT
34 requirements. The type and quantities of solid radioactive waste generated at and shipped from
35 the site vary from year to year, depending on plant activities (i.e., refueling outage, maintenance
36 work, and fuel integrity). Entergy ships radioactive waste to the Studsvic facility in Irwin,
37 Tennessee, the Race facility in Memphis, Tennessee, or the Duratek facility in Oak Ridge,
38 Tennessee, where the wastes undergo additional processing before being sent to a facility for
39 disposal. In the recent past, Entergy had shipped waste to the Barnwell facility in Barnwell
40 County, South Carolina, or the Envirocare facility in Clive, Utah, for disposal (Entergy 2007a).
41 In July 2008, however, the State of South Carolina closed access to radioactive waste
42 generators in States that are not part of the Atlantic Low-Level Waste Compact. (Envirocare,
43 however, remains open for Class A wastes.)

1 In the near term, Entergy is working to address the loss of the low-level solid radioactive waste
2 disposal repository in Barnwell, South Carolina. During the NRC environmental site audit, IP2
3 and IP3 staff indicated that they would be able to safely store their low-level waste on site in
4 existing onsite buildings. Entergy indicates that it is currently developing a comprehensive plan
5 to address the potential need for long-term storage. The radiation dose from the storage of
6 low-level radioactive waste would be required to continue to result in doses to members of the
7 public that are below the limits in 10 CFR Part 20 and 40 CFR Part 190, "Environmental
8 Radiation Protection Requirements for Normal Operations of Activities in the Uranium Fuel
9 Cycle," which apply to all operations and facilities at the site.

10 In 2006, Entergy made a total of 49 shipments of Class A, B, and C solid radioactive waste to
11 offsite processing vendors. The solid waste volumes were 5.31×10^4 cubic feet ($1.50 \times 10^3 \text{ m}^3$) of
12 resins, filters, evaporator bottoms, and dry active waste, with an activity of 9.49×10^2 Ci
13 (3.51×10^7 MBq). Entergy shipped no irradiated components or control rods in 2006 (Entergy
14 2007c). The solid waste volumes and radioactivity amounts generated in 2006 are typical of
15 annual waste shipments made by Entergy. The NRC staff expects variations in the amount of
16 solid radioactive waste generated and shipped from year to year based on the overall
17 performance of the plant and the number and scope of maintenance work and refueling
18 outages. The NRC staff finds the volume and activity of solid radioactive waste reported by
19 Entergy are reasonable, and no unusual trends were noted.

20 Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive
21 mechanisms during the period of extended operation (Entergy 2008b), and such replacement
22 actions are likely to result in a small increase in the amount of solid radioactive waste
23 generated. This is partly because the number of personnel working at the plant will increase,
24 leading to increased use of protective clothing and safety equipment and an increased use of
25 filters. Also, work activities will create a general increase in debris that will have to be disposed
26 of as radioactive waste. However, the increased volume is expected to be within the range of
27 solid waste that can be safely handled by IP2 and IP3 during the period of extended operation.
28 In the GEIS (NRC 1996), NRC indicated that doses from onsite storage of assemblies removed
29 during refurbishment would be "very small and insignificant." Retired vessel heads will likely be
30 stored on site in a concrete building (Entergy 2008b), subject to regular monitoring and dose
31 limits under 10 CFR Part 20 and 40 CFR Part 190.

32 **2.1.5 Nonradioactive Waste Systems**

33 IP2 and IP3 generate solid, hazardous, universal, and mixed waste from routine facility
34 operations and maintenance activities.

35 **2.1.5.1 Nonradioactive Waste Streams**

36 Nonradioactive waste is produced during plant maintenance, cleaning, and operational
37 processes. Most of the wastes consist of nonhazardous waste oil and oily debris and result
38 from operation and maintenance of oil-filled equipment.

39 The facility generates solid waste, as defined by the Resource Conservation and Recovery Act
40 (RCRA), as part of routine plant maintenance, cleaning activities, and plant operations. These
41 solid waste streams include nonradioactive resins and sludges, putrescible wastes, and
42 recyclable wastes.

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1 Universal wastes constitute a majority of the remaining waste volumes generated at the facility.
2 Universal waste is hazardous waste that has been specified as universal waste by EPA.
3 Universal wastes, including mercury-containing equipment, batteries, fluorescent bulbs, and
4 pesticides, have specific regulations (40 CFR Part 273, "Standards for Universal Waste
5 Management") to ensure proper collection and recycling or treatment.

6 Hazardous wastes routinely make up a small percentage of the total wastes generated at the
7 IP2 and IP3 facility and include spent and expired chemicals, laboratory chemical wastes, and
8 other chemical wastes (Entergy 2007a). Hazardous waste is nonradioactive waste that is listed
9 by EPA as hazardous waste or that exhibits characteristics of ignitability, corrosivity, reactivity,
10 or toxicity (40 CFR Part 261, "Identification and Listing of Hazardous Waste"). RCRA, as well
11 as the NYSDEC regulatory requirements set forth in Title 6 of the New York Codes, Rules, and
12 Regulations (NYCRR) Parts 371-376, that regulate storage and handling of hazardous waste
13 and requires a hazardous waste permit for facilities that store large quantities of hazardous
14 waste for more than 90 days.

15 The IP2 and IP3 facility has hazardous and mixed waste storage facilities covered by permits
16 issued by NYSDEC under NYCRR Part 373. The permits, NYD991304411 and
17 NYD085503746, are for the accumulation and temporary onsite storage of hazardous and
18 mixed waste for more than 90 days at IP2 and IP3 respectively. The permits have been
19 administratively continued based on a conditional mixed waste exemption (Entergy 2007a).

20 Some amounts of chemical and biocide wastes are produced at the facility from processes used
21 to control the pH in the coolant, to control scale, to control corrosion, to regenerate resins, and
22 to clean and defoul the condensers. These waste liquids are typically discharged in accordance
23 with the site's State Pollutant Discharge Elimination System (SPDES) Permit, NY-0004472,
24 along with cooling water discharges (Entergy 2007a).

25 Hazardous and universal wastes are collected in central collection areas. The materials are
26 received in various forms and are packaged to meet all regulatory requirements before final
27 disposition at an appropriate offsite facility. Entergy tracks wastes like waste oil, oily debris,
28 glycol, lighting ballasts containing polychlorinated biphenyls (PCBs), fluorescent lamps,
29 batteries, and hazardous wastes (i.e., paints, lead abatement waste, broken lamps, off-
30 specification and expired chemicals)—by volume at the facility. The total amount of tracked
31 hazardous and universal wastes for 2006 was 17,987 pounds (lb) (8158 kilograms (kg)) with
32 waste oil making up 70 percent of the total weight (Entergy 2007a).

33 Most sanitary wastewater from the IP2 and IP3 facility operations is transferred to the Village of
34 Buchanan publicly owned treatment works system. A few isolated areas at the facility have their
35 own septic tanks. Although the sanitary wastewaters are nonradioactive, a radiation monitoring
36 system continuously monitors the effluent from the protected area (Entergy 2007a).

37 The testing of the emergency generators and boiler operations generates nonradioactive
38 gaseous effluents. Emissions are managed in accordance with IP2 and IP3 air quality permits,
39 3-5522-00011/00026 and 3-5522-00105/00009, respectively (Entergy 2007a).

40 Low-level mixed waste (LLMW) is waste that exhibits hazardous characteristics and contains
41 low levels of radioactivity. LLMW at IP2 and IP3 is regulated under RCRA and NYSDEC
42 regulatory requirements as set forth in 6 NYCRR Parts 373 and 374.

2.1.5.2 Pollution Prevention and Waste Minimization

Entergy's Waste Minimization Plan describes programs that have been implemented at the facility. This plan is used in conjunction with other waste minimization procedures, waste management procedures, chemical control procedures, and other site-specific procedures to reduce waste generation (Entergy 2007a).

2.1.6 Facility Operation and Maintenance

Maintenance activities conducted at IP2 and IP3 include inspection, testing, and surveillance to maintain licensing requirements and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at the facility to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, in-service inspection and testing of boilers and pressure vessels, the maintenance structures monitoring program, and water chemistry maintenance.

Additional programs include those implemented to meet technical specification surveillance requirements, those implemented in response to the NRC generic communications, and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit, while others are performed during scheduled refueling outages. As mentioned in Section 2.1.2, Entergy typically refuels IP2 and IP3 on 24-month cycles.

2.1.7 Power Transmission System

The applicant has identified two 345-kV transmission lines that connect IP2 and IP3 to the Con Edison electrical transmission grid. Feeder W95 and feeder W96 deliver power from IP2 and IP3, respectively, to the Buchanan substation located across Broadway near the entrance to the IP2 and IP3 site. Other than these two transmission lines, no other lines or facilities were constructed specifically to connect the two generating units to the existing transmission grid. Because the Buchanan substation and the regional transmission system to which it connects were designed and constructed before IP2 and IP3 (Entergy 2007a; NRC 1975; USAEC 1972), they are beyond the scope of this evaluation.

Each of the W95 and W96 lines is approximately 2000 ft (610 m) long. The lines are within the site except for the terminal 100-ft (30.5-m) segments that cross Broadway and enter the substation. In addition to transmitting the output power from IP2 and IP3 off site, the transmission system also provides IP2 and IP3 with the auxiliary power necessary for startup and normal shutdown. Offsite (standby) power is supplied to IP2 and IP3 by 138-kV input lines that use the same transmission towers as the W95 and W96 output lines (Entergy 2005b; NRC 1975). The W95 and W96 lines are each within a separate right-of-way (ROW), so the ROWs total approximately 4000 ft (1220 m) in length. About 500 ft (150 m) of this ROW length is vegetated; the remainder crosses roads, parking lots, buildings, and other facilities. In the vegetated segments, the NRC staff observed that the ROW is approximately 150 ft (46 m) wide, the growth of trees is prevented, and a cover of mainly grasses and forbs is maintained.

2.2 Plant Interaction with the Environment

2.2.1 Land Use

Within the 239-acre (97-ha) Indian Point site, IP2 and IP3 (see Figure 2-3) are located north and south, respectively, of IP1, which is in SAFSTOR until it is eventually decommissioned. The developed portion of the IP2 and IP3 site is approximately 124.3 acres (50.3 ha), or over half the site (see Figure 2-3). The remaining portions of the site are unused, undeveloped, and include fields and forest uplands (approximately 112.4 acres (45.5 ha) and wetlands, streams, and a pond (2.4 acres (0.97 ha)). Much of the site (approximately 159 acres (64.3 ha)) has been disturbed at some time during the construction and operation of the three units (ENN 2007b).

The immediate area around the station is completely enclosed by a fence with access to the station controlled at a security gate. The plant site can be accessed by road or from the Hudson River. Land access to the plant site is from Broadway (main entrance). The existing wharf is used to receive heavy equipment as needed, although access to the site from the river is controlled by site access procedures. The plant site is not served by railroad. The exclusion area, as defined by 10 CFR 100.3, "Definitions," surrounds the site as shown in Figure 2-3 (Entergy 2007a).

2.2.2 Water Use

The Hudson River is an important regional resource of significant aesthetic value in addition to providing transportation, recreation, and water supply. The Hudson River at IP2 and IP3 is tidally influenced and becomes increasingly so as it proceeds south. IP2 and IP3 have a once-through condenser cooling system that withdraws water from the Hudson River. The same amount of water that is withdrawn for condenser cooling is discharged. However, the discharged water is at an elevated temperature and, therefore, can induce some additional evaporation. The NRC staff conservatively estimates that this induced evaporation from elevated discharge temperature is less than 60 cfs (1.7 m³/s). The remaining consumptive water uses are insignificant relative to induced evaporation.

2.2.3 Water Quality

Being tidally influenced, the salinity of the Hudson River varies as upstream flows and tides fluctuate. The salinity decreases when stream flows increase and tides drop. The salinity increases during periods of low flow and high tides. The periodic higher salinity levels limit some of the uses that a lower salinity river might support (e.g., drinking water supply).

Discharges to the Hudson River are regulated by the Clean Water Act (CWA). The CWA is administered by EPA. EPA has delegated responsibility for administration of the National Pollutant Discharge Elimination System to NYSDEC. The IP2 and IP3 ownership submitted timely and sufficient applications to renew its SPDES permits before the expiration of those permits in 1992. Pursuant to the New York State Administrative Procedure Act, these permits do not expire until NYSDEC makes its final determination. To date, this final determination has not been made. In 1991, NYSDEC, the facility owners, and several stakeholder groups entered into a consent order (issued pursuant to the Hudson River Settlement Agreement; see Section 2.2.5.3 for more information) to mitigate impacts of the thermal plume entering the Hudson River from the plant's discharge.



1 Source: Maptech, Inc.

2 **Figure 2-9. Topographic features surrounding IP2 and IP3**

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IP2 and IP3 do not intentionally discharge contaminants in a manner that would contaminate the ground water beneath the site. However, in 2005, tritium was located beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these leaks on ground water is discussed in Section 2.2.7 of this draft SEIS (the leaks are also mentioned in Section 2.1.4.1 of this draft SEIS).

2.2.4 Meteorology and Air Quality

2.2.4.1 Climate

IP2 and IP3 are located in the Village of Buchanan, New York, in Westchester County on the eastern bank of the Hudson River at approximately RM 43 (RKM 69). The river bisects the area within a 6-mi (9.7-km) radius of the site and geographically separates Westchester County from Rockland County to the west. The Hudson River flows northeast to southwest at the site but turns sharply northwest approximately 2 mi northeast of the plant. The western bank of the Hudson River is flanked by the steep, heavily wooded slopes of the Dunderberg and West Mountains to the northwest (elevations 1086 and 1257 ft (331 and 383 m) above mean sea level (MSL), respectively) and Buckberg Mountain to the west-southwest (elevation 793 ft (242 m) above MSL). These peaks extend to the west and gradually rise to slightly higher peaks (Entergy 2007a).

The climate is continental, characterized by rapid changes in temperature, resulting in hot summers and cold winters. The area, being adjacent to the St. Lawrence River Valley storm track, is subject to cold air masses approaching from the west and north. It has a variable climate, characterized by frequent and swift changes. The climate is also subject to some modification by the Atlantic Ocean. The moderating effect on temperatures is more pronounced during the warmer months than in winter when bursts of cold air sweep down from Canada. In the warmer seasons, temperatures rise rapidly in the daytime. However, temperatures also fall rapidly after sunset so that the nights are relatively cool. Occasionally, there are extended periods of oppressive heat up to a week or more in duration. Winters are usually cold and sometimes fairly severe. Furthermore, the area is also close to the path of most storm and frontal systems that move across the North American continent. Weather conditions often approach from a westerly direction, and the frequent passage of weather systems often helps reduce the length of both warm and cold spells. This is also a major factor in keeping periods of prolonged air stagnation to a minimum (NOAA 2004).

The State of New York has a climate that varies greatly. For example, the average January temperature ranges from 14 degrees Fahrenheit (F) (-10 degrees Celsius (C)) in the central Adirondacks to 30 degrees F (-1.1 degrees C) on Long Island. The average July temperature in the central Adirondacks is 66 degrees F (19 degrees C), and 74 degrees F (23 degrees C) on Long Island. The highest temperature ever recorded in the State was 108 degrees F (42 degrees C) at Troy on July 22, 1926. The lowest recorded temperature, -52 degrees F (-47 degrees C), occurred at Old Forge, in the Fulton Chain of Lakes area, on February 18, 1979 (World Book Encyclopedia 2006). In Westchester County, where IP2 and IP3 are located, temperatures are mild in the summer and cold in the winter. Buchanan, New York, has a mean daily maximum temperature range from 28 degrees F (-2.2 degrees C) in winter to 87 degrees F (31 degrees C) in summer. The mean daily minimum temperatures range from about

20 degrees F (-6.7 degrees C) in winter to about 72 degrees F (22 degrees C) in summer (Indian Point Energy Center 2004).

Precipitation varies considerably in New York. The areas of Tug Hill, the southwestern slopes of the Adirondacks, the central Catskills, and the southeast areas usually receive 44 in. (110 cm) of rain a year, while other portions of the State get only 36 in. (91 cm). The Great Lakes, with their broad expanse of open water, supply moisture for abundant winter snowfall. Syracuse, Rochester, and Buffalo routinely receive annual snowfalls that are the highest for any major city in the United States (World Book Encyclopedia 2006). Most of the precipitation in this area is derived from moisture-laden air transported from the Gulf of Mexico and cyclonic systems moving northward along the Atlantic coast. The annual rainfall is rather evenly distributed over the year. Also, being adjacent to the track of storms that move through the Saint Lawrence River Valley, and under the influence of winds that sweep across Lakes Erie and Ontario to the interior of the State, the area is subject to cloudiness and winter snow flurries. Furthermore, the combination of a valley location and surrounding hills produces numerous advection fogs which also reduce the amount of sunshine received (NOAA 2004).

In the IP2 and IP3 Buchanan area, precipitation averages 37 in. (94 cm) per year and is distributed rather evenly throughout the 12-month period. The lowest amount is in February, and the highest is in May (Indian Point Energy Center 2004). Although the Village of Buchanan area is subject to a wide range of snowfall amounting to as little as 20 in. (51 cm) or as much as 70 in. (180 cm), Westchester County snowfall amounts typically average between approximately 25 to 55 in. (64 to 140 cm) per year (NRCC 2006).

Wind velocities are moderate. The north-south Hudson River Valley has a marked effect on the lighter winds, and in the warm months, average wind direction is usually southerly. For the most part, the winds at Buchanan have northerly and westerly components. Destructive winds rarely occur. Tornadoes, although rare, have struck the area, causing major damage (NOAA 2004).

On average, seven tornadoes strike New York every year (USDOD 2008a). Westchester County has had a total of eight tornadoes since 1950, seven of which have been F1 or less ("weak" tornadoes). The eighth tornado, which struck portions of Westchester County on July 12, 2006, was rated as an F2 at its maximum intensity (briefly a "strong" tornado) but was an F1 for most of its existence. Based on climatic data compared to other regions of the United States, the probability of a tornado striking the IP2 and IP3 site is small, and tornado intensities in Westchester County are relatively low (USDOD 2008b).

2.2.4.2 Meteorological System

Entergy's meteorological system consists of three instrumented towers, redundant power and ventilation systems, redundant communication systems, and a computer processor/recorder.

Entergy describes the primary system as a 122-m (400-ft) instrumented tower located on the site that provides the following:

- wind direction and speed measurement at a minimum of two levels, one of which is representative of the 10-m (33-ft) level
- standard deviations of wind direction fluctuations as calculated at all measured levels
- vertical temperature difference for two layers (122–10 m (400–33 ft) and 60–10 m (197–33 ft))

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- ambient temperature measurements at the 10-m (33-ft) level
- precipitation measurements near ground level
- Pasquill stability classes as calculated from temperature difference (Indian Point Energy Center 2005)

The meteorological measurement system is located in a controlled environmental housing and connected to a power supply system with a redundant power source. A diesel generator provides immediate power to the meteorological tower system within 15 seconds after an outage trips the automatic transfer switch. Support systems include an uninterruptible power supply, dedicated ventilation systems, halon fire protection, and dedicated communications (Indian Point Energy Center 2005).

Entergy indicates that the meteorological system transmits 15-minute average data simultaneously to two loggers at the primary tower site. One data logger transmits to a computer that determines joint frequency distributions, and the second transmits to a computer in the Buchanan Service Center that allows remote access to the data. Meteorological data can be transmitted simultaneously to emergency responders and the NRC in a format designated by NUREG-0654/FEMA-REP-1. Fifteen-minute averages of meteorological parameters for the preceding 12 hours are available from the system (Indian Point Energy Center 2005).

The backup meteorological system is independent of the primary system and consists of a backup tower located approximately 2700 ft (833 m) north of the primary tower and a data acquisition system located in the Emergency Operations Facility. The backup system provides measurements at the 10-m (33-ft) level of wind direction and speed and an estimate of atmospheric stability (Pasquill category using sigma theta, which is a standard deviation of wind fluctuation). The backup system provides information in real-time mode. Changeover from the primary system to the backup system occurs automatically. In the event of a failure of the backup meteorological measurement system, a standby backup system exists at the 10-m (33-ft) level of the Buchanan Service Center building roof. It also provides measurements of the 10-m (33-ft) level of wind direction and speed and an estimate of atmospheric stability (Pasquill category using sigma theta, which is a standard deviation of wind fluctuations). The changeover from the backup system to the standby system also occurs automatically. As in the case of the primary system, the backup meteorological measurement system and associated controlled environmental housing system are connected to a power system which is supplied from redundant power sources. In addition to the backup meteorological measurement system, a backup communications line to the meteorological system is operational. During an interim period, the backup communications are provided via telephone lines routed through a telephone company central office separate from the primary circuits (Indian Point Energy Center 2005).

2.2.4.3 Air Quality

Under the Clean Air Act, EPA established National Ambient Air Quality Standards (NAAQS) for specific concentrations of certain pollutants, called criteria pollutants. Areas in the United States having air quality as good as or better than these standards (i.e., pollutant levels lower than the NAAQS) were designated as attainment areas for the various pollutants. Areas with monitored pollutant levels greater than these standards are designated as nonattainment areas. Areas in the United States whose pollutant levels were greater than the NAAQS and are now lower than the NAAQS are designated as maintenance areas.

Four States are located within a 50-mi (80-km) radius of the site. These include Pennsylvania's eastern tip, Connecticut, New York, and New Jersey. The 50-mi (80-km) radius includes nonattainment areas for the ozone (O₃) 8-hour standard, particulate matter less than 10 microns in diameter (PM₁₀), and particulate matter less than 2.5 microns in diameter (PM_{2.5}). The portion of Pennsylvania (Pike County) located within the 50-mi (80-km) radius is in attainment for all criteria pollutants.

The currently designated nonattainment areas for Connecticut counties within a 50-mi (80-km) radius of the site are as follows:

- Fairfield and New Haven*—O₃ and PM_{2.5}
- Litchfield—O₃

The currently designated nonattainment areas for New Jersey counties within a 50-mi (80-km) radius of the site are as follows:

- Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Union*—O₃ and PM_{2.5}
- Sussex*—O₃

The currently designated nonattainment areas for New York counties within a 50-mi (80-km) radius of the site are as follows:

Bronx, King, Nassau, Orange, Queens, Richmond, Rockland, Suffolk, and Westchester*—O₃ and PM_{2.5}

- Dutchess—O₃
- New York*—O₃, PM₁₀, and PM_{2.5}
- Putnam—O₃

Note that the counties labeled with an "*" are part of the EPA-designated "New York—New Jersey—Long Island Nonattainment Area" (EPA 2006a).

New York State air permits for IP2 and IP3, 3-5522-00011/00026 and 3-5522-000105/00009, respectively, regulate emissions from boilers, turbines, and generators. These permits restrict nitrogen oxides (NO_x) emissions to 25 tons (t) (23 metric tons (MT)) per year per station by restricting engine run time and fuel consumption. IP2 and IP3 are not subject to the Risk Management Plan (RMP) requirements described in 40 CFR Part 68, as no RMP-regulated chemicals stored on site exceed the threshold values listed in 40 CFR Part 68 (Entergy 2007a).

There are no Mandatory Class I Federal areas designated by the National Park Service, U.S. Fish and Wildlife Service (FWS), or the U.S. Forest Service within 50 mi (80 km) of the site. Class I areas are locations in which visibility is an important attribute. As defined in the Clean Air Act, they include several types of areas that were in existence as of August 7, 1977—national parks over 6000 acres (2430 ha), national wilderness areas, and national memorial parks over 5000 acres (2020 ha), and international parks (NPS 2006a). The closest Class I Area is Lye Brook Wilderness Area, Vermont, approximately 150 mi (240 km) east-northeast of IP2 and IP3 (NPS 2006b).

2.2.5 Aquatic Resources

In this section, the NRC staff describes the physical, chemical, and biological characteristics of the Hudson River estuary. In addition, the NRC staff describes the major anthropogenic events that have influenced the estuary and the history of regulatory action over the past 50 years.

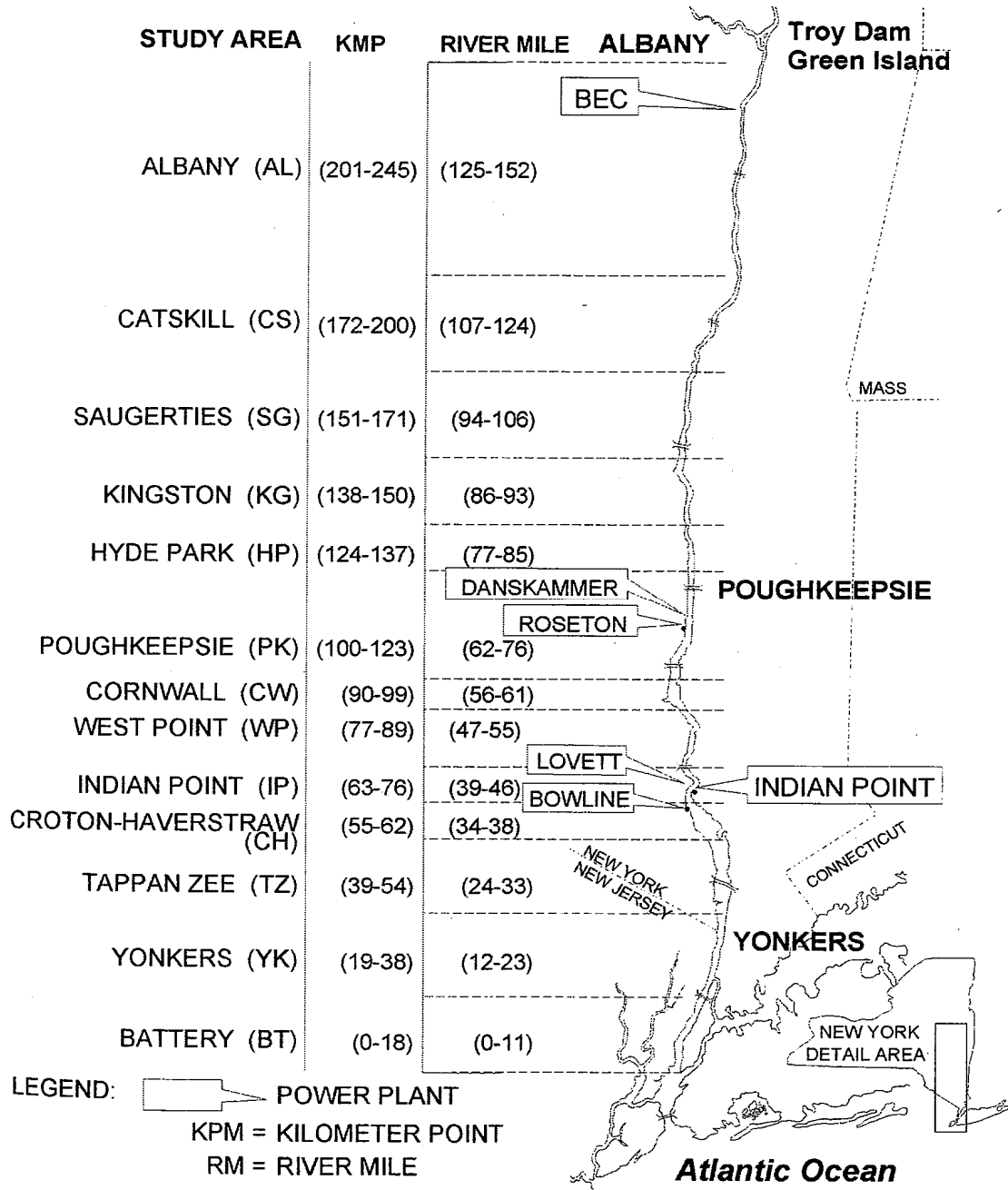
2.2.5.1 The Hudson River Estuary

Watershed Description

The Hudson River originates at Tear-of-the-Clouds in the Adirondack Mountains of northern New York State. From its source, the river flows south 315 mi (507 km) to its mouth at the Battery, at the south end of the island of Manhattan. The Hudson River basin extends 128 mi (206 km) from east to west and 238 mi (383 km) from north to south and drains an area of 13,336 square miles (sq mi) (34,540 sq km), with most of this area located in the eastern-central part of New York State and small portions in Vermont, Massachusetts, Connecticut, and New Jersey (Abood et al. 2006). The basin is bounded by the St. Lawrence and Lake Champlain drainage basins to the north; the Connecticut and Housatonic River basins to the east; the Delaware, Susquehanna, Oswego, and Black River basins to the west; and the basins of small tributaries and New York Harbor on the south. From the Troy Dam to the Battery, the lower Hudson River basin is about 154 mi (248 km) long and drains an area of about 5277 sq mi (13,670 sq km). The average slope of the lower Hudson River, defined in terms of the half-tide level, is about 0.6 m (2 ft) over 150 mi (240 km) (Abood et al. 2006). During the development of the multiutility studies in the 1970s, the lower portion of the Hudson River from the Troy Dam to the Battery was divided into 13 study areas (river segments), depicted in Figure 2-10. The study area and river segment designations identified in the figure will be used to discuss monitoring results and data collection locations throughout this document.

Lower Hudson River Basin Habitats

The lower Hudson River estuary contains a variety of habitats, including tidal marshes, intertidal mudflats, and subtidal aquatic beds. These habitats exist throughout the length of the river and can be freshwater, brackish, or saline. The freshwater communities are generally located north of Newburgh (CHGEC 1999), with brackish communities found farther south. There are four locations within the estuary designated as National Estuarine Research Reserve System Sites by the National Oceanic and Atmospheric Administration (NOAA) and NYSDEC, including, from north to south, Stockport Flats, Tivoli Bay, Iona Island, and Piermont Marsh (NOAA 2008), as shown in Figure 2-11. The lower Hudson River basin also contains Haverstraw Bay, shown in Figure 2-11, a significant nursery area for a variety of fish, including striped bass, white perch, Atlantic tomcod, and Atlantic sturgeon, and a wintering area for the federally listed endangered shortnose sturgeon (FWS 2008a).



1 Source: Abood et al. 2006

2 **Figure 2-10. Hudson study area and river segments**



1

Figure 2-11. Hudson river area and national estuarine research sites

1 Community type and habitat characteristics are influenced by the extent of tidal excursions,
2 which are controlled by tidal stage and river flow. During drought periods, the 100 milligrams
3 per liter (mg/L) (0.1 parts per thousand (ppt)) salinity front can extend up to 130 km (81 mi)
4 above the ocean entrance (Abood et al. 2006).

5 In general, narrow, shallow river reaches with high current flow have extensive bottom scour
6 and low organic carbon levels. The coarse gravel substrate provides spawning habitat for some
7 species. Similar characteristics can also be found where tributaries to the main river stem join
8 the Hudson. High current speeds through deep basins can generate turbulent flow that keeps
9 weakly swimming zoo- and ichthyoplankton suspended in the water column and away from silty
10 nearshore locations and potential predators. Shallow, shore-zone habitats often support
11 submerged aquatic vegetation that provides habitat and protection for juvenile fish and other
12 aquatic communities. Broad, shallow basins often create depositional environments where fine
13 sediments, high levels of organic carbon, and nutrients are present. These environments are
14 generally highly productive and may serve as nursery areas for juvenile fish species (CHGEC
15 1999).

16 Human activities, however, have significantly affected the lower Hudson River estuary.
17 Increasing human populations along the estuary throughout recent history have contributed to
18 increased habitat alteration. (Section 2.2.5.2 examines human influences in greater detail.)

19 The construction of railroad lines along the banks of the river disrupted the connection of the
20 river to marshland and wetland habitats. Construction of causeways interfered with or
21 completely blocked tributary inlets, disrupting sediment transport and other natural phenomena.
22 Anthropogenic activities also resulted in the dredging of some habitats and the filling of others.
23 The historical impacts to the lower Hudson River habitats are discussed later in this section.

24 To describe the predominant habitat features associated with the lower Hudson River estuary,
25 Central Hudson Gas and Electric Corporation (CHGEC 1999) divided the lower river from the
26 Troy Dam to the Battery into five subsections of roughly comparable volume consisting of one or
27 more of the regions and river segments identified in Figure 2-10. Beginning at the Troy Dam,
28 the first subsection extends from RM 152 to 94 (RKM 245 to 151) and includes the Albany,
29 Catskill, and Saugerties study areas. This subsection of the river is relatively narrow and has
30 extensive shoals and numerous tributaries. Within this subsection and approximately 6.2 mi
31 (10 km) south of the Troy Dam, the river is about 574 ft (175 m) wide—the narrowest part of the
32 lower Hudson (Abood et al. 2006). The slope of the river is also greatest in this subsection and
33 generates current velocities greater than in other areas.

34 The second subsection of the river extends from RM 93 to 56 (RKM 150 to 90) and includes the
35 Kingston, Hyde Park, Poughkeepsie, and Cornwall study areas. This subsection contains a
36 series of progressively deeper basins, and the volume of this area is approximately 1.5 times
37 larger than that of the adjacent upriver areas. Shallow shoreline and shoal areas are common
38 only in the southernmost end of this subsection.

39 The third subsection defined by CHGEC (1999) extends from RM 55 to 39 (RKM 89 to 63), and
40 includes the West Point and IP2 and IP3 study areas. At this location, the Hudson Highlands
41 land mass forced glaciers through a narrow constriction, resulting in the deepest and most
42 turbulent flow observed in the lower Hudson. Within this subsection, the river channel narrows
43 abruptly, bends sharply to the east, and reaches a depth of over 150 ft (46 m). At the lower
44 portions of this subsection, the river bottom consists of a series of progressively shallower

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gouges that result in a corrugated bottom that ends in shallow water behind the Hudson Highlands. The IP2 and IP3 and Bowline Point power stations (along with the no-longer-operating Lovett station) are located within this river subsection.

The fourth subsection of the river identified by CHGEC (1999) is located from RM 38 to 24 (RKM 62 to 39) and includes the Croton-Haverstraw and Tappan Zee study areas (Figure 2-6). This is the widest and shallowest portion of the lower Hudson River and has the most extensive shoal and shore zone areas. The presence of slow-moving currents and shoal areas results in the deposition of suspended sediment, organic carbon, and nutrients. The major source of suspended sediment to the Hudson is associated with watershed basin runoff and erosion, and basin-wide loads have been estimated at 800,000 t/yr (726,000 MT/yr) (Abood et al. 2006). The presence of slow-moving currents, shoal and shore-zone habitat, and high carbon and nutrient inputs makes this a highly productive portion of the lower Hudson River and provides important spawning and nursery areas for juvenile fish.

The fifth subsection of the river begins at RM 24 (RKM 38) and extends to the river's entrance into New York Harbor, encompassing the Yonkers and Battery study areas. In this subsection, the river again constricts and gradually deepens as it enters New York Harbor. In this location, the river is generally straight and contains few shoal areas or shore-zone habitats. The final 12 mi (19 km) of the lower Hudson have extensive armoring and contain little remaining natural shoreline (CHGEC 1999).

Sampling Strata Definitions

To effectively sample and study the lower Hudson, researchers have attempted to define specific zones, habitats, or locations within the river. These specific locations, often called strata, provide researchers with a quantitative way to sample the environment and integrate the resulting information. A variety of attempts have been made to define the channel morphology and thus the potential strata of the lower Hudson. Miller et al. (2006) describe three major habitat areas in the lower Hudson:

- (1) Intertidal: Areas exposed at low tide and submerged at high tide that include mud flats, sand, broadleaf marsh, and emergent intertidal vegetation.
- (2) Shallows: Areas of the river less than 6.6 ft (2.0 m) deep at mean low tide. This habitat supports submerged aquatic vegetation (SAV) in the river and is considered one of the most productive habitats in the estuary and of great ecological importance.
- (3) Deepwater: Areas of the river greater than 6.6 ft (2.0 m) deep at mean low tide. This area represents the limit of light penetration and generally does not support SAV.

During the development of the Hudson River Utilities studies of the lower Hudson River in the 1970s, the study areas and river segments were divided into four primary strata to support fish and plankton investigations. These strata provide a geomorphological basis for partitioning the river and are still used to define sampling locations (ASA 2007):

- (4) Shore: The portion of the Hudson River estuary extending from the shore to a depth of 10 ft (3.0 m). This area was primarily sampled by beach seine.
- (5) Shoal: The portion of the Hudson River extending from the shore to a depth of 20 ft (6.1 m) at mean low tide.

(6) Bottom: The portion of Hudson River extending from the bottom to 10 ft (3.0 m) above the bottom where the river depth is greater than 20 ft (6.1 m) mean low tide.

(7) Channel: The portion of the Hudson River not considered bottom where river depth is greater than 20 ft (6.1 m) at mean low tide.

Hydrodynamics and Flow Characteristics

In the lower Hudson River, freshwater flow is one of the most important factors in determining and influencing the physical, chemical, and biological processes in the estuary and the resulting interactions within the food web. Hydrodynamics and flow characteristics are controlled by a complex series of interactions that include short- and long-term fluctuations in meteorological conditions, precipitation and runoff in the upstream portion of the watershed, the influence of tides and currents in downstream portions of the river, and the presence of a “salt wedge” that moves up- or downstream depending on river flow and tidal fluctuation (Blumberg and Hellweger 2006). Freshwater flow varies throughout the year, with maximum flow occurring during the months of March through May, with low-flow conditions beginning in June and continuing until November (Abood et al. 2006). Under normal conditions, approximately 75 percent of the total freshwater flow enters the lower Hudson River at Troy, with the remaining portion contributed by tributaries discharging into the upper reach of the estuary (CHGEC 1999; Abood et al. 2006). Because of tidal oscillation in the estuary, it is not possible to accurately measure freshwater flow in the lower estuary. Freshwater flow is, however, monitored by the U.S. Geological Survey (USGS) at Green Island, the farthest downstream USGS gauge above tidewater (CHGEC 1999; Abood et al. 2006). Data recorded from this gauge from 1948 to 2006 show that the mean annual flow was approximately 14,028 cfs (397.23 m³/s). The lowest recorded annual flow was 6400 cfs (180 m³/s) in 1965; the highest was 22,100 cfs (626 m³/s) in 1976. Measured flows from Green Island from 1996 to 2006 ranged from 11,400 cfs (323 m³/s) in 2002 to over 18,000 cfs (510 m³/s) in 1996 (USGS 2008).

Salinity

CHGEC (1999) describes four salinity habitat zones in the Hudson River:

(1) polyhaline (high salinity): RM 1–19 (RKM 2–31)

(2) mesohaline (moderate salinity): RM 19–40 (RKM 31–64)

(3) oligohaline (low salinity): RM 40–68 (RKM 64–109)

(4) tidal freshwater: RM 68–152 (RKM 109–245)

The IP2 and IP3 and Bowline Point facilities are located in the oligohaline zone and generally experience salinities of 0.5 to 5 ppt. The actual salinity present at a given time and place can vary considerably in the lower regions of the river because of salinity intrusion, which occurs throughout the year. The typical tidal excursion in the lower Hudson River is generally 3 to 6 mi (5 to 10 km), but can extend up to 12 mi (19 km) upstream. During the spring, the salt front is located between Yonkers and Tappan Zee and moves upstream to just south of Poughkeepsie during the summer (Blumberg and Hellweger 2006). Abood et al. (2006) report that, during drought periods, the salt front (defined as water with a salinity of 100 mg/L (0.1 ppt)) can extend up to RM 81. Stratification also occurs within this salt-intruded reach. Studies by Abood et al. (2006) suggest that from 1997–2003, salinity in the Hudson River has increased approximately 15 percent for a given flow rate. The authors suggest that this conclusion be viewed with

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caution and that further analysis is required to confirm this finding. Real-time monitoring of the salt front position on the lower Hudson River is provided by USGS and can be accessed via its Web site (USGS 2008).

Temperature

Water temperatures in the Hudson River vary seasonally, with a maximum temperature of 25 degrees C (77 degrees F) occurring in August and a minimum temperature of 1 degree C (34 degrees F) occurring in January–February. The magnitude and distribution of water temperatures in the estuary are influenced by a variety of factors and complex relationships. Abood et al. (2006) identified four categories of parameters that play a significant role in water temperature—(1) atmospheric conditions, including radiation, evaporation, and conduction, (2) hydrodynamic conditions, including channel geometry, flow, and dispersion, (3) boundary conditions associated with the temperature of the ocean and freshwater, and (4) anthropogenic inputs, including those associated with activities that use river water for cooling purposes. The four parameters are interrelated and collectively influence temperature ranges and distributions in the estuary. Anthropogenic influences are of particular concern because they generally represent a constant influence on the system that may be controlled or managed, unlike those influences associated with climate, river morphology/geometry, and natural interactions between the river and ocean. Abood et al. (2006) indicate that the greatest percentage of artificial (anthropogenic) heat input into the lower Hudson River estuary is associated with the use of river water for condenser cooling in support of electrical power generation. The authors indicate that there are currently six power plants operating in the lower Hudson River estuary, with a total electrical generation of approximately 6000 MW(e), that use the Hudson River as cooling water. These plants collectively use 4.6 million gpm (290 m³/s) and reject approximately 8x10¹¹ British thermal units per day (Btu/day) (2.3x10⁸ kilowatt-hours per day (kWh/day)), or 9800 MW of thermal power output). Anthropogenic activities can also result in a net cooling effect on the river. An example given by Abood et al. (2006) suggests that a 1-million-gallon-per-day (mgd) (3800-m³/day) sewage effluent facility discharging water at 18 degrees C (64 degrees F) during the summer would cool the river because river ambient temperatures are higher.

Attempts to determine long-term changes to the temperature of the lower Hudson River are often confounded by changes in measurement locations and procedures, especially in long-term studies.

An analysis of long-term temperature trends in the lower Hudson River was attempted by Ashizawa and Cole (1997), using data obtained from the Poughkeepsie Water Works (PWW), which processes drinking water. This facility is located in the Poughkeepsie study area approximately 30 mi (48 km) upstream from IP2 and IP3 (Figure 2-6). A nearly continuous data set is available from PWW, beginning in 1908 and continuing to the present day. The data set represents water withdrawn from the Hudson River approximately 14 ft (4.3 m) below low tide. The results of the study show that the overall mean annual water temperature at the intake location was 12.2 degrees C (54 degrees F), and that water temperatures were highly correlated with air temperature during the winter and spring months. Although the overall trends in temperature suggested a gradual warming, the authors concluded that the relationship was not monotonic (i.e., showing change in only one direction over time). Rather, there were periods of both increasing and decreasing temperatures, with episodes of statistically significant warming occurring approximately 22.7 percent of the time and episodes of significant cooling occurring 11.5 percent of the time. During the period from 1918 to 1990, the authors observed

1 a significant increase in temperature, with a rate of warming of 0.12 degrees C (0.22 degrees F)
2 per decade. The sharpest increase during that time occurred from 1971 to 1990 at 0.46
3 degrees C (0.83 degrees F) per decade; the sharpest cooling occurred from 1908 to 1923 at
4 0.79 degrees C (1.42 degrees F) per decade. The authors noted that there has been only one
5 cooling event since 1923 (1968 to 1977), which occurred during a time of greater than average
6 rainfall and record-setting freshwater flows, illustrating the complex relationships between
7 weather, river flow, hydrodynamic connections, and anthropogenic effects discussed earlier.

8 Dissolved Oxygen

9 As discussed above, obtaining reliable data and trends associated with temperature and
10 dissolved oxygen (DO) can be problematic in dynamic, open-ended systems. Measurements
11 obtained during routine sampling within the river provide only a snapshot of actual conditions;
12 measurements taken continuously from fixed, known locations provide long-term records, but
13 only for the point or area of interest. Declines in DO can be caused by both natural and
14 anthropogenic activities and may be transient or persist episodically or continually through time.

15 In some cases, observed declines in DO at specific times and locations in the Hudson River
16 have been at least partially attributed to the appearance of invasive species, such as zebra
17 mussels (Caraco et al. 2000). Even episodic events can have serious implications for fish and
18 invertebrate communities and dramatically alter marine and estuarine food webs. To evaluate
19 long-term DO trends in the lower Hudson River, Abood et al. (2006) examined two long-term
20 data sets of DO observations collected by the New York City Department of Environmental
21 Protection (NYCDEP) and covering the lower reaches of the river. Measurements of DO taken
22 in August from 1975 to 2000 during the Long River Surveys indicate the lowest percent
23 saturation (less than 75 percent) at West Point and the highest (greater than 90 percent) at the
24 Kingston and Catskill reaches (Figure 2-6). Percent saturation at the river segment
25 encompassing IP2 and IP3 was approximately 76 percent. Based on the NYCDEP data set, the
26 authors concluded that there has been a substantial increase in DO since the early 1980s,
27 probably resulting from the significant upgrades to the Yonkers and North River Sewage
28 Treatment Plants in the lower reach of the Hudson.

29 Organic Matter

30 Organic matter can enter and influence a food web from two sources—autochthonous inputs,
31 which are produced within the aquatic system, and allochthonous inputs, which are imported to
32 the aquatic system from the surrounding terrestrial watershed (Caraco and Cole 2006). In the
33 lower Hudson River, autochthonous sources of carbon originating within the river are associated
34 with the primary production of phytoplankton and macrophyte communities. Studies by Caraco
35 and Cole (2006) of the Hudson River from Albany to Newburgh during May–August 1999 and
36 2000 concluded that runoff from the upper Hudson and Mohawk River watershed was
37 responsible for the majority of the allochthonous sources of carbon, represented as dissolved
38 organic carbon (DOC) and particulate organic carbon (POC). Inputs from sewage, adjoining
39 marshes, and tributaries accounted for less than 25 percent of the inputs. Total organic carbon
40 (TOC) inputs were on average highest at the uppermost stretch of the Hudson and decreased
41 down river by over twofold. Allochthonous loads were approximately fourfold lower in 1999 than
42 in 2000 for all three river sections studied. The authors noted that the importance of
43 allochthonous and autochothonous loads varied more than thirtyfold across space and time and
44 that the variation was related to hydrologic inputs. During the summer of 1999 (the driest in

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15 years), loadings of allochthonous inputs were low, but phytoplankton biomass and primary productivity were high. The resulting ratio of autochthonous/allochthonous inputs was tenfold greater than that measured during the summer of 2000 (the wettest in 15 years). These data suggest to the NRC staff that variations in sources and the importance of carbon inputs can be influenced by a variety of nonanthropogenic factors and result in changes to food web structure and function that directly impact higher trophic levels.

Nitrogen loading to rivers and estuaries comes primarily from forest and agricultural drainage, discharge from sewage treatment plants, and from nonpoint sources associated with urbanization. The most common forms of nitrogen in these systems are amino compounds originating from plant and animal proteins (CHGEC 1999). In the Hudson River, nitrate is the major contributor to the total nitrogen load, and in the lower Hudson River, approximately half of the total inorganic nitrogen loading is attributed to wastewater treatment systems and urban runoff (CHGEC 1999).

Total nitrogen and ammonia concentrations in the Hudson from Troy to Yonkers (obtained from EPA STORET) show differing trends from 1975 through 1992. Total nitrogen concentrations appear to vary without trend, while ammonia concentrations appear to be highest in river stretches near Yonkers and at locations upstream of Poughkeepsie (CHGEC 1999).

Phosphorus, in the form of phosphates, enters river systems as leachates from rock formations and soil. Additional inputs are associated with wastewater treatment plant discharges. Inorganic phosphates are used by plants and converted to organic forms that are used by animals (CHGEC 1999). Total phosphorus concentrations in the Hudson River during August 1974 suggest that the highest concentrations are associated with the lower 25 RM (40 RKM). Ortho-phosphorus concentrations from the EPA STORET database from 1975 through 1992 suggest that the highest concentrations are associated with the Yonkers-Piermont and Glenmont-Troy areas of the upper river.

The distribution and ratios of allochthonous and autochthonous nutrient inputs form the basis of complex food webs that can have large influences on upper trophic levels. Macronutrients such as carbon, nitrogen, phosphorus, and silicon are used by plants as raw materials to produce new biomass through photosynthesis. In some freshwater systems, the lack or excess of a specific macronutrient can limit growth or contribute to eutrophication and result in basinwide impacts to aquatic resources.

2.2.5.2 Significant Environmental Issues Associated with the Hudson River Estuary

Early Settlement

Anthropogenic impacts to the Hudson River ecosystem have existed for many centuries, with a possible origin approximately 11,000 years ago, after the retreat of the Wisconsin-stage ice sheet (CHGEC 1999). Swaney et al. (2006) categorized changes in watershed characteristics and effects based on four broad time scales—pre-European settlement, precolonial and colonial settlement, 19th century, and 20th century (Table 2-1). To put the scale of the anthropogenic impacts to the Hudson River watershed in context, the human population within the watershed has grown from approximately 230,000 at the time of the first census in 1790 to approximately 5 million today (not including parts of the boroughs of New York City outside the watershed, such as Queens). In 1609, the Hudson River watershed was almost entirely forested; by 1880, 68 percent of the watershed was farmland. Available records show that from the early 18th century to 1993, nearly 800 dams were constructed in the watershed, ranging in height from 2 to

700 ft (0.6 to 213 meters) (Swaney et al. 2006). A brief chronology of significant events that occurred from pre-European settlement to modern times is presented below.

Before settlement by European explorers, impacts associated with aboriginal populations were restricted to those from activities associated with hunting and gathering, and localized fires. During precolonial and colonial settlement, immigrants cleared large portions of forest cover to accommodate agriculture. These activities altered watershed dynamics and increased settlement loads and temperature in streams and rivers. Dramatic anthropogenic impacts occurred during the 19th century as populations along rivers, streams, and coastal areas increased, land clearing continued, and construction of roads, bridges, railroads, canals, and industrial centers occurred to support the emerging industrial revolution. The emergence of tanning and logging activities resulted in large-scale clearing of forests, construction of roads that were later expanded into highways and railroad lines, and the development of dams and canals to control floods and divert water for human needs. All of these activities resulted in profound changes to the dynamics of the Hudson River watershed. In some cases, the presence of railroad lines or highways effectively isolated nearby wetland communities from the main stem of the river; in other cases, wetland and marsh areas were filled and destroyed. Dredging and dam development significantly altered the flow characteristics of the Hudson River and influenced the migratory patterns of many species. (Swaney et al. 2006)

During the latter part of the 19th century, the growing human population created increased pollution and nutrient loading, which remained unregulated until the mid-20th century. Anthropogenic impacts occurring during the 20th century include the expansion of human population centers, further development of infrastructure to support industrial development (highways, roads, rail lines, factories), and a gradual shift in agricultural practices from traditional methods to new technologies that used specialized fertilizers, pesticides, and other agrochemicals. Industrialization during the 19th and 20th centuries also provided pathways for invasive species and nuisance organisms to colonize new habitats via canals, ship ballast water, and accidental or deliberate agricultural introductions. (Swaney et al. 2006)

During the latter part of the 20th century, environmental awareness of degraded conditions resulted in the creation of important environmental laws and monitoring programs and significant improvements to wastewater treatment facilities. The laws and activities resulted in significant improvements to some water-quality parameters and a new awareness of emerging threats (e.g., the presence of endocrine-disrupting pharmaceuticals, nanomaterials, and other contaminants or constituents). A brief description of some of the significant environmental issues and anthropogenic events is presented below. (Swaney et al. 2006)

Dredging, Channelization, and Dam Construction

As described above, dredging, channelization, and dam construction within the Hudson River watershed has occurred for over 200 years. The U.S. Army Corps of Engineers (USACE) has maintained a shipping channel from the ocean to the Port of Albany since the late 18th century and dredges the channel on an as-needed basis (CHGEC 1999). Dredging in some river segments occurs every 5 years (Miller et al. 2006). In some cases, dredging has significantly changed the hydrodynamic characteristics of the river and resulted in significant losses of intertidal and shallow water nursery habitats for fish (Miller et al. 2006). As described above, from the early 18th century to 1993, nearly 800 dams were constructed in the watershed, ranging in height from 2 to 700 ft (0.6 to 213 m) (Swaney et al. 2006). A study of the inorganic

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1 and organic content of marshes within the watershed by Peteet et al. (2006) revealed a pattern
2 of decreasing inorganic content with the arrival of the Europeans to the present day that was
3 probably the result of the construction of tributary dams. The presence of dams, river
4 channelization, and shoreline armoring to protect road and rail lines disconnects or interferes
5 with normal river processes and often results in an overall decrease of sediment transport into
6 and through the estuary. Because these structures are now an existing part of the landscape, in
7 most cases, it is extremely difficult or impossible to restore historical river structure and function.

8 Industry and Water Use Impacts

9 As described above, anthropogenic impacts on the watershed from aboriginal cultures were
10 generally small and restricted to effects associated with hunter-gatherer community activities
11 and the presence of fires. Before the 1900s, the dominant industries were those of the primary
12 sector (agriculture, forestry, fishing, mining). During the 1900s, there was an increase in the
13 use of the Hudson River to provide transportation, drinking water, and water for industrial
14 activities. During the development of industrial activity, there was a progressive increase in
15 secondary sector industries, including the manufacture of food products, textiles, pulp and paper
16 products, chemical, machinery, and transportation-related goods (CHGEC 1999).

17 The Hudson River was and is used as a source of potable water, a location for permitted waste
18 disposal, a mode of transportation, and a source of cooling water by industry and municipalities.
19 As of 1999, at least five municipalities use the lower Hudson as a source of potable water, and
20 Rohmann et al. (1987) identified 183 separate industrial and municipal discharges to the
21 Hudson and Mohawk rivers. The chemical industry has the greatest number of industrial users,
22 followed by oil, paper, and textile manufacturers; sand, gravel, and rock processors; power
23 plants; and cement companies (CHGEC 1999).

Table 2-1. Historical Impacts on the Hudson River Watershed

Pre-European Settlement	
Aboriginal agriculture	Localized fires and associated changes in biomass, habitat, and nutrient dynamics
Precolonial and Colonial Settlement	
Land clearing	Removal of forest cover and changes in habitat and streamflow characteristics
19th Century	
Tanning	Preferential clearing of forests leading to increased sediment and organic loads to water bodies
Logging	Extensive clearing of forests that affects water quality and habitat
Agriculture	Clearing of forests, use of fertilizers and nitrogen-fixing crops
Canal and dam development	Increase of waterborne invasive species, wetland drainage, flow alterations, habitat fragmentation
Railroad development	Increased access to forests leading to risk of fire; terrestrial, wetland, and aquatic habitat loss
Road development	Increases in impervious surfaces and runoff
Urbanization and industrialization	Increased pollution from unregulated sewage and factory waste discharges
Dam development for water supply infrastructure needs	Changes in flow regime and sediment transport
Highway and road development	Increase in impervious surfaces and runoff, impacts to terrestrial communities
Agriculture decline	Changes in land use practices (reforestation or increased land development)
Changing agricultural practices	Increased inorganic nutrients (fertilizers) and changes in organic (manure) loads
Urban development and sprawl	Impervious surface impacts, increased runoff, construction impacts, stream channelization
Adapted from: Swaney et al. 2006	

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At present, there are 11 facilities along the lower Hudson River with water discharges of 50 mgd (189,000 m³/day) or greater (Table 2-2). Of these, two are associated with wastewater discharge, and nine are associated with power generation. Between Poughkeepsie and Yonkers (RM 24–77 (RKM 39–124)), there are four steam power generating stations that use water from the Hudson River for condenser cooling (Danskammer Point, Roseton, IP2 and IP3, and Bowline Point). Of these, IP2 and IP3 have traditionally used the greatest quantity of water for cooling (2800 mgd, or 10.6 million m³/day), and Danskammer Point the least. Presently, Roseton operates intermittently, based on energy needs and the current prices of oil and natural gas. Excluding the water use of this facility, the IP2 and IP3 facility accounts for 60 percent of the water use from RM 24–77 (RKM 39–124). Impacts associated with industrial water use can include impingement or entrainment of fish, larval forms, and invertebrates from water intake; heat or cold shock associated with water discharges; and the cumulative effects of the discharge of low levels of permitted chemicals (CHGEC 1999).

Municipal Wastewater Treatment Plants

Wastewater collection and sewage treatment construction began in New York City in the late 17th century, and many of the sewer systems were connected in lower and central Manhattan Island between 1830 and 1870. The first wastewater treatment system was constructed in 1886 and included a screen system designed to protect bathers on Coney Island (Brosnan and O'Shea 1996.)

In 2004, the NYSDEC identified 610 municipal wastewater treatment plants in New York State (NYSDEC 2004a). These facilities produce a total discharge flow of approximately 3694 mgd (13.98 million m³/day). In the lower Hudson River basin, there are 78 secondary treatment facilities with a total flow of 556 mgd (2.1 million m³/day), 41 tertiary facilities with a total flow of 11 mgd (42,000 m³/day), and 10 other/unknown facilities with a total flow of approximately 1 mgd (3800 m³/day). The total flow associated with all 129 facilities is approximately 568 mgd (2.15 million m³/day). There are 33 facilities that use what is described as less than primary, primary, or intermediate treatment. A total of 404 facilities employ secondary treatment, and 173 employ tertiary treatment (NYSDEC 2004a).

As discussed above, the increasing populations along the river and within the watershed resulted in an increased discharge of sewage into the Hudson and an overall degradation of water quality. Beginning in 1906 with the creation of the Metropolitan Sewerage Commission of New York, a series of studies was conducted to formulate plans to improve water quality within the region (Brosnan and O'Shea 1996). In the freshwater portion of the lower Hudson River, the most dramatic improvements in wastewater treatment were made between 1974 and 1985, resulting in a decrease in the discharge of suspended solids by 56 percent.

Improvements in the brackish portion of the river were even greater. In the New York City area, the construction and upgrading of water treatment plants reduced the discharge of untreated wastewater from 450 mgd (1.7 million m³/day) in 1970 to less than 5 mgd (19,000 m³/day) in 1988 (CHGEC 1999). The discharge of raw sewage was further reduced between 1989 and 1993 by the implementation of additional treatment programs (Brosnan and O'Shea 1996).

During the 1990s, three municipal treatment plants located in the lower Hudson River converted to full secondary treatment—North River (1991), North Bergen MUA-Woodcliff (1991), and North Hudson Sewerage Authority West New York (1992). In addition, the North Hudson Sewerage Authority-Hoboken plant, located on the western bank of the Hudson River opposite

Manhattan Island, went to full secondary treatment in 1994 (CHGEC 1999). Upgrades to the Yonkers Joint Treatment plant in 1988 and the Rockland County Sewer District #1 in 1989 also resulted in improvements in water quality in the brackish portion of the Hudson River. In the mid-1990s, the Rockland County Sewer District #1 and Orangetown Sewer District plants were also upgraded. (CHGEC 1999)

Table 2-2. Facilities Discharging at Least 50 mgd (190,000 m³/day) into the Lower Hudson River

Facility	Activity	Location			Discharge (mgd)
		Region	RM	RKM	
59 th Street Station	Power generation	Battery (BT)	7	11	70
North River	Wastewater discharge	Battery (BT)	10	16	170
Yonkers	Wastewater discharge	Yonkers (YK)	17	27	92
Bowline Point	Power generation	Croton-Haverstraw (CH)	37	60	912
Lovett	Power generation	Indian Point	42	68	496
Indian Point	Power generation	Indian Point	43	69	2,800
Westchester Resource Recovery	Power generation	Indian Point	43	69	55
Danskammer Point	Power generation	Poughkeepsie (PK)	66	106	457
Roseton ^a	Power generation	Poughkeepsie (PK)	67	108	926
Bethlehem	Power generation	Albany (AL)	140	225	515
Empire State Plaza	Power generation	Albany (AL)	146	235	108

^a Roseton currently operates intermittently based on availability and cost of oil and natural gas.

Adapted from: Entergy 2007a

A review of long-term trends in DO and total coliform bacteria concentrations by Brosnan and O'Shea (1996) has shown that improvements to water treatment facilities have improved water quality. The authors noted that, between the 1970s and 1990s, DO concentrations in the Hudson River generally increased. The increases coincided with the upgrading of the North River plant to secondary treatment in spring 1991. DO, expressed as the average percent saturation, exceeded 80 percent in surface waters and 60 percent in bottom waters during summers in the early 1990s. DO minimums also increased from less than 1.5 mg/L in the early 1970s to greater than 3.0 mg/L in the 1990s, and the duration of low DO (hypoxia) events was also reduced (Brosnan and O'Shea 1996). Similar trends showing improvements in DO were noted by Abood et al. (2006) from an examination of two long-term data sets collected by NYCDEP in the lower reaches of the river. Brosnan and O'Shea (1996) also noted a strong

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decline in total coliform bacteria concentrations that began in the 1970s and continued into the 1990s, coinciding with sewage treatment plant upgrades.

Chemical Contaminants

The lower Hudson River currently appears on the EPA 303-d list as an impaired waterway because of the presence of PCBs and the need for fishing restrictions (EPA 2004). The following is a description of the chemical contaminants in the river.

Chemical contaminants in the Hudson River and surrounding watershed generally fall into three major categories—(1) pesticides and herbicides, including dichloro-diphenyl-trichloroethane (DDT) and its metabolites, aldrin, lindane, chlordane, endrin, heptachlor, and toxaphene, (2) heavy metals, including arsenic, cadmium, chromium, copper, inorganic and methylated mercury, lead, and zinc, and (3) other organic contaminants, including PCBs, and polycyclic aromatic hydrocarbons (PAHs) (CHGEC 1999). In addition, there is a growing concern that the discharge of pharmaceuticals and hormones via wastewater may pose a risk to aquatic biota and human communities (NOAA 2008b). There is also a concern that waste products or residuals associated with the emerging nanotechnology market could create a new source of environmental risk (EPA 2007b).

Pesticides and herbicides generally enter the Hudson River via runoff from agricultural activities in the upper watershed and have a high affinity to binding with organic carbon. In the Hudson and Raritan River basins, the use of DDT, once a common pesticide, peaked in 1957 and subsequently decreased until the compound was banned in the early 1970s (Phillips and Hanchar 1996). Sediment contaminant trends suggest that the concentration of DDT in sediment has generally decreased since the 1970s and is currently at or near the effects-range-median (ER-M), which is the median sediment concentration for a particular chemical or contaminant at which adverse biological effects have been observed (Steinberg et al. 2004). In the lower Hudson River, comparison of the EPA-sponsored regional environmental monitoring and assessment program (R-EMAP) results from 1993 to 1994 and 1998 show that the concentrations of the metals cadmium, nickel, lead, and silver have generally declined and are at or below ER-M. The concentrations of mercury, however, continue to be above ER-M at many locations in the lower river (Steinberg et al. 2004).

Contamination of the sediment, water, and biota of the Hudson River estuary resulted from the manufacture of capacitors and other electronic equipment in the towns of Fort Edward and Hudson Falls, New York, from the 1940s to the 1970s. Investigations conducted by EPA and others over the past 25 years have delineated the extent and magnitude of contamination, and numerous cleanup plans have been devised and implemented. Recently, EPA Region 2 released a “Fact Sheet” describing a remedial dredging program designed to remove over 1.5 million cubic yards (1.15 million m³) of contaminated sediment covering 400 acres (160 ha) extending from the Fort Edwards Dam to the Federal Dam at Troy (EPA 2008a). Concentrations of PCBs in river sediments below the Troy Dam are much lower. Work summarized by Steinberg et al. (2004) suggests that the sediment-bound concentrations of PCBs and dioxins have generally declined in the lower Hudson River since the 1970s and are now at or below ER-M limits.

Chemical contaminants present in the tissues of fish in the Hudson River estuary have been extensively studied for many years and resulted in the posting of consumption advisories by the States of New York and New Jersey. Current information summarized in Steinberg et al. (2004)

1 suggests that many recreationally and important fish and shellfish still contain levels of metals,
2 pesticides, PCB, and dioxins above U.S. Food and Drug Association (FDA) guidance values for
3 commercial sales. Tissue concentrations of mercury were of concern only for striped bass;
4 other fish and shellfish, including flounder, perch, eels, blue crab, and lobster, contained
5 concentrations of mercury in their tissues well below the FDA limit for commercial sale of 2 parts
6 per million (ppm). Concentrations of chlordane in white perch, American eels, and the
7 hepatopancreas (green gland) of blue crab were also above FDA guidelines. Concentrations of
8 DDT in the tissues of most recreationally and commercially valuable fish and shellfish in the
9 estuary were below the 2 ppm FDA limit with the exception of American eel. The concentrations
10 of 2,3,7,8-TCDD (commonly referred to as dioxin) and total PCBs in fish and shellfish tissues
11 were often above FDA guidance limits, suggesting that fish and shellfish obtained from some
12 locations within the estuary should be eaten in moderation or not at all. A detailed list of fish
13 consumption advisories for both New York and New Jersey may be found in the *Health of the*
14 *Harbor* report published by the Hudson River Foundation in 2004 (Steinberg et al. 2004).

15 Steinberg et al (2004) found that although a wide variety of contaminants still exists in sediment,
16 water, and biota in the lower Hudson River, the overall levels appear to be decreasing because
17 of the imposition of strict discharge controls by Federal and State regulatory agencies and
18 improvements in wastewater treatment. These trends appear to be confirmed by the results of
19 a NOAA-sponsored toxicological evaluation of the estuary in 1991, as described in Wolfe et al.
20 (1996). Employing a combination of bioassay tests using amphipods, bivalve larvae, and
21 luminescent bacteria and measurements of contaminants in a variety of environmental media,
22 the NOAA study showed that spatial patterns of toxicity generally corresponded to the
23 distributions of toxic chemicals in the sediments. Areas that exhibited the greatest sediment
24 toxicity were the upper East River, Arthur Kill, Newark Bay, and Sandy Hook Bay. The lower
25 Hudson River adjacent to Manhattan Island, upper New York Harbor, lower New York Harbor off
26 Staten Island, and parts of western Raritan Bay generally showed lower toxicity. The supporting
27 sediment chemistry, including acid-volatile sulfide and simultaneously extracted metals,
28 suggests that metals were generally not the cause of the observed toxicity, with the possible
29 exception of mercury. Among all contaminants analyzed, toxicity was most strongly associated
30 with PAHs, which were substantially more concentrated in toxic samples than in nontoxic
31 samples, and which frequently exceeded sediment quality criteria (Wolfe et al. 1996).

32 There is continuing concern, however, that legacy PCB waste may still pose a threat to
33 invertebrate, fish, and human populations. A study by Achman et al. (1996) suggests that PCB
34 concentrations in sediment measured at several locations in the lower Hudson River from the
35 mouth to Haverstraw Bay are above equilibrium with overlying water and may be available for
36 transfer within the food web. The authors concluded in some locations within the lower river,
37 the sediments could act as a source of PCBs and pose a long-term chronic threat, but that fate
38 and transport modeling would be required to fully understand the implications of this potential
39 contaminant source.

40 Nonpoint Pollution

41 Nonpoint pollution can include the intentional or unintentional discharges of chemicals and
42 constituents into rivers, streams, and estuaries. This section briefly summarizes three types of
43 nonpoint pollution that may affect fish and shellfish resources in the Hudson River estuary—
44 coliform bacteria that affect shellfish resources or swimmers, floatable debris, and surface
45 slicks. All information is derived from Steinberg et al. (2004).

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Levels of coliform bacteria in the Hudson River estuary have generally decreased from 1974 to 1998, primarily in response to wastewater treatment improvements. At present, only stretches of the river near the southern end of the island of Manhattan have geometric mean coliform concentrations of 201–2000 coliform cells/100 mL. The incidence of shellfish-related illness in New York State has also decreased from a high of over 100 reported cases per year in 1982 to only a few in 1999. Steinberg et al. (2004) caution, however, that the incidence of shellfish-related illness is probably underreported and likely misdiagnosed when reported.

Common floatable debris found on New York beaches includes cigarette butts, food containers and wrappings, plastic and glass, and medical waste. The amount of debris removed from New York Harbor annually has generally exceeded 5000 t (4500 MT) since 1988, with no apparent downward trend. The presence of surface slicks in the harbor has appeared to decline since 1994.

Invasive or Exotic Species

The presence of invasive or exotic species in the Hudson River estuary has been documented for over 200 years and probably began occurring after the Wisconsin-stage ice sheet receded over 10,000 years ago. In a compilation of information concerning the distribution of exotic organisms in the freshwater portions of the Hudson River basin, Mills et al. (1996) determined that at least 113 nonindigenous species of vertebrates, plants, and large invertebrates have established populations in the basin. The list would undoubtedly be larger if better information was available concerning the historical populations of small invertebrates and algae. Most invasive species arrive through unintentional releases (e.g., from ship ballast water or agricultural cultivation activities) or via vectors introduced by the construction of canals.

While the presence of new or exotic species can result in a benefit (e.g., the largemouth and smallmouth bass recreational fishery), many have had a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Beginning in early fall 1992, zebra mussels have been dominant in the freshwater tidal Hudson, constituting more than half of heterotrophic biomass and filtering a volume of water equal to all of the water in the estuary every 1–4 days during the summer (Strayer 2007). The impacts of this species on the freshwater portions of the Hudson River are presented in Section 2.2.5.6.

The impacts of other invasive aquatic species are discussed elsewhere in this chapter. The issue is of magnitude significant enough to result in Federal actions to control future introductions. In 1992, the U.S. Congress passed an amendment to Public Law 101-646, the “Nonindigenous Aquatic Nuisance Species Act,” extending some of the Great Lakes-oriented provisions of that Act and the regulations that followed from it to the Hudson River. In particular, as of late 1994, vessels entering the Hudson River with foreign ballast water must have exchanged that water in midocean and must arrive with a salinity of at least 30 ppt (Mills et al. 1996).

2.2.5.3 Regulatory Framework and Monitoring Programs

The regulatory framework, actions, and authorities governing environmental permitting and monitoring on the Hudson River are complex and have evolved significantly over time. The following is a chronological description of the major activities that have occurred over the past four decades.

Early Environmental Investigations

Early biological studies of the Hudson River began as a river survey program known as the Hudson River Fisheries Investigation (HRFI) which occurred from 1965 to 1968 under the direction of the Hudson River Policy Committee (HRPC) (Barnthouse and Van Winkle 1988). The investigations were intended to address the potential entrainment impacts of the proposed Cornwall pumped storage facility on striped bass. The objective of the HRFI program was to define the spatial and temporal distribution of striped bass eggs, larvae, and juveniles in relation to the intake to better understand the potential impacts of facility operation. The summary report produced by HRPC concluded that entrainment impacts associated with the operation of the Cornwall facility would be negligible, and this conclusion formed the basis of the decision by the Federal Power Commission (FPC) to license the facility in 1971. These conclusions were challenged on the grounds that an erroneous method had been used to estimate striped bass entrainment. This challenge ultimately resulted in a halt to the construction of the Cornwall facility in 1974 pending resolution of this issue (Barnthouse and Van Winkle 1988; Christensen and Englert 1988).

During this period, IP1 was in operation, IP2 and IP3 were under construction, and a modest fish sampling program was being conducted in the area of Indian Point by New York University and Raytheon (Barnthouse and Van Winkle 1988). The enactment of the National Environmental Policy Act of 1969 (NEPA) on January 1, 1970, and the interpretation that it required the Atomic Energy Commission (AEC) to explicitly consider nonradiological impacts in its licensing decisions had immediate and dramatic impacts on IP2 and IP3. During the permitting process for IP2, the major point of contention again centered on whether facility operation would significantly affect striped bass eggs, larvae, and juveniles because of entrainment. The Consolidated Edison Company of New York, the owner of IP2 at the time, concluded in its ER that entrainment impacts would be insignificant. The environmental impact statement (EIS) prepared by the AEC staff in 1972 expressed concern about the impacts of thermal discharges, entrainment, and impingement associated with cooling system operation and concluded that "The operation of IP1 and IP2 with the present once-through cooling system has the potential for a long-term environmental impact on the aquatic biota inhabiting the Hudson River which [sic] would result in permanent damage to and severe reduction in the fish population, particularly striped bass, in the Hudson River, Long Island Sound, the adjacent New Jersey coast, and the New York Bight" (USAEC 1972). The final conclusion reached by AEC for IP2 was a recommendation that an operating license be issued with the following conditions to protect the environment—(1) once-through cooling was permitted only until January 1, 1978, and thereafter a closed-cycle system would be required, (2) the applicant would evaluate the economic and environmental impacts of an alternative closed-cycle system and submit this evaluation to AEC by July 1, 1973, (3) after approval by AEC, the required closed-cycle system would be designed, built, and placed in operation no later than January 1, 1978 (USAEC 1972).

The USAEC results published in 1972 were influenced to a great extent by the results of an entrainment model developed by C.P. Goodyear of the Oak Ridge National Laboratory (described in Hall 1977), and during subsequent years, the use of numerical simulation models to assess the impacts of entrainment from once-through facilities received a great deal of attention. As the models were developed, there was much debate concerning the assumptions used by the modelers, and the predictive ability of the models was the subject of numerous scientific symposia, peer-reviewed journal articles, and hearings. This information formed the

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1 basis of the decisions handed down by the Atomic Safety and Licensing Board in 1973 and the
2 Atomic Safety and Licensing Appeals Board in 1974. These decisions stipulated that IP2 would
3 be allowed to operate using once-through cooling but only until May 1, 1979. Unless the
4 operator of the facility could demonstrate through new studies that the environmental impacts of
5 once-through cooling were negligible, cooling towers would have to be installed (Barnthouse
6 and Van Winkle 1988).

7 In late 1974, FPC held hearings to reconsider the Cornwall facility application. Recent data and
8 numerical models that had been developed for IP2 were also evaluated. Because the
9 information and assessment presented at the hearings provided conflicting conclusions
10 concerning impacts, FPC was unable to determine the magnitude of potential environmental
11 impacts, and the hearings were adjourned without resolution concerning plant licensing. In
12 1975, the NRC, the successor agency to AEC, published an EIS for IP3 that once again
13 expressed concern associated with the impacts of the once-through cooling system, including
14 impacts associated with entrainment, impingement, and thermal releases. Using a combination
15 of entrainment modeling and an improved striped bass life-cycle model, the NRC concluded that
16 impingement and entrainment impacts were "likely to result in a substantial decrease in the
17 Hudson River spawned striped bass population" (NRC 1975). The NRC indicated that the
18 applicant, who had used different parameters in its impingement and entrainment simulation
19 modeling, did not share this conclusion. The NRC agreed to allow IP3 to operate as a once-
20 through facility but required the applicant to comply with a variety of technical specifications
21 including the collection of additional environmental data to evaluate the impact of entrainment,
22 impingement, and thermal discharges. The applicant was also required to comply with the
23 license conditions agreed to in 1974 that required a cessation of once-through cooling by 1979
24 unless new evidence demonstrated that environmental impacts were negligible (NRC 1975;
25 Barnthouse and Van Winkle 1988).

26 Pollutant Discharge Elimination System Permitting

27 On October 28, 1975, EPA gave its approval to NYSDEC to issue SPDES permits in the State
28 of New York. Before that time, national pollutant discharge elimination system (NPDES) (the
29 federally administered analog to SPDES for States in which EPA has not granted authority to
30 discharge to waters of the United States) permits were issued directly by EPA. Issues
31 considered by EPA before the issuance of the 1975 permits included the thermal impacts of
32 once-through cooling and fish mortalities associated with the cooling water intakes. During this
33 time, scientists representing both the applicants and the regulatory agencies had embarked on
34 ambitious programs to better understand the impacts of once-through cooling systems on
35 sensitive fish species. This included a large-scale field program and the use and refinement of
36 numerical simulation models to better understand entrainment impacts.

37 Depending on the model used and the assumptions employed, the impacts of once-through
38 cooling ranged from negligible to catastrophic (Barnthouse and Van Winkle 1988). Further,
39 although field collections were occurring, the amount of information available to be used as
40 input data or to calibrate model output was limited. As a result, the EPA deemphasized the use
41 of simulation modeling to estimate entrainment impacts and, in 1975, issued permits for IP2 and
42 IP3, Bowline Units 1 and 2, and Roseton Unit 1 that required the construction of cooling towers.
43 The utility companies contested the permits and requested adjudicatory hearings. In 1977, the
44 owners of IP2 and IP3, Bowline, and Roseton facilities sought an administrative adjudicatory
45 hearing against the EPA NPDES permits issued in 1975 to overturn the cooling water intake

1 conditions and other requirements. The EPA hearings began in 1977 and ended in 1980 with
2 the Hudson River Settlement Agreement (HRSA).

3 Hudson River Settlement Agreement

4 After a number of years of adjudicatory proceedings, the owners of IP2 and IP3, Roseton, and
5 Bowline facilities signed the HRSA. The 10-year agreement was intended to resolve the
6 disputes related to the issuance of the 1975 NPDES permits and provide the necessary funding
7 to support a long-term investigation of the lower Hudson River estuary. Parties to the
8 agreement, which was effective for the 10-year period from May 10, 1981, to May 10, 1991,
9 included EPA, the New York State Attorney General, NYSDEC, the Scenic Hudson
10 Preservation Conference (Scenic Hudson), the Hudson River Fishermen's Association (the
11 predecessor to Riverkeeper), and the Natural Resources Defense Council (NYSDEC 2003a).
12 HRSA provided for mitigative measures to reduce fish mortalities at each generation station
13 from impingement and entrainment during once-through cooling operation, seasonal outages
14 during sensitive aquatic life stages, and the installation of variable speed pumps at IP2 and IP3
15 within 3½ years of the effective date of the agreement to allow for more efficient use of cooling
16 water. In addition, HRSA established a biological monitoring program of fish species at various
17 life stages within the lower Hudson River to better understand spatial and temporal trends.

18 In 1982, NYSDEC, under authority from EPA, issued SPDES permits to each of the facilities
19 covered by HRSA. The permits included limitations on thermal releases and incorporated the
20 terms of HRSA in the permit language to ensure that the environmentally protective mitigative
21 measures stipulated in the agreement were included as conditions. These permits expired in
22 1987, and NYSDEC issued SPDES permit renewals to each of the three HRSA facilities.
23 Permits for IP2 and IP3, Bowline Point 1 and 2, and Roseton 1 and 2 became effective on
24 October 1, 1987, and expired on October 1, 1992 (NYSDEC 2003a). HRSA conditions were
25 incorporated into the permit language as before. Before the expiration of the permits in 1992,
26 NYSDEC received timely renewal applications, and the department and the applicants executed
27 an agreement on May 15, 1991, to continue the mitigative measures described in HRSA until
28 the SPDES renewal permits were issued. The agreement also stipulated that the parties would
29 negotiate in good faith to resolve issues associated with impingement, entrainment, and thermal
30 discharges, and to resolve issues associated with mitigation and alternatives (NYSDEC 2003a).

31 In response to a lawsuit filed in 1991 by Riverkeeper, Scenic Hudson, and the Natural
32 Resources Defense Council, a consent order was signed by all parties on March 23, 1992,
33 which stipulated that the operators of IP2 and IP3, Roseton, and Bowline would continue the
34 HRSA mitigative measures, such as timed outages to reduce impacts to fish, and continue to
35 fund the ongoing environmental studies of the lower Hudson River. The 1992 consent order
36 was extended by the parties on four separate occasions, with the fourth extension expiring on
37 February 1, 1998. At present, there has been no agreement on a fifth consent order because of
38 the ongoing SPDES renewal process, but the operators of IP2 and IP3, Roseton, and Bowline
39 have agreed to continue the mitigative measures included in their existing SPDES permit and to
40 follow the provisions of the fourth consent order until new SPDES permits are issued (NYSDEC
41 2003b). The major monitoring and assessment programs conducted under HRSA that form the
42 basis for the staff's assessment of impacts are discussed below.

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Environmental Studies in the Lower Hudson Estuary

Numerous environmental studies were conducted in the Hudson River in support of HRSA and by other organizations to develop a baseline and to assess changes to key components of the ecosystem over time. A general description of the studies evaluated during the development of this draft SEIS is presented in Table 2-3. Other studies are cited throughout the description and historical assessment of impacts; however, only the data obtained from these studies were made available for further analysis.

Impingement losses associated with IP2 and IP3 were studied annually from 1975 to 1990. Data from 1975 to 1980 provided for analysis were weekly estimates of the total number impinged, organized by operating unit and taxon. From 1979 to 1980, estimates were further delineated by life stage (young of the year, yearling, yearling or older). Data from 1981 to 1990 included seasonal estimates of the total number impinged by operating unit, taxon, and life stage.

As a part of HRSA, IP2 and IP3 were required to replace the existing debris screens in 12 of the intake bays with angled screens and fish bypass systems. A subsequent analysis, however, showed that the angled screen system did not significantly reduce impingement mortality, and so the HRSA settlement parties rejected this mitigation option (Fletcher 1990). Con Edison and the New York Power Authority elected to install and test a Ristroph screen system at IP2 and IP3. The trial machine, referred to as "screen version 1" by Fletcher (1990), was installed in a single intake bay of IP2 and IP3 and evaluated from January 16 to April 19, 1985. At the request of the Hudson River Fishermen's Association, Fletcher (1990) evaluated the design of the trial machine, conducted flume tests, and suggested improvements to the design that were incorporated into "screen version 2." This final design, also known as a modified Ristroph screen, was installed in all intake bays of IP2 and IP3. No further studies were conducted after the installation of the modified Ristroph system at IP2 and IP3 to determine actual mortality of key species, and no additional impingement monitoring was conducted.

Ichthyoplankton entrainment losses associated with IP2 and IP3 were studied between May and August in 1981, 1983 through 1985, and in 1987, as well as between January and August 1986. Data provided for this analysis were the combined IP2 and IP3 weekly mean densities (number/1000 m³) of each life stage (egg, yolk-sac larvae, post-yolk-sac larvae, and juvenile) by taxon.

Data from the three field surveys from the Hudson River Estuary Monitoring Program were also provided for this analysis (Long River Survey (LRS), Fall Juvenile Survey (FJS), and the Beach Seine Survey (BSS)). All three data sets include the annual total catch and volume sampled per taxon from 1974 through 2005, the annual abundance index per taxon and life stage from 1974 through 2005, and the weekly regional density of each life stage by taxon from 1979 through 2005.

Table 2-3. Table 2-3 Hudson River Environmental Studies Table
(Information used in draft SEIS to assess impacts; data provided by Entergy)

Study	Study Dates	Information Available
Impingement Abundance	1975–1990	Number of fish impinged at IP2 and IP3.

Entrainment Abundance Studies	1981 1983–1987	Entrainment density by species and life stage for IP2 and IP3 combined.
Longitudinal River Ichthyoplankton Surveys	1974–2004	Standing crop, temporal and geographic distributions, and growth rates for ichthyoplankton forms of fish species, with an emphasis on Atlantic tomcod, American shad, striped bass, white perch, and bay anchovy. Sampling generally occurred in spring, summer, and fall.
Fall Juvenile Surveys	1974–2005	Standing crop and temporal and geographic indices for young-of-the-year fish in shoal, bottom, and channel habitats in the estuary with an emphasis on Atlantic tomcod, American shad, striped bass, and white perch. Surveys generally conducted in midsummer and fall.
Beach Seine Surveys	1974–2005	Abundance and distribution of young-of-the- year fish in the shore-zone habitat in the estuary, with an emphasis on American shad, Atlantic tomcod, striped bass, and white perch. Surveys generally conducted in summer and fall.

2.2.5.4 Potentially Affected Fish and Shellfish Resources

The Hudson River estuary is home to a large and diverse assemblage of fish and shellfish. Species richness and abundance vary according to season and location and can be influenced by climatological changes that affect water temperature, salinity, and sediment load. Waldman et al. (2006) report that 212 species of fish have been recorded north of the southern tip of Manhattan Island, with the largest contributions associated with temperate marine strays (65), introduced species (28), and freshwater species surviving the Pleistocene glaciations in the Atlantic coast refugia (21). The authors also note that only 10 diadromous (traveling between fresh- and salt-water) species are known to occur in the estuary.

The NRC staff identified 18 representative important species (RIS) to use in assessing the impacts of IP2 and IP3 (Table 2-4). This list contains RIS identified in past analyses conducted by NYSDEC, the NRC, and the current and past owners of IP2 and IP3. The RIS identified in this section are meant to represent the overall aquatic resource and reflect the complexity of the Hudson River ecosystem by encompassing a broad range of attributes, such as biological importance, commercial or recreational value, trophic position, commonness or rarity, interaction with other species, vulnerability to cooling system operation, and fidelity or transience in the local community. The distribution of each RIS is presented in Table 2-5.

Table 2-4. Representative Important Aquatic Species

Common Name	Scientific Name	Occurrence and Status	Predator/Prey Relationships
Alewife	<i>Alosa pseudoharengus</i>	Anadromous	Juveniles eat insect larvae and amphipods; adults eat zooplankton, small fish, and fish eggs. Species is prey of bluefish,

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			weakfish, and striped bass.
Atlantic menhaden	<i>Brevoortia tyrannus</i>	Permanent or seasonal resident	Juveniles and adults eat phytoplankton, zooplankton, copepods, and detritus. Species is prey of bluefish and striped bass.
American shad	<i>Alosa sapidissima</i>	Anadromous	Juveniles and adults primarily eat zooplankton, small crustaceans, copepods, mysids, small fish, and fish eggs. Species is prey of oceanic species.
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	Anadromous protected	Juveniles and adults are bottom feeders, subsisting on mussels, worms, shrimp, and small fish.
Atlantic tomcod	<i>Microgadus tomcod</i>	Anadromous permanent or seasonal resident	Diet includes crustaceans, polychaete worms, mollusks, and small fish. Juveniles are prey of striped bass when anchovies are scarce.
Bay anchovy	<i>Anchoa mitchilli</i>	Estuarine	Species primarily eats zooplankton and is prey of YOY bluefish and striped bass.
Blueback herring	<i>Alosa aestivalis</i>	Anadromous	Species' diet includes insect larvae and copepods. It is prey of bluefish, weakfish, and striped bass.
Bluefish	<i>Pomatomus saltatrix</i>	Permanent or seasonal resident	Juveniles eat bay anchovy, Atlantic silverside, striped bass, blueback herring, Atlantic tomcod, and American shad. Species is prey of a variety of birds.
Gizzard shad	<i>Dorosoma cepedianum</i>	Freshwater	Juveniles eat daphnids, cladocerans, adult copepods, rotifers, algae, phytoplankton, and detritus; adults eat phyto- and zooplankton. Species is prey of striped bass, other bass species, and catfish.
Hogchoker	<i>Trinectes maculatus</i>	Estuarine	Adults are generalists and eat annelids, arthropods, and tellinid siphons. Species is prey of striped bass.
Rainbow smelt	<i>Osmerus mordax</i>	Anadromous	Larval and juvenile smelt eat planktonic crustaceans; larger juveniles and adults feed on crustaceans, polychaetes, and fish. Adults eat anchovies and alewives. Species is prey of striped bass and bluefish.
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Federally endangered; permanent or seasonal resident	Juveniles feed on benthic insects and crustaceans.
Spottail	<i>Notropis</i>	Freshwater	Species eats aquatic insect larvae,

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shiner	<i>hudsonius</i>		zooplankton, benthic invertebrates, and the eggs and larvae of fish, including their own species. Species is prey of striped bass.
Striped bass	<i>Morone saxatilis</i>	Anadromous	Species eats menhaden, river herring, tomcod, and smelt. Larvae are prey of spottail shiner, white perch, striped bass, bluegill, and white catfish.
Weakfish	<i>Cynoscion regalis</i>	Permanent or seasonal resident	Small weakfish feed primarily on crustaceans, while larger weakfish feed primarily on anchovies, herrings, spot. Species is prey of bluefish, striped bass, and other weakfish.
White catfish	<i>Ameiurus catus</i>	Freshwater	Juveniles eat midge larvae. Adults are omnivores, feeding on anything from fish to insects to crustaceans.
White perch	<i>Morone americana</i>	Estuarine	Species eat eggs of other fish and larvae of walleye and striped bass. Prey of larger piscivorous fish and terrestrial aquatic vertebrates.
Blue Crab	<i>Callinectes sapidus</i>	Estuarine	Zoea eat phytoplankton, and dinoflagellates; adults opportunistic. Larval crabs are the prey of fish, shellfish, jellyfish; juvenile and adult blue crabs are prey of a wide variety of fish, birds, and mammals.

Table 2-5. Locations in the Hudson River Estuary (see Figure 2-6) Where the Presence of RIS Life Stages Represented at Least 10 Percent of the Total Number Collected in Referenced Surveys or Studies (adapted from ASA 2007; river segment abbreviations from Figure 2-10)

Species	Lifestage	BT	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
Alewife	Eggs											LRS ^(c)		
	YSL ^(d)											LRS		
	PYSL ^(e)								LRS					
	YOY ^(f)			BSS ^(a)				BSS				BSS		
	Year + ^(g)													
Atlantic menhaden ^(h)	Eggs													
	YSL													
	PYSL													
	YOY	ASMFC 2006a												
	Year +													
American shad	Eggs											LRS		
	YSL											LRS		
	PYSL										LRS			
	YOY							BSS	LRS			LRS/BSS		BSS
	Year +													
Atlantic sturgeon	Eggs													
	YSL													
	PYSL													
	YOY													
	Year +					FJS ^(b) : Only 12 fish caught 2005								
Atlantic tomcod	Eggs													
	YSL													
	PYSL		LRS											
	YOY		LRS/FJS			LRS/FJS		FJS						
	Year +		FJS			FJS								

1

Table 2-5 (continued)

Species	Lifestage	BT	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
Bay anchovy	Eggs	LRS												
	YSL	LRS												
	PYSL	LRS												
	YOY	LRS/BSS												
	Year +		BSS											
Blueback herring	Eggs											LRS		
	YSL											LRS		
	PYSL								LRS					
	YOY							LRS/BSS						
	Year +													
Bluefish	Eggs													
	YSL													
	PYSL													
	YOY		BSS											
	Year +													
Gizzard shad	Eggs													
	YSL													
	PYSL													
	YOY							BSS			BSS			BSS
	Year +							BSS			BSS			

Table 2-5 (continued)

Species	Lifestage	BT	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
Hogchoker	Eggs													
	YSL													
	PYSL													
	YOY			FJS		FJS								
	Year +			FJS										
Rainbow smelt	Eggs										LRS			
	YSL							LRS						
	PYSL			LRS										
	YOY		LRS/FJS											
	Year +					FJS								
Shortnosed sturgeon	Eggs													
	YSL													ER Text
	PYSL													
	YOY													
	Year +	FJS/LRS: Only 32 fish caught in 2005												
Spottail shiner	Eggs													
	YSL													
	PYSL													
	YOY								BSS		BSS			
	Year +								BSS			BSS		
Striped bass	Eggs						LRS							
	YSL					LRS								
	PYSL			LRS										
	YOY			LRS/BSS									LRS	
	Year +			BSS								BSS		

1

Table 2-5 (continued)

Species	Lifestage	BT	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
Weakfish	Eggs													
	YSL													
	PYSL													
	YOY		FJS											
	Year +		FJS				FJS							
White catfish	Eggs													
	YSL													
	PYSL													
	YOY								FJS			FJS		
	Year +			FJS								FJS		
White perch	Eggs										LRS			
	YSL								LRS					
	PYSL								LRS					
	YOY			BSS		LRS						BSS		
	Year +			BSS								BSS		
Blue crab ⁽ⁱ⁾	Eggs													
	Zoea													
	Megalops													
	Juvenile													
	Year +													

(a) BSS: Beach Seine Survey (1974–2005)

(b) FJS: Fall Juvenile Survey (also known as Fall Shoals Survey) (1979–2004)

(c) LRS: Long River Survey (1974–2004)

(d) YSL: yolk-sac larvae

(e) PYSL: post-yolk-sac larvae

(f) YOY: young of year

(g) Year +: yearling and older

(h) Obtained from ASMFC 2006a distribution

(i) Obtained from ASMFC 2006a distribution

Source: NYSDEC 2004b

Alewife

The alewife (*Alosa pseudoharengus*, family Clupeidae) is a pelagic, anadromous species found in riverine and estuarine habitats along the Atlantic coast from Newfoundland to South Carolina; landlocked populations have also been introduced in the Great Lakes and Finger Lakes. The species is historically one of the most commercially important fish species in Massachusetts and continues to be harvested as a source of fish meal, fish oil, and protein for animal food industries (Fay et al. 1983). The commercial fishing industry does not differentiate between the alewife and the blueback herring (*Alosa aestivalis*) and refers to the two species collectively as river herring. Commercial landings of river herrings peaked in the 1950s at approximately 34,000 MT (37,500 t) and then declined to less than 4000 MT (4400 t) in the 1970s (Haas-Castro 2006a). Between 1996 and 2005, landings of river herring ranged from 300 to 900 MT (330 to 990 t) annually, with 90 percent of landings in Maine, North Carolina, and Virginia (Haas-Castro 2006a). The river herring fishery is one of the oldest fisheries in the United States; however, no commercial fisheries for river herring exist in the Hudson River today. River herring are often taken as bycatch in the offshore mackerel fishery; within New York and New Jersey, river herring accounted for 0.3 percent of annual landings on the Atlantic coast (CHGEC 1999).

Spawning adults enter the Hudson River from the Atlantic Ocean in early spring and spawn once per year between late May and mid-July in shallow, freshwater tributaries with low current at temperatures between 11 degrees C (52 degrees F) and 27 degrees C (81 degrees F) (Everly and Boreman 1999; Fay et al. 1983). Females first spawn at 3 to 4 years of age and produce 60,000 to 100,000 eggs. Alewives spawn 3 to 4 weeks before blueback herring in areas where the two species occur sympatrically, and the peak spawning of each species occurs 2 to 3 weeks apart from one another (Fay et al. 1983). Within the Hudson River estuary, peak abundance of river herring eggs generally occurs within the Catskill region of the upper estuary during mid-May (CHGEC 1999). Incubation time varies inversely with water temperature and ranges from 2 to 15 days, and eggs are semidemersal and are easily carried by currents (Fay et al. 1983; CHGEC 1999). The yolk sac larvae (YSL) stage lasts approximately 2 to 5 days, and the post-yolk-sac larvae (PYSL) stage lasts until transformation to the juvenile stage at approximately 20 millimeters (mm) (0.78 in.). Full development occurs at approximately 45 mm (1.8 in.) at the age of about 1 month (Fay et al. 1983; CHGEC 1999).

Young-of-the-year (YOY) have been found in both lower and upper regions of the river (Table 2-5). Juveniles migrate to the ocean between July and November of their first year. At sexual maturity, alewives weigh 153 to 164 grams (g) (0.34 to 0.36 pounds (lb)) and can weigh 325 to 356 g (0.72 to 0.78 lb) by their seventh year; the average length for males is 29 cm and for females is 31 cm (Fay et al. 1983). Alewives in the Hudson River estuary have a life span of up to 9 years (Haas-Castro 2006a). Juveniles in the lower Hudson River have been reported to feed on chironomid larvae and amphipods, and the diet of adult alewives consists primarily of zooplankton, amphipods, mysids, copepods, small fish, and fish eggs. After spawning, alewives feed heavily on shrimp (Fay et al. 1983; CHGEC 1999). The species fulfills an important link in the estuarine food web between zooplankton and top piscivores. Juvenile and adult alewife is prey for gulls, terns, and other coastal birds, as well as bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), and striped bass (*Morone saxatilis*) (CHGEC 1999).

1 The annual abundance of YOY alewives has been estimated to range from 110,000 to 690,000
2 individuals (CHGEC 1999). For each annual cohort, entrainment mortality for the combined
3 abundance of alewife and blueback herring for all water withdrawal locations within the Hudson
4 River varies widely, ranging from 8 to 41 percent for data taken between 1974 and 1997, while
5 impingement mortality of the alewife is low, ranging from 1.1 to 1.9 percent for the same time
6 period (CHGEC 1999). The Atlantic States Marine Fisheries Commission (ASMFC)
7 implemented a Fisheries Management Plan for the American shad and river herring in 1985.
8 Restoration efforts under the plan include habitat improvement, fish passage, stocking, and
9 transfer programs; however, the abundance of river herring remains well below historic
10 estimates (Haas-Castro 2006a).

11 Atlantic Menhaden

12 The Atlantic menhaden (*Brevoortia tyrannus*, family Clupeidae) is a euryhaline species found in
13 inland tidal waters along the Atlantic coast from Nova Scotia to Florida (MRC 2006). Menhaden
14 is commercially harvested as a high-grade source of omega-3 fatty acid, which is used in
15 pharmaceuticals and processed food production (ASMFC 2006a). Atlantic menhaden make up
16 between 25 and 40 percent of the combined annual landings of menhaden species along the
17 Atlantic coast and Gulf of Mexico (Rogers and Van Den Avyle 1989). The Atlantic menhaden
18 was first commercially fished in the late 1600s and early 1700s for use in agricultural fertilizer,
19 and the species was later harvested for oil beginning in the early 1800s (Rogers and Van Den
20 Avyle 1989). Fish meal from menhaden also became a staple component in swine and
21 ruminant feed beginning in the mid-1900s and began to be used in aquaculture feed in the
22 1990s (ASMFC 2006a).

23 Atlantic menhaden migrate seasonally and exhibit north-south and inshore-offshore movement
24 in large schools composed of individuals of a similar size and age (Rogers and Van Den Avyle
25 1989). Migration patterns are linked to spawning habits, and the species spawns year-round
26 throughout the majority of its range, with spawning peaks in the spring and fall in mid-Atlantic
27 and northern Atlantic regions (MRC 2006). Menhaden reach sexual maturity at lengths of 18 to
28 23 cm (7.1 to 9.1 in.), and female fecundity ranges from 38,000 eggs for a small female to
29 362,000 eggs for a large female (ASMFC 2006a; MRC 2006). Eggs are pelagic and hatch
30 offshore in 2.5 to 2.9 days at an average temperature of 15.5 degrees C (59.9 degrees F)
31 (ASMFC 2006a; Rogers and Van Den Avyle 1989). Larvae absorb the yolk sac within
32 approximately 4 days of hatching and begin to feed on zooplankters (Rogers and Van Den
33 Avyle 1989).

34 The survival of larvae is a function of temperature and salinity, with the highest survival rates
35 occurring in laboratory experiments at temperatures greater than 4 degrees C (39 degrees F)
36 and salinities of 10 to 20 ppt (ASMFC 2006a). Larvae migrate shoreward into estuaries at 1 to
37 3 months of age at a size of 14 to 34 mm (0.55 to 1.3 in.) (ASMFC 2006a). Metamorphosis to
38 the juvenile stage occurs at approximately 38 mm (1.5 in.), and menhaden begin to filter feed on
39 phytoplankton, zooplankton, copepods, and detritus (MRC 2006). Juveniles move into shallow
40 portions of estuaries and are generally more abundant in areas of lower salinity (less than 5 ppt)
41 and waters above the brackish-freshwater boundary in rivers. Juveniles leave estuaries in
42 dense schools between August and November at lengths of 55 to 140 mm (2.2 to 5.5 in.) and
43 migrate southward along the North Carolina coast as far south as Florida in late fall and early
44 winter (Rogers and Van Den Avyle 1989). During the following spring and summer, menhaden
45 move northward, redistributing in schools consisting of similarly sized individuals (ASMFC

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2006a). Most menhaden reach maturity at 2 years of age, at which point approximately 90 percent of individuals are capable of spawning (Rogers and Van Den Avyle 1989). Menhaden lose their teeth as juveniles, and adults are strictly filter feeders, feeding on planktonic organisms (ASMFC 2006a). Atlantic menhaden can live 8 to 10 years; however, fish over 4 years of age are uncommon in commercial catches. Maximum adult length is 500 mm (19.7 in.) and maximum weight is 1500 g (3.3 lb) (Rogers and Van Den Avyle 1989). Menhaden are prey for a number of piscivorous fish, including bluefish (*P. saltatrix*), striped bass (*M. saxatilis*), bluefin tuna (*Thunnus thynnus*), as well as birds and marine mammals because of their abundance in nearshore and estuarine waters (ASMFC 2006a; Rogers and Van Den Avyle 1989).

Atlantic menhaden were not a focus of the Hudson River monitoring programs; therefore, historical records for the Hudson River population trends are unavailable. However, based on tagging studies, the Atlantic menhaden population appears to be composed of a single population that undergoes extensive seasonal migration (ASMFC 2006a). Menhaden are primarily harvested via reduction purse-seine fishing, and Virginia and North Carolina are the only States that currently permit this type of fishing for this species (ASMFC 2006a). Menhaden landings peaked during the late 1950s at an annual average of over 600,000 t (544,000 MT) and then declined during the 1960s from 576,000 t (523,000 MT) in 1961 to 162,000 t (147,000 MT) in 1969. Landings rose in the 1970s as the stock rebuilt, maintained moderate levels during the 1980s, and declined again in the 1990s. Landings have varied in the 2000s with average annual landings of 184,900 t (168,000 MT) from 2000 to 2004, and 146,900 t (133,000 MT) landed in 2005. Landings from the reduction purse-seine fishery accounted for 79 percent of total landings along the Atlantic coast in 2005 (ASMFC 2006a). Atlantic menhaden are also harvested for bait in many Atlantic coast States; however, no data are available for these landings as they are taken via cast net, pound net, gill net, and as bycatch.

American Shad

The American shad (*Alosa sapidissima*, family Clupeidae) is the largest of the anadromous herring species found in the Hudson River estuary and ranges from Newfoundland to northern Florida. The species is most abundant between Connecticut and North Carolina. The stock was introduced along the Pacific coast in the Sacramento and Columbia Rivers in 1871, and the population is now established from Cook Inlet, Alaska, to southern California (Facey and Van Den Avyle 1986). American shad has been commercially harvested via gillnets for meat and roe since the late 17th century (Haas-Castro 2006b). Before World War II, American shad was the most valuable fish along the east coast (Facey and Van Den Avyle 1986).

American shad spend most of their life at sea and only return to their natal rivers at sexual maturity (at the age of about 5 years) to spawn. Adult American shad have an average length of 30 in. (76.2 cm), weigh up to 12 lb (5.4 kg), and have a life span in the Hudson River of about 11 years (CHGEC 1999). Shad eggs have a high mortality rate, and fecundity of females changes with latitude, decreasing from south to north. Females in southern rivers produce 300,000 to 400,000 eggs, and females in northern rivers produce an average of 125,000 eggs (Haas-Castro 2006b). Spawning occurs at night in shallow waters of moderate current in sand, gravel, or mud substrates (Facey and Van Den Avyle 1986). The species can repeat annual spawning up to five times within their lifetime in northeastern rivers; however, most shad from southeastern rivers die after spawning (Facey and Van Den Avyle 1986; CHGEC 1999). Egg abundance in the Hudson River peaks in May, and once hatched, YSL transform into PYSL

1 within 4 days to 1 week in waters at a temperature of 17 degrees C (63 degrees F) (Everly and
2 Boreman 1999; CHGEC 1999). Larvae inhabit riffle pools of moderate depth near spawning
3 grounds and develop into juveniles 4 to 5 weeks after hatching when they are approximately
4 25 mm (1 in.) in length (Everly and Boreman 1999; Facey and Van Den Avyle 1986). American
5 shad eggs, YSL, PYSL, and YOY are generally found between Kingston and Albany
6 (Table 2-5), probably in response to food availability (Limburg 1996). Juveniles travel downriver
7 in schools between June and July (Everly and Boreman 1999), utilize the middle estuary by
8 September, and move to the lower estuary by late October (Limburg 1996). Adults spend the
9 summer months in the northwestern Atlantic waters off the Gulf of Maine, the Bay of Fundy, and
10 the coast of Nova Scotia. In the fall months, individuals migrate southward as far as North
11 Carolina (CHGEC 1999).

12 Shad stop eating before running and spawning and resume feeding after spawning during their
13 downriver migration back to the Atlantic Ocean (Everly and Boreman 1999). Larvae feed on
14 *Bosmina* spp., cyclopoid copepodites, and chironomid larvae. Juveniles are opportunistic
15 feeders and consume free-swimming organisms at the surface as well as insects (CHGEC
16 1999). The principal food source of the adult American shad is zooplankton, though the species
17 also consumes small crustaceans, copepods, mysids, small fish, and fish eggs (Facey and Van
18 Den Avyle 1986). The American eel (*Anguilla rostrata*) and catfish (*Ictalurus* spp.) prey upon
19 American shad eggs, and bluefish (*Pomatomus saltatrix*) prey upon larvae (CHGEC 1999).
20 Once juveniles migrate to the Atlantic Ocean, likely predators include sharks, tuna, and
21 porpoises; adult shad are not thought to have many predators (Facey and Van Den Avyle
22 1986).

23 The estimated population of American shad in the Hudson River has declined from 2.3 million in
24 1980 to 404,000 in 1996 (ASMFC 1998). The decline of the species in the Hudson and
25 Connecticut Rivers in the past century is attributed to overfishing, degradation of riverine
26 habitat, and dam construction (Haas-Castro 2006b). Entrainment mortality has caused a
27 23.8 percent annual decrease in abundance of juvenile American shad, and impingement may
28 reduce the population by an additional 1 percent annually. The majority of entrainment mortality
29 is believed to occur in the Albany region as a result of the Albany Steam Station and Empire
30 State Plaza (CHGEC 1999). ASMFC implemented a Fisheries Management Plan for the
31 American shad and river herring in 1985. Restoration efforts under the plan include habitat
32 improvement, fish passage, stocking, and transfer programs; however, abundance of the
33 American shad remains well below historic estimates (Haas-Castro 2006b). Low DO conditions
34 can affect the migration patterns of American shad and limit spawning. Improvements in
35 sewage treatment facilities along the Hudson River in the late 1960s have eliminated the low
36 DO conditions that were problematic in waters south of Albany and have allowed adult shad to
37 spawn farther upriver (CHGEC 1999).

38 Atlantic Tomcod

39 The demersal, anadromous Atlantic tomcod (*Microgadus tomcod*, family Gadidae) is found in
40 northwest Atlantic estuarine habitats, with a range extending from southern Labrador and
41 northern Newfoundland to Virginia (Stewart and Auster 1987). The species is nonmigratory and
42 inhabits brackish waters, including estuarine habitats, salt marshes, mud flats, eel grass beds,
43 and bays. The species is short-lived, with an estimated mortality rate ranging from 81 to
44 98 percent by the age of 2 years (McLaren et al. 1988). Mean lifespan within the Hudson River
45 is 3 years, though populations north of the Hudson River tend to be longer lived (Stewart and

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Auster 1987). Most tomcod within the Hudson River are thought to remain within the estuary for life; however, a small number of individuals have been marked and recaptured in the lower New York Bay, the East River, and western Long Island Sound (Klauda et al. 1988). The tomcod has not been a commercially important species in the northeast within the past century, and no catch statistics have been recorded since the 1950s, as the species is generally a target for winter sport fishing only along the New England coast (Stewart and Auster 1987). Tomcod are particularly vulnerable to impingement and entrainment because of their high concentration near the lower portion of the Hudson River estuary (Barnhouse and Van Winkle 1988; Boreman and Goodyear 1988) (Table 2-5).

Spawning occurs under ice between December and January in shallow stream mouths (Stewart and Auster 1987). In the Hudson River, tomcod aged 11 to 13 months contribute approximately 85 to 97 percent of annual egg production, and the majority of tomcod in the Hudson River spawn only once in their lifetime (McLaren et al. 1988). Females produce an average of 20,000 eggs, and incubation time correlates inversely with salinity and ranges from 24 to 63 days (Dew and Hecht 1994; Stewart and Auster 1987). Once hatched, larvae float to the surface and are swept by currents into estuaries, where they develop into juveniles. YSL are found throughout the lower half of the estuary, and PYSL are concentrated in the Yonkers and Tappan Zee regions of the estuary (CHGEC 1999) (Table 2-5). Adults are found at all levels of salinity, but larvae and juvenile densities are highest within the 4.5 to 6.7 ppt salinity range (Stewart and Auster 1987). The Hudson River represents the southernmost major spawning area of the species, and the tomcod is the only major species within the freshwater region of the Hudson River to hatch between February and March (Dew and Hecht 1994). Because the species hatches earlier than herring species within the Hudson and larvae and juveniles are able to tolerate low temperatures, tomcod experience little interspecific competition for food until the fall of their first year (McLaren et al. 1988). Tomcod are found at temperatures as low as -1.2 degrees C (30 degrees F) and have not been observed to inhabit waters at temperatures higher than 26 degrees C (79 degrees F) (Stewart and Auster 1987). The species has also been observed at a wide range of depths varying from the surface to 69 m (226 ft) (Froese and Pauly 2007a). Tomcod have three visible stages of first year growth within the Hudson River population. Juveniles show rapid growth during the spring, little to no growth during the summer, and rapid growth again in the fall, which is highly correlated with prevailing water temperatures (McLaren et al. 1988). Growth has been found to slow at temperatures above 19 degrees C (66 degrees F), and growth essentially ceases at temperatures above 22 degrees C (72 degrees F) (CHGEC 1999).

The diet of tomcod consists primarily of small crustaceans but also may include polychaete worms, mollusks, and small fish. Because tomcod have a lipid-rich liver and prey on many benthic organisms, they are especially sensitive to contaminants in highly polluted waterways, including PCBs and other chlorinated hydrocarbons (Levinton and Waldman 2006). Recent work by Wirgin and Chambers (2006) has reported evidence of induction of hepatic expression of cytochrome P4501A1 and messenger ribonucleic acid (mRNA) in Hudson River tomcod, suggesting a potential for deoxyribonucleic acid (DNA) damage, somatic mutations, and initiation of carcinogenesis consistent with chemical exposure. Within the Hudson River estuary, juvenile tomcod serve as alternate prey in the summer months for yearling striped bass (*M. saxatilis*) during years when juvenile striped bass's main prey, the bay anchovy (*A. mitchilli*), is scarce (Dew and Hecht 1976 cited in Stewart and Auster 1987). Juvenile tomcod are also the prey of large juvenile bluefish (*P. saltatrix*) (Juanes et al. 1993).

1 The Hudson River tomcod population exhibits wide fluctuations in annual abundance because
2 the species is relatively short lived, and a yearly population is generally composed of only one
3 age class (Levinton and Waldman 2006). The population of tomcod aged 11 to 13 months has
4 been estimated to vary year-to-year between 2 to 5 million individuals, and numbers of tomcod
5 aged 23 to 25 months may vary from 100,000 to 900,000 individuals. A combined abundance
6 index suggests that a population decline has occurred since 1989 (CHGEC 1999). Recent
7 information provided by Entergy (2006c) estimated the population of Atlantic tomcod spawning
8 in the Hudson River during the winter of 2003–2004 to be 1.7 million fish, with 95 percent
9 confidence limits of 1.0 and 2.9 million fish. This estimate, derived by a Petersen mark-
10 recapture technique, is based on the number of tomcod caught and marked between RM 25
11 and 76 (RKM 40 to 122) in box traps between December 15, 2003, and February 1, 2004, and
12 recaptured in trawls in the Battery region from January 5 through April 11, 2004. The estimated
13 2003–2004 Atlantic tomcod spawning population in the Hudson River is the ninth lowest
14 observed among 20 recent years of Petersen estimates (Entergy 2006c).

15 Bay Anchovy

16 The bay anchovy (*Anchoa mitchilli*, family Engraulidae) occurs along the Atlantic coastline from
17 Maine to the Gulf of Mexico and the Yucatan Peninsula (Morton 1989) and is a common
18 shallow-water fish in the Hudson River estuary. No commercial fishery for the bay anchovy
19 exists on the Hudson River, but it is preyed upon by other fish, such as the striped bass (*M.*
20 *saxatilis*), which is recreationally important on the Hudson River. Unless otherwise noted, the
21 information below is from Morton (1989).

22 Considered a warm water migrant, the bay anchovy uses the Hudson River estuary for
23 spawning and as a nursery ground. Adults are found in a variety of habitats, including shallow
24 to moderately deep offshore waters, nearshore waters off sandy beaches, open bays, and river
25 mouths. Studies conducted in the Hudson River from 1974–2005 suggest that eggs, YSL,
26 PYSL, YOY, and older individuals occur in greatest abundance from the Battery to IP2 and IP3
27 (Table 2-5, Figure 2-6). There is also evidence from recent work by Dunning et al. (2006a) that
28 the peak standing crops of bay anchovy eggs and larvae in New York Harbor, the East River,
29 and Long Island Sound are approximately eight times larger than the population estimates for
30 the lower Hudson River, probably because of the larger water volumes in those areas and the
31 salinity preference of the species. Spawning generally occurs at water temperatures between
32 9 and 31 degrees C (48 and 88 degrees F). The spawning period for the species is long,
33 typically ranging from May through October. Spawning generally occurs in the late evening or
34 at night, and the eggs are pelagic. Schultz et al. (2006) has reported that anchovies that spawn
35 in the Hudson River are mostly 2 years old, whereas yearlings predominate in other locations,
36 such as Chesapeake Bay. Eggs are usually concentrated in salinities of 8 to 15 ppt and, at
37 temperatures around 27 degrees C (81 degrees F), hatch in 24 hours. At hatching, the YSL are
38 about 1.8 to 2.0 mm (0.07 to 0.08 in.) long. Within 24 hours of hatching, YSL consume the yolk
39 sac and become PYSL. Fins begin to develop during the PYSL stage. Larvae are transparent
40 and become darker as they develop into juveniles. PYSL eat copepod larvae and other small
41 zooplankton.

42 Larvae metamorphose to juveniles at about a length of 16 mm (0.63 in.). Juveniles and adults
43 travel and hunt in large schools. Juveniles acquire adult characteristics at about 60 mm (2.4 in.)
44 in length and gain a silvery lateral band. Adults have a relatively high tolerance to fluctuations in
45 both river temperature and salinity, and there is evidence in the Hudson River that early-stage

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1 anchovies migrate up-estuary at a rate of 0.6 km/day (0.4 mi/day) and are capable of periodic
2 vertical migration (Schultz et al. 2006). Adult and juvenile bay anchovy feed primarily on mysid
3 shrimp, copepods, other small crustaceans, small mollusks, other plankton, and larval fish
4 (Hartman et al. 2004). Important predators include birds, bluefish (*P. saltatrix*), weakfish (*C.*
5 *regalis*), summer flounder (*Paralichthys dentatus*), and striped bass (*M. saxatilis*) (CHGEC
6 1999). The population trend in the Hudson River appears to show a population decline,
7 although exact population counts are not available (Tipton 2003). Tipton (2003) also speculates
8 that the reduction in bay anchovy may be linked to increased predation and overall populations
9 of striped bass, bluefish, or other important commercial fish. Fishery statistics are not available
10 for this species from National Marine Fisheries Service (NMFS) because of the lack of
11 commercial and recreational fishing. The Mid-Atlantic Fishery Management Council has not
12 identified bay anchovy as a managed species.

13 Blueback Herring

14 The blueback herring (*Alosa aestivalis*, family Clupeidae) is an anadromous species found in
15 riverine and estuarine waters along the Atlantic coast ranging from Nova Scotia to St. Johns
16 River, Florida. As noted in the life history of the alewife (*A. pseudoharengus*), commercial
17 fisheries do not differentiate between the blueback herring (*A. aestivalis*) and alewife, and the
18 two species are collectively referred to as river herring. River herring are harvested for fish
19 meal, fish oil, and protein for animal food industries (Fay et al. 1983). Commercial landings of
20 river herrings peaked in the 1950s at approximately 34,000 MT (37,000 t) and then declined to
21 less than 4000 MT (4400 t) in the 1970s. Between 1996 and 2005, landings of river herring
22 ranged from 300 to 900 MT (330 to 990 t) annually, with the majority of the landings in Maine,
23 North Carolina, and Virginia (Haas-Castro 2006a). The river herring fishery is one of the oldest
24 fisheries in the United States; however, no commercial fisheries for river herring exist in the
25 Hudson River today. River herring are often taken as bycatch in the offshore mackerel fishery.
26 Within New York and New Jersey, river herring accounted for 0.3 percent of annual landings on
27 the Atlantic coast (CHGEC 1999).

28 Blueback herring spawn once per year between late May and mid-July in the main channels of
29 estuaries or relatively deep freshwater with swift currents on sand or gravel substrate at
30 temperatures between 14 degrees C (57 degrees F) and 27 degrees C (81 degrees F) (Everly
31 and Boreman 1999; Fay et al. 1983). Female egg production varies greatly, ranging from
32 46,000 to 350,000 eggs per female (Fay et al. 1983), and incubation time is approximately
33 6 days (Bigelow and Schroeder 1953). Blueback herring spawn 3 to 4 weeks after alewives in
34 areas where the two species occur sympatrically, and the peak spawning of each species
35 occurs 2 to 3 weeks apart from one another (Fay et al. 1983). In the Hudson, blueback herring
36 spawn most commonly within the Mohawk River and upper Hudson River (CHGEC 1999). The
37 YSL stage exists 2 to 3 days before yolk-sac absorption, and the PYSL stage lasts until larvae
38 reach approximately 20 mm (0.79 in.), with full development occurring at 45 mm (1.8 in.) (Fay
39 et al. 1983). Eggs, YSL, PYSL, and YOY are generally found between Poughkeepsie and
40 Albany (Table 2-5). Juvenile blueback herring assume adult characteristics within a month of
41 hatching, at which point growth slows. Peak abundance of juveniles occurs during late June
42 within the upper estuary (CHGEC 1999) (Table 2-5). Migration downriver to the Atlantic Ocean
43 occurs in October, which is generally later than peak migration for both the American shad and
44 the alewife within the Hudson River estuary (Fay et al. 1983). Some blueback herring do not
45 migrate and tend to stay within the lower reaches of the estuary during their first 1 to 2 years

(CHGEC 1999). Average length for males is 23 cm (9.1 in.) and for females is 26 cm (10 in.) (Collette and Klein-MacPhee 2002).

Adult blueback herring feed mainly on copepods but also eat amphipods, shrimp, fish eggs, crustacean eggs, insects, and insect eggs. The diet of blueback herring in the lower Hudson River consists primarily of chironomid larvae and copepods. As described for the alewife, blueback herring is an important link in the estuarine food web between zooplankton and top piscivores. The blueback herring is prey for gulls, terns, and other coastal birds, as well as for bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), and striped bass (*Morone saxatilis*) (CHGEC 1999).

Annual abundance of blueback herring YOY in the Hudson River estuary has been estimated to range from 1.2 million to 50.1 million individuals from sampling conducted with a Tucker trawl since 1979 (CHGEC 1999). Entrainment mortality for the combined abundance of blueback herring and alewife for all water withdrawal locations within the Hudson River varies widely, ranging from 8 to 41 percent in data taken between 1974 and 1997, while impingement mortality of the two species is low, ranging from 0.2 to 0.7 percent for the same time period (CHGEC 1999).

Bluefish

The bluefish (*Pomatomus saltatrix*, family Pomatomidae) is a migratory, pelagic species that occurs in temperate and tropical waters worldwide on the continental shelf and in estuaries. Along the Atlantic coast, the bluefish ranges from Nova Scotia to the Gulf of Mexico (Pottern et al. 1989). Bluefish are a highly sought-after sport fish along the North Atlantic Coast, and State and Federal regulations on the commercial catch of the species began in the early 1970s (CHGEC 1999; Pottern et al. 1989). The majority of the Atlantic coast bluefish catch occurs between New York and Virginia, and recreational fishing has accounted for 80 to 90 percent of the total bluefish catch in the past, with a peak in 1981 and 1985 of over 43,000 MT (47,000 t). Landings have since decreased, reaching a low of 3300 MT (3600 t) in 1999; landings in 2005 totaled 3500 MT (3300 t) (Shepherd 2006a). The bluefish is also harvested commercially for human consumption, and during peak years in 1981 to 1983, average annual landings were 7.4 million kg (16.3 million lb), accounting for 0.5 percent of the total Atlantic coast commercial finfish and shellfish landings (Pottern et al. 1989).

North American bluefish populations range from New England to Cape Hatteras, North Carolina, in the summer, and migrate to Florida and the Gulf Stream during the winter. Fisheries data also indicate the existence of small nonmigratory populations in southern Florida waters and the Gulf of Mexico (Pottern et al. 1989). Bluefish are generally not found in waters colder than 14 to 16 degrees C (57.2 to 60.8 degrees F) and exhibit signs of stress at temperatures below 11.8 degrees C (53.2 degrees F) and above 30.4 degrees C (86.7 degrees F) (Collette and Klein-MacPhee 2002).

Generally, bluefish have two major spawnings per year. The first spawning occurs during the spring migration as bluefish move northward to the South Atlantic Bight between April and May; the second spawning occurs in the summer in offshore waters of the Middle Atlantic Bight between June and August. Two distinct cohorts of juvenile bluefish in the fall result from the two spawning events, which mix during the year creating a single genetic pool (Shepherd 2006a). Females can produce 600,000 to 1.4 million eggs (CHGEC 1999). Larvae hatch in 46 to 48 hours at temperatures of 18 to 22 degrees C (64.4 to 71.6 degrees F) (Collette and Klein-

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MacPhee 2002). Newly hatched larvae are pelagic and stay in offshore waters for the first 1 to 2 months of life before migrating shoreward to shallower waters (CHGEC 1999). Beach seine survey results indicate YOY bluefish are generally found between Yonkers and Croton-Haverstraw (Table 2-5). YSL typically consume the yolk sac by the time they reach 3 to 4 mm (0.12 to 0.16 in.) in length (Pottern et al. 1989). Bluefish larvae grow rapidly; spring-spawned juveniles reach lengths of 25 to 50 mm (0.99 to 2 in.) once they move to mid-Atlantic bays in the summer, grow to lengths of 175 to 200 mm (6.9 to 7.9 in.) by late September when migration begins, and reach lengths of about 260 mm (10.2 in.) by the following spring. Summer-spawned juveniles exhibit slower growth because they are unable to inhabit bays and estuaries until after their first migration, though summer-spawned juvenile growth rates exceed those of spring-spawned juveniles during the second year, at which point differences between the two stocks are less pronounced (Pottern et al. 1989). Adult bluefish can live up to 12 years and reach weights of 14 kg (31 lb) and lengths of 100 cm (39 in.) (Shepherd 2006a).

Bluefish are avid predators, and the Atlantic coast population is estimated to consume eight times its biomass in prey annually. Larvae feed on zooplankton and larvae of other pelagic-spawning fish (Pottern et al. 1989). In the Hudson River estuary, YOY feed on bay anchovy (*A. mitchilli*), Atlantic silverside (*M. menidia*), striped bass (*M. saxatilis*), blueback herring (*A. aestivalis*), Atlantic tomcod (*M. tomcod*), and American shad (*A. sapidissima*) (CHGEC 1999; Juanes et al. 1993). Adult bluefish diets are dominated by squids, clupeids, and butterfish. YOY bluefish are prey for birds including Atlantic puffin (*Fratercula arctica arctica*), Arctic tern (*Sterna paradioaea*), and roseate tern (*Sterna dougalli dougalli*) (Collette and Klein-MacPhee 2002). Sharks also prey on bluefish; species include the bigeye thresher (*Alopias superciliosus*), white shark (*Carcharodon carcharias*), shortfin mako (*Isurus oxyrinchus*), longfin mako (*I. paucus*), tiger shark (*Galeocerdo cuvier*), blue shark (*Prionace glauca*), sandbar shark (*Carcharhinus plumbeus*), smooth dogfish (*Mustelus canis*), spiny dogfish (*Squalus acanthias*), and angel shark (*Squatina* spp.) (Collette and Klein-MacPhee 2002).

The bluefish population data from the Hudson River estuary show a declining trend since the population peaked in 1981 and 1982 (CHGEC 1999). Bluefish populations along the east coast have historically fluctuated widely, though analysis by the NMFS of data between 1974 and 1986 did not find evidence of a systematic decline of the species (CHGEC 1999). Bluefish have not been found in entrainment samples from power plants along the Hudson River, which include Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2 (CHGEC 1999). Juvenile bluefish may be impinged, but the numbers are estimated to be relatively small (CHGEC 1999).

Gizzard Shad

The gizzard shad (*Dorosoma cepedianum*, family Clupeidae) is a pelagic herring species that is found in the waters of the Atlantic and Gulf coastal plains streams as well as in freshwater lakes and reservoirs ranging from New York to Mexico (MDNR 2007a). Gizzard shad are found mainly in freshwater rivers, reservoirs, lakes, and swamps, and in slightly brackish waters of estuaries and bays (Froese and Pauly 2007b). The gizzard shad is a relatively recent immigrant to the Hudson River estuary, though it is now considered a permanent resident, and the species is continuing to expand its range throughout the northeastern United States (CHGEC 1999; Levinton and Waldman 2006). No commercial or sport fishery for gizzard shad exists on the Hudson River (CHGEC 1999). Larvae have been observed in the tidal waters of the Hudson

River since 1989 (Levinton and Waldman 2006). A spawning population is believed to exist in the Mohawk River, but no spawning has been observed in the Hudson River (CHGEC 1999). Adult gizzard shad grow to 23 to 36 cm (9 to 14 in.) in length with an average weight of 907 g (2 lb) and an average life span of 7 years in northern populations (CHGEC 1999; Morris 2001). Both males and females mature between 2 and 3 years of age, and females spawn between April and June in shallow waters between 10 and 21 degrees C (50 and 70 degrees F) (CHGEC 1999; MDNR 2007a). Fecundity is thought to be highly variable but does appear to increase with size of the female (CHGEC 1999). Females can produce between 50,000 and 379,000 eggs (MDNR 2007a). Eggs hatch in 1.5 to 7 days, depending on water temperature (CHGEC 1999). YSL transform into PYSL within 5 days of hatching and begin to feed on microzooplankton until they reach 2.5 cm (1 in.) in length. At this point, development of the digestive system supports a diet including plant material; juveniles eat a variety of daphnids, cladocerans, adult copepod, rotifers, algae, phytoplankton, and detritus (CHGEC 1999). Gizzard shad grow rapidly during the first 5 to 6 weeks of life, at which point growth slows; individuals reach a length of 10 to 25 cm (4 to 10 in.) by their first summer (CHGEC 1999). Adults are filter feeders, eating a variety of phytoplankton and zooplankton. Larvae are not an important prey species because of their size, but age 0 gizzard shad are consumed by a number of species including striped bass, largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), white bass (*Morone chrysops*), and spotted bass (*Micropterus punctulatus*) (CHGEC 1999). Predators of adult gizzard shad include catfish (order Siluriformes) and striped bass (*M. saxatilis*) (Morris 2001). Abundance data are not available for the gizzard shad from the Hudson River sampling programs because of the low capture rate of the species in these programs (CHGEC 1999). Beach seine surveys from 1974 to 2005 suggest YOY and older gizzard shad occur primarily from Cornwall north to Albany (Table 2-5). Impingement data are available at three power stations along the Hudson River (Danskammer, Roseton Units 1 and 2, and the now-shuttered Lovett Generating Station) and indicate year-to-year fluctuations with a general trend of increasing impingement and peak adult impingement during the winter months. Entrainment of early life stages is thought to be low, and small gizzard shad are rare in utility ichthyoplankton surveys (CHGEC 1999).

Hogchoker

The hogchoker (*Trinectes maculatus*, family Soleidae) is a right-eyed flatfish species found along the Atlantic coast in bays and estuaries from Maine to Panama (Dovel et al. 1969). The hogchoker is common in the Hudson River estuary and surrounding bays and coastal waters, and abundance indices from the annual Fall Juvenile Survey (also known as the Fall Shoals Survey) channel sampling in the Hudson River from 1974 to 1997 indicate that the hogchoker population has remained relatively stable with a nonsignificant 1 percent increase per year (CHGEC 1999). Because of its small size (adults range from 6 to 15 cm (2.4 to 5.9 in.) with a maximum size of 20 cm (7.9 in.)), the hogchoker is not commercially harvested in any area within its geographic range (Collette and Klein-MacPhee 2002). CHGEC (1999) indicates that hogchoker larvae are found mainly within deeper channel waters and are not often captured during the Longitudinal River Survey; low numbers of juveniles are captured during the Beach Seine and Fall Juvenile Surveys, and yearlings and adults are generally not exposed to Hudson River generating stations because they remain in the waters below RM 34 (CHGEC 1999). However, the Fall Juvenile Survey information reviewed by the NRC staff suggests that YOY

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1 and older hogchokers have been collected from Tappan Zee to Poughkeepsie—an area that
2 includes IP2 and IP3 (Table 2-5).

3 The majority of hogchokers in the Hudson River reach sexual maturity at the age of 2 years,
4 though some faster growing males have been observed to spawn at age 1 year (Koski 1978).
5 Spawning occurs in estuaries between May and October in the Hudson River estuary, which is
6 a 5-week longer spawning period than that of the Chesapeake Bay population (Collette and
7 Klein-MacPhee 2002; Koski 1978). Spawning occurs in waters 20 to 25 degrees C (68 to
8 77 degrees F) and a salinity of 10 to 16 ppt (Collette and Klein-MacPhee 2002). Eggs are
9 observed in greatest numbers from the last week in May through July in lower estuary waters.
10 Egg production is positively correlated with size, and females can produce between 11,000 and
11 54,000 eggs. Within the Hudson River, eggs are most common between RM 12 and 24
12 (RKM 19 and 39). Eggs hatch in 24 to 36 hours at temperatures between 23.3 and
13 24.5 degrees C (73.9 and 76.1 degrees F). YSL absorb the yolk sac within 48 hours of
14 hatching, and eye migration occurs within 34 days of hatching or at lengths of 0.2 to 0.4 in.
15 (0.51 to 0.02 cm) (Collette and Klein-MacPhee 2002; CHGEC 1999). Larvae have been
16 observed to congregate upstream in waters with lower salinity than their hatching ground (Dovel
17 et al. 1969). Within the Hudson River, YSL are most abundant between RM 24 and 33 (RKM 39
18 and 53), and PYSL are most abundant from RM 24 through RM 55 (RKM 39 and 89). Juveniles
19 are found above RM 39 (RKM 63), while yearling and older individuals are found below RM 34
20 (RKM 55) (CHGEC 1999). Adult individuals inhabit nonvegetated waters with sandy or silty
21 bottoms (Whiteside and Bonner 2007).

22 Adult hogchokers feed mainly on annelids, arthropods, and tellinid siphons (Derrick and
23 Kennedy 1997). The species is a generalist and may also prey on midges, ostracods, aquatic
24 insects, annelids, crustaceans, and foraminiferans (Whiteside and Bonner 2007). Larger striped
25 bass (*M. saxatilis*) prey on yearling and older hogchokers within the Hudson River estuary,
26 which may affect the abundance of those age groups (CHGEC 1999). The Northeast Fisheries
27 Science Center also found the smooth dogfish (*Mustelus canis*) to be a predator of hogchoker
28 (Roundtree 1999 as cited in Collette and Klein-MacPhee 2002).

29 Rainbow Smelt

30 Rainbow smelt (*Osmerus mordax*, family Osmeridae) is an anadromous species once found
31 along the Atlantic coast from Labrador to the Delaware River, although the southern end of the
32 range is now north of the Hudson River. NOAA (2007) lists rainbow smelt as a Species of
33 Concern. Unless otherwise noted, information below comes from Buckley (1989).

34 Adult rainbow smelt along the east coast move into saltwater in summer, where they are found
35 in waters less than 1 mi (1.6 km) from shore and usually no deeper than 6 m (20 ft). In spring,
36 spawning adults typically move up the estuaries before ice breaks up to spawn above the head
37 of tide in water temperatures of 4.0 to 9.0 degrees C (39 to 48 degrees F). They have been
38 found to run up into coastal streams to spawn at night and then return to the estuary during the
39 day. Females, depending on size, produce about 7,000 to 75,000 eggs (summarized in NOAA
40 2007a), which are from 1.0 to 1.2 mm (about 0.04 in.) in diameter. Eggs are typically deposited
41 over gravel, and egg survival appears to be influenced by water flow, substrate type, and egg
42 density. Exposure to salt or brackish water can cause egg mortality, as can sudden increases
43 in temperature, diseases, parasites, contaminant exposure, and predation by other fish species.
44 Incubation times can be 8 to 29 days and decrease with increasing water temperature.

Common mummichog (*Fundulus heteroclitus*) and fourspine stickleback (*Apeltes quadracus*) are reported to be major predators on smelt eggs.

YSL are 5 to 6 mm (0.20 to 0.24 in.) long at hatching. The yolk sac is absorbed by the time the larvae reach 7 mm (0.28 in.) and enter the PYSL stage. Larvae now concentrate near the surface and drift downstream. As they grow, they seek deeper water and congregate near the bottom. Vertical migration begins, and they move to the surface to feed during the day and deeper at night. The vertical migration patterns may maintain their position in two-layered estuarine systems. Larval and small juvenile smelt eat copepods and other small planktonic crustaceans as well as fish. In turn, larval and juvenile smelt are probably eaten by most estuarine piscivores.

Smelt grow fairly rapidly and begin to school when they reach a length of 19 mm (0.75 in.). As the smelt grow, they move down estuaries into higher salinity and, as adults, migrate to sea. They are mature and participate in spawning runs at age 1. Adults grow to average approximately 25.4 cm (10 in.) in length. Larger juveniles and adults feed on euphausiids, amphipods, polychaetes, and fish such as anchovies (family Engraulidae) and alewives (*A. pseudoharengus*). Adults also eat other fish species, including common mummichog, cunner (*Tautoglabrus adspersus*), and Atlantic silversides (*Menidia menidia*). Bluefish (*P. saltatrix*), striped bass (*M. saxatilis*), harbor seals (*Phoca vitulina*), and other large piscivores eat adult smelt.

Once a prevalent fish in the Hudson River, an abrupt population decline in the Hudson River was observed from 1994, and the species may now have no viable population within the Hudson River. The last tributary run of rainbow smelt was recorded in 1988, and the Hudson River Utilities' Long River Ichthyoplankton Survey show that PYSL essentially disappeared from the river after 1995 (Daniels et al. 2005). When present, the largest abundances of eggs and YSL occurred from Poughkeepsie to the Catskills, and the largest abundances of PYSL, YOY, and older individuals were distributed from approximately Yonkers to Hyde Park (Table 2-5, Figure 2-6). Rainbow smelt runs in the coastal streams of western Connecticut declined at about the same time as in the Hudson River (Daniels et al. 2005). Smelt landings in waters south of New England have dramatically decreased, although the reasons for this are unknown. Daniels et al. (2005) note slowly increasing water temperatures in the Hudson River and suggest that the disappearance of rainbow smelt from the Hudson River may be a result of global warming.

Spottail Shiner

The spottail shiner (*Notropis hudsonius*, family Cyprinidae) is a freshwater species which occurs across much of Canada, south to the Missouri River drainage, and in Atlantic States from New Hampshire to Georgia, with habitat ranging from small streams to large rivers and lakes, including Lake Erie (Smith 1985a). One of the most abundant fishes in the Hudson River, spottail shiners are commonly 3.9 in. (100 mm) in length, which is large for shiner species (Smith 1985a). The maximum length is approximately 5.8 in. (147 mm) (Schmidt and Lake 2006; Smith 1985a; Marcy et al. 2005a).

Spottail shiners spawn from May to June or July (typically later for the northern populations) over sandy bottoms and stream mouths (Smith 1985a; Marcy et al. 2005a); water chestnut (*Trapa natans*) beds provide important spawning habitat (CHGEC 1999). Individuals older than 3 years are seldom found, but there is evidence of individuals living up to 4 or 5 years (Marcy et

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al. 2005a). Fecundity is a factor of age: the ovaries of younger females contain 1400 eggs, and ovaries of older females contain from 1300 to 2600 eggs; a correlation between fecundity and size does not appear to exist (Marcy et al. 2005a). In the Hudson River Estuary, beach seine survey data from 1974 to 2005 showed the largest abundances of YOY and Year 1+ individuals occurred from Poughkeepsie north to Albany (Table 2-5).

Spottail shiners are opportunistic feeders, typically eating insects, bivalve mollusks, and microcrustaceans throughout the water column (Marcy et al. 2005a). Aggregations of spottail shiners have been observed preying on eggs of alewives (*Alosa pseudoharengus*) and mayflies (Marcy et al. 2005a). Striped bass (*M. saxatilis*) larvae are also prey for spottail shiners (McGovern and Olney 1988), as are spottail eggs and larvae (Smith 1985a). Spottail shiners are frequently used as bait (Smith 1985a), and they are an important prey species for some fish, including walleye (*Sander vitreus*), channel catfish (*I. punctatus*), northern pike (*Esox lucius*), and smallmouth bass (*Micropterus dolomieu*) (IDFG 1985). The Hudson River population of spottail shiners is known to be susceptible to impingement and entrainment at water intakes, and this could be affecting the survivorship of most life stages (CHGEC 1999).

Striped Bass

The striped bass (*Morone saxatilis*, family Moronidae) is an anadromous species, with a range extending from St. Johns River, Florida, to St. Lawrence River, Canada (ASMFC 2006b). Individual stocks of striped bass spawn in rivers and estuaries from Maine to North Carolina. When adults leave the estuaries to go to the Atlantic, the stocks mix; striped bass return to their natal rivers and estuaries to spawn. The Atlantic coast striped bass fishery has been one of the most important commercial fisheries on the east coast for centuries and has been regulated since European settlement in North America (ASMFC 2006b). In 1982, overfishing depleted the striped bass population to fewer than 5 million fish. Since that time, the Atlantic coast population has been restored to 65 million in 2005 (ASMFC 2006b). Striped bass have been important in both commercial and recreational fisheries, and while the majority of the stock spawns in the Chesapeake Bay, the Hudson River contributes to the stock as well. Fabrizio (1987) reported that of the age 2–5 individuals sampled from the Rhode Island commercial trap-net fishery in November 1982, 54 percent were from the Chesapeake Bay stock and 46 percent were from the Hudson River stock. Wirgin et al. (1993) estimated that the Chesapeake Bay and Hudson River stocks combined contributed up to 87 percent of the mixed fishery stock on the Atlantic coast.

The striped bass is a long-lived species, reaching 30 years of age, and spends the majority of its life in coastal estuaries and the ocean. Females reach maturity between 6 and 9 years, and then produce between .5 million and 3 million eggs per year, which are released into riverine spawning areas (ASMFC 2006b). The males, reaching maturity between 2 and 3 years, fertilize the eggs as they drift downstream (ASMFC 2006b). The eggs hatch into larvae, which absorb their yolk and then feed on microscopic organisms. PYSL mature into juveniles in the nursery areas, such as river deltas and inland portions of coastal sounds and estuaries, where they remain for 2 to 4 years, before joining the coastal migratory population in the Atlantic (ASMFC 2006b). Recent field investigations by Dunning et al. (2006b) have suggested that dispersal of age 2+ striped bass out of the Hudson River may be influenced by cohort abundance. In the spring or summer, adults migrate northward from the mouth of their spawning rivers up the Atlantic coast, and in the fall or winter they return south, in time to spawn in their natal rivers (Berggren and Lieberman 1978; ASMFC 2006b). Work by Wingate and Secor (2007), using

1 remote biotelemetry on a total of 12 fish, suggested that specific homing patterns are possible
2 for this species, and these patterns may influence their susceptibility to localized natural and
3 anthropogenic stressors. Based on long-term monitoring data, various life-stages associated
4 with this species are found in the Hudson River from Tappan Zee to Albany (Table 2-5).

5 Several factors play a role in spawning, including water temperature, salinity, total dissolved
6 solids concentration, and water velocity and flow. Peak spawning occurs in water temperatures
7 of 15 to 20 degrees C (59 to 68 degrees F) but can occur between 10 and 23 degrees C
8 (50 and 73 degrees F) (Shepherd 2006b). Striped bass reach 150 cm (59 in.) in length and 25
9 to 35 kg (55 to 77 lb) in weight (Shepherd 2006b). Adult striped bass are omnivores and prey
10 on invertebrates and fish, especially clupeids, including menhaden (*B. tyrannus*) and river
11 herring (*Alosa* spp.) (Shepherd 2006b). Diets vary by season and location, typically including
12 whatever species are available (Bigelow and Schroeder 1953). YOY striped bass diet is made
13 up of fish and mysid shrimp (Walter et al. 2003).

14 Compared to other anadromous species, striped bass appear to spend extended periods in the
15 Hudson River, contributing to their PCB body burdens. In 1976, the Hudson River commercial
16 fishery was closed because of PCB contamination, although shad fishermen continue to catch
17 striped bass in their nets (CHGEC 1999). Commercial restrictions on harvesting the Atlantic
18 coastal fishery, in part supported by the Atlantic Striped Bass Conservation Act of 1984
19 (16 U.S.C. 5151–5158), which allows coastal States to cooperatively regulate and manage the
20 stock, have led to the declaration of full recovery of the population in 1995 (ASMFC 2006b).
21 Abundance levels have continued to increase in the Atlantic population. Restrictions on both
22 commercial and recreational fisheries have been relaxed because of the recovery of the
23 population (ASMFC 2006b), but the fisheries continue to be limited to State waters (within
24 3 nautical miles of land), and New York State's commercial fishery remains completely closed.
25 While commercial landings have remained lower than the levels seen in the early 1970s,
26 recreational landings have increased, and in 2004 made up 72 percent of the total weight
27 harvested from the Atlantic stock (Shepherd 2006b). Recreational fishing in the Hudson River
28 during the spring generally occurs north of the Bear Mountain Bridge (RKM 75 (RM 46)) (Euston
29 et al. 2006).

30 Weakfish

31 The weakfish (*Cynoscion regalis*, family Sciaenidae) is a demersal species found along the
32 Atlantic coast ranging from Massachusetts Bay to southern Florida and is occasionally found as
33 far north as Nova Scotia and as far south as the eastern Gulf of Mexico (Mercer 1989). The
34 weakfish is one of the most abundant fish species along the Atlantic coast and is fished
35 recreationally as well as commercially via gill-net, pound-net, haulseine, and trawl (Mercer
36 1989). ASMFC considers weakfish to be composed of one stock based on genetic analysis;
37 however, more recent tagging studies have indicated that weakfish may return to their natal
38 estuary to spawn (ASMFC 2006c). The stock as a whole is thought to be declining as
39 evidenced by decreased landings in recent years. Landings peaked in 1981 and 1982 at
40 12,500 MT (13,800 t), declined from 1989 through 1993, peaked again in 1998 at over 5000 MT
41 (5500 t), and then declined from 1999 through 2004, at which point a record low of less than
42 1000 MT (1100 t) was reported (ASMFC 2006c). Entrainment of eggs and larvae at power
43 plants within the Hudson River is not common because weakfish spawn in waters with higher
44 salinity, though movement of juveniles into the Hudson River estuary during late winter and

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1 early spring results in some entrainment of young juveniles and impingement of larger juveniles
2 (CHGEC 1999).

3 Weakfish are found at a depth range of 10 to 26 m (33 to 85 ft) and temperatures between
4 17 and 27 degrees C (63 and 81 degrees F) (Froese and Pauly 2007c). Adults favor shallow
5 coastal waters with sandy substrate and a salinity of 10 ppt or higher, though they are found in a
6 variety of estuarine environments (CHGEC 1999). Adult weakfish vary greatly in size, ranging
7 from 6 to 31 in. (15 to 79 cm) in length, with a maximum weight of 20 lb (9.1 kg), and can live up
8 to 11 years (CHGEC 1999). Most weakfish mature at the age of 2 during the late summer
9 months, and almost all weakfish are mature by the end of their third summer (CHGEC 1999).
10 Size at maturity varies with latitude: in northern populations, females have been observed to
11 mature at 256 mm (10.1 in.) and males at 251 mm (9.9 in.), while in North Carolina populations,
12 females have been observed to spawn at 230 mm (9.1 in.) and males at 180 mm (7.1 in.)
13 (Mercer 1989). Weakfish migrate southward in the fall to the coastal waters of North Carolina
14 and Virginia and then move northward in the spring to spawn (ASMFC 2006c).

15 Spawning takes place along the northeastern coast of the Atlantic between the Chesapeake
16 Bay and Montauk, Long Island, New York, in nearshore coastal and estuarine waters during the
17 spring and summer (CHGEC 1999). Within the New York Bight, two spawning peaks occur in
18 mid-May, consisting of larger individuals that migrate northward earlier, and in June, consisting
19 of smaller individuals (Mercer 1989). Fecundity estimates vary widely, though fecundity can be
20 generally correlated with size and geographic area (from 4593 eggs for a 203-mm (8-in.) female
21 to 4,969,940 eggs for a 569-mm (22.4-in.) female and from 306,159 eggs for a northern female
22 to 2,051,080 eggs for a similarly sized female in North Carolina) (Collette and Klein-MacPhee
23 2002). Eggs can tolerate a temperature range of 12 to 31.5 degrees C (53.6 to 88.7 degrees F)
24 and a salinity range of 10 to 33 ppt (Collette and Klein-MacPhee 2002). Larvae hatch within
25 36 to 40 hours at temperatures of 20 to 21 degrees C (68 to 69.8 degrees F) (Mercer 1989).
26 Larvae move into bays and estuaries after hatching; in the Hudson River estuary, larvae are
27 rarely observed north of the George Washington Bridge because of the lower salinity of these
28 waters (CHGEC 1999). Larvae feed primarily on cyclopoid copepods, as well as calanoid
29 copepods, tintinnids, and polychaete larvae (Collette and Klein-MacPhee 2002). Weakfish
30 juveniles grow rapidly during their first year and reach lengths of 7.6 to 15.2 cm (3 to 6 in.) by
31 the end of the summer (CHGEC 1999). Juveniles are typically distributed from Long Island to
32 North Carolina in late summer and fall in waters of slightly higher salinity, sand or sand-grass
33 substrates, and depths of 9 to 26 m (30 to 85 ft) (Mercer 1989). Juveniles are considered adults
34 at approximately 30 mm (1.2 in.) (Collette and Klein-MacPhee 2002).

35 Adult weakfish feed on a variety of organisms, and their diet varies with locality and availability
36 of food sources. Smaller weakfish (less than 20 cm (7.9 in.)) feed primarily on crustaceans,
37 while larger weakfish feed primarily on anchovies, herrings, spot, and other fish (CHGEC 1999;
38 Mercer 1989). Adult weakfish of all sizes also prey on decapod shrimps, squids, mollusks, and
39 annelid worms (CHGEC 1999; Mercer 1989). Bluefish (*P. saltatrix*), striped bass (*M. saxatilis*),
40 and older weakfish prey on younger weakfish, while weakfish of larger size are preyed on by
41 dusky sharks (*Carcharhinus obscurus*), spiny dogfish (*Squalus acanthias*), smooth dogfish
42 (*Mustelus canis*), clearnose skate (*Raja eglanteria*), angel sharks (*Squatina* spp.), goosefish
43 (family Lophiidae), and summer flounder (*Paralichthys dentatus*) (Collette and Klein-MacPhee
44 2002).

YOY and older weakfish are generally found from Yonkers to West Point (Table 2-5). Weakfish abundance fluctuated from 1979 to 1990, and abundance was relatively low between 1990 and 1997; overall, abundance declined 6 percent between 1979 and 1997 (CHGEC 1999). The weakfish stock as a whole declined suddenly in 1999 and approached even lower levels by 2003, which ASMFC determined to be the result of higher natural mortality rates rather than the result of fishing mortality (ASMFC 2007b). A leading hypothesis suggests that insufficient prey species and increased predation by striped bass may contribute significantly to rising natural mortality rates in the weakfish population (ASMFC 2007b).

White Catfish

The white catfish (*Ictalurus catus*, family Ictaluridae) is a demersal species found in estuarine and freshwater habitats along the Atlantic coast from the lower Hudson River to Florida, though it has been introduced in other areas, including Ohio and California (Smith 1985b). The natural distribution of the species is thought to be in coastal streams from the Chesapeake Bay to Texas; limited recreational fishing for this species occurs in the Hudson River (CHGEC 1999). White catfish are the least common species of catfish in New York waters (NYSDEC 2008a). The New York State Department of Health has issued a fish advisory for the species because of the potential for elevated levels of PCBs (NYSDOH 2007). Additionally, the New Jersey Department of Environmental Protection (NJDEP) has issued a health advisory for the white catfish downstream of the New York-New Jersey border, which includes portions of the Hudson River and Upper New York Bay (NJDEP and NJDHSS 2006).

The white catfish is of intermediate size compared with other species in the family; adults grow to lengths of 8.3 to 24 in. (21 to 62 cm) and reach weights of 0.6 to 2.2 lb (0.25 to 1.0 kg) (Marcy et al. 2005b). The species has been reported to live 11 or more years as evidenced by individuals observed in South Carolina (Marcy et al. 2005b). White catfish prefer fresh or brackish water and, in the upper Hudson River, are most commonly found in channel borders, shoals, and vegetated backwaters (Marcy et al. 2005b). Though the white catfish is more salt tolerant than most catfish species, it is not typically found in waters with salinities above 8 ppt (CHGEC 1999; NJDEP 2005). Fall Juvenile Survey data from 1979 to 2004 suggests that YOY and older individuals were generally found from the Saugerties to Albany segments of the Hudson River (Figure 2-10, Table 2-5).

White catfish are sexually mature between 3 to 4 years of age at the size of 7 to 8 in. (18 to 20 cm). Adults move upstream for spawning between late June and early July when Hudson River water temperatures reach approximately 70 degrees F (21 degrees C) (CHGEC 1999). Before spawning, both males and females construct nests on sand or gravel bars, and males protect the nest once females lay eggs. Females that are 11 to 12 in. (28 to 30 cm) can lay 3200 to 3500 eggs. Eggs hatch in 6 to 7 days at temperatures between 75 to 85 degrees F (24 to 29 degrees C) (CHGEC 1999; Smith 1985b). Males continue to protect young until the juveniles form large schools and disperse from the nest (MDNR 2007b). YOY migrate downstream to deeper waters in September and October, and generally, yearling and older white catfish move out of the upper Hudson River estuary once the water temperatures drop below 59 degrees F (15 degrees C) to overwinter in the lower estuary. (Smith 1985b, CHGEC 1999).

White catfish have an especially varied diet. Adults collected from the North Newport River in Georgia were found to consume over 50 different species of prey (Marcy et al. 2005b).

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Juveniles and smaller adults feed primarily on midge larvae and macroinvertebrates, while larger adults have a more diverse diet, which may consist of midge larvae, crustaceans, algae, fish eggs, and a number of fish species, including herring (*Clupea* spp.), menhaden (*Brevoortia* spp.), gizzard shad (*Dorosoma cepedianum*), and bluegills (*Lepomis macrochirus*) (CHGEC 1999; Smith 1985b). Amphipods are widely consumed by adult catfish and make up a large percentage (up to 80 percent) of the volume of food eaten (CHGEC 1999).

The white catfish population is considered stable throughout the majority of its range, though the Hudson River population appears to have been in decline since 1975 (CHGEC 1999). The decline may partially be a result of food-limited growth and survival of larvae and YOY as a result of resource depletion by PYSL and YOY striped bass (*Morone saxatilis*) (CHGEC 1999). Generally, early life stages of the species are not at risk of entrainment because spawning and early development occurs upstream near nests, which adult white catfish guard (CHGEC 1999). Juvenile and adult white catfish are infrequently impinged; the species has been recorded to consist of 0.42 percent of total fish impinged at IP2 and IP3 (CHGEC 1999).

White Perch

White perch (*Morone americana*) is endemic to the North American eastern coastal areas and range from Nova Scotia to South Carolina. It is not actually a perch, but a member of the temperate bass family Percichthyidae, along with striped bass (*M. saxatilis*). White perch are year-round residents in the Hudson River between New York City and the Troy Dam near Albany. They have never been a recreationally or commercially important resource for the Hudson River, and commercial fishing was closed in 1976 because of PCB contamination, but they are well represented in impingement collections of Hudson River power plants. In other parts of its range, white perch is intensively fished (Klauda et al. 1988).

Spawning habitats vary and can be clear or turbid, fast or slow, in water less than 7 m (23 ft) deep (Stanley and Danie 1983). In the Hudson River, most spawning occurs in the upper reaches (RKM 138 to 198 (RM 86 to 123)) in shallow embayments and tidal creeks, and adults move offshore and downriver after spawning (Klauda et al. 1988). Spawning in the Hudson begins in late April when water temperatures reach 10 to 12 degrees C (50 to 54 degrees F) and can continue until late May or early June when temperatures reach 16 to 20 degrees C (61 to 68 degrees F) (Klauda et al. 1988). Fecundity depends on age and size of the females and ranges from about 5,000 to over 300,000 eggs (Stanley and Danie 1983). The eggs are adhesive and sink and may stick to the substrate or each other.

Hatching takes place between 1 and 6 days following fertilization, and the incubation period is inversely related to water temperature but relatively unaffected by salinity and silt levels (Collette and Klein-MacPhee 2002; Stanley and Danie 1983). Newly hatched YSL are about 2 mm (0.08 in.) long, and after 5 to 6 days, the yolk sac is absorbed (Collette and Klein-MacPhee 2002). The YSL generally remain in the same area where they hatched for 4 to 13 days (Stanley and Danie 1983). PYSL eat zooplankton and grow rapidly.

Juveniles tend to stay in inshore areas of the estuary and in creeks until they are about a year old and 20 to 30 cm (8 to 12 in.) in length and then tend to move downstream to brackish areas (Stanley and Danie 1983). Although they may move offshore during the day, they tend to return to shoal areas at night. Most males and females mature at 2 years. Juveniles eat larger zooplankton. In the spring as water temperature rises, adults, which can reach maximum

lengths of 495 mm (19.5 in.), begin their spawning migration and start to move upstream into shallower, fresher waters and into tidal streams. After spawning, they return to deeper waters. In summer, large schools of white perch tend to move slowly without direction, and they tend not to travel very far. (Stanley and Danie 1983)

White perch are opportunistic feeders and have a broad range of prey. Young adults in freshwater environments feed on aquatic insects, crustaceans, and other smaller fishes (Stanley and Danie 1983). In brackish and estuarine environments, the white perch feed on fish eggs, the larvae of walleye (*Sander vitreus*) and striped bass, and other smaller adult fish (Chesapeake Bay Program 2006). Young adult white perch also consume amphipods, snails, crayfish, crabs, shrimp, and squid where available. White perch larger than 22 cm (9 in.) feed almost exclusively on other fish. White perch are consumed by many larger predatory fish species.

Blue Crab

Blue crab (*Callinectes sapidus*, family Portunidae) is an important commercial and recreational resource throughout much of its range, which in the western Atlantic is from Nova Scotia through the Gulf of Mexico to northern Argentina. The life history of blue crab in the Hudson River estuary is largely based on the Delaware and Chesapeake Bays where the most relevant information in the United States has been gathered. Unless otherwise noted, information below is from Perry and McIlwain (1986).

Spawning and mating in blue crabs occur at different times. Mating takes place when female crabs are in the soft condition after their terminal, or last, molt. Males then carry the soft-shelled females until their shell hardens. Females store the sperm, which is used to fertilize the eggs for repeated spawnings. After the shell hardens, the females move downstream to the mouths of estuaries to spawn. Females extrude fertilized eggs and attach them on the underside of their bodies as a bright orange "sponge" consisting of up to 2 million eggs. The eggs become darker as they mature, and the sponge is almost black at the time of hatching. The eggs hatch and release the first zoea stage after about 2 weeks.

Larval crabs go through seven zoeal stages (and sometimes eight) in 31 to 49 days, depending on temperature and salinity. The zoeae are planktonic and live in the ocean near shore. Zoeae eat small zooplankton, such as rotifers. The last zoeal stage metamorphoses with its molt to a megalops larva, which persists from 6 to 20 days. Megalops larvae have more crab-like features than zoeae and are initially planktonic but gradually become more benthic. Megalops larvae inhabit the lower estuary and nearshore areas (ASMFC 2004) and have been found as far as 40 mi (64 km) offshore. Winds, tides, and storms transport the larvae back in towards shore (Kenny 2002). Among others, jellyfish are predators on crab larvae.

The megalops larvae molt and metamorphose into the first crab stage, which has all the features of a blue crab, and, like all crustaceans, grows by molting. The early crab stages, which are 10 to 20 mm (0.4 to 0.8 in.) carapace width in size, migrate to fresher water. Although benthic, blue crabs are good swimmers. They feed less and cease molting as winter nears and bury themselves in the mud in winter. Because the Hudson River is at the northern end of the blue crab's range, severe winters may affect over-winter survival (Kenney 2002).

In the Chesapeake Bay, blue crabs mature in 18 to 20 molts, at which time females undergo a final, or terminal, molt, and males continue to grow and molt (Kenney 2002). In the Hudson River, most females make the terminal molt before they reach a carapace width of about

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125 mm (4.92 in.) (Kenney 2002). Adult males prefer the low salinity areas of upper estuaries, while females, after mating, move to and remain in the higher salinity areas of the lower estuary. Blue crabs can live about 3 or 4 years, although most probably do not live past the age of 2. Adult blue crabs are benthic predators that will lie in wait to catch small fish. They also eat other crabs and crustaceans, mollusks, dead organisms, zebra mussels, aquatic plants, and organic debris. They will also eat other blue crabs. Young and adult blue crabs are prey for many predators, including a variety of birds, including herons and diving ducks; humans; raccoons; and fish, including various members of the sciaenid (drum) family, American eel, and striped bass. Cannibalism is thought to be a major source of mortality. Environmental factors thought to affect juvenile and adult blue crab populations include drought, winter mortality, hypoxia, hurricanes, and the effects of human development (ASMFC 2004).

New York has a relatively small blue crab fishery, which reported a large decrease in landings in 1997; since then, the harvest has been about a million pounds a year (ASMFC 2004). Blue crab fishing in the Hudson River Estuary occurs mostly in the summer and fall (Kenney 2002). Egg-bearing females are returned to the river to help protect spawning stock (Kenney 2002).

2.2.5.5 Protected Aquatic Resources

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrinchus*, family Acipenseridae) is an anadromous species, with a range extending from St. Johns River, Florida, to Labrador, Canada. Considered the “cash crop” of Jamestown before tobacco, the Atlantic sturgeon has been harvested for its flesh and caviar, as well as its skin and swim bladder. A long-lived, slowly maturing species, the Atlantic sturgeon can reach 60 years of age (ASMFC 2007c; Gilbert 1989). Maturity is reached at 7 to 30 years for females, and 5 to 24 for males, with fish in the southern range maturing earlier than those inhabiting the northern range (ASMFC 2007c). Fecundity is correlated with age and size, ranging from 400,000 to 8 million eggs per female (NMFS 2007). Individuals reach lengths of about 79 in. (200 cm), while the largest recorded sturgeon was 15 ft (4.5 m) and 811 lb (368 kg) (ASMFC 2007c).

In the spring, adult Atlantic sturgeons migrate to freshwater to spawn, with males arriving a few weeks before the females. In the Hudson, the males’ migration occurs when water temperatures reach 5.6 to 6.1 degrees C (42 to 43 degrees F); the females appear when water temperatures warm to 12.2 to 12.8 degrees C (54 to 55 degrees F). Spawning occurs a few weeks later (Gilbert 1989). Eggs are deposited on hard surfaces on the river bottom, and hatch after 4 to 6 days (Shepherd 2006c). Individuals do not spawn annually—spawning intervals range from 1 to 5 years for males and 2 to 5 years for females (NMFS 2007). Females typically leave the estuary 4 to 6 weeks after spawning, but the males can remain in the estuary until the fall. Larvae feed from their yolk sac for 9 to 10 days, and then the PYSL begin feeding on the river bottom (Gilbert 1989). In the fall, the juveniles move downstream from freshwater to the estuaries, where they remain for 3 to 5 years, and then migrate to the ocean as adults (Shepherd 2006c). Individuals return to their natal river for spawning, and so the species is divided into five distinct population segments (ASSRT 2007). Juveniles and adults are bottom feeders, subsisting on mussels, worms, shrimp, and small fish (Gilbert 1989; ASMFC 2007c).

Before 1900, landings of Atlantic sturgeon reached 3500 MT (3860 t) per year. This number dropped in the 20th century, and from 1950 to 1990, landings ranged from 45 to 115 MT (50 to 127 t) per year (Shepherd 2006c). ASMFC placed a moratorium on harvesting wild Atlantic

sturgeon for the entire coast in 1997, in an attempt to allow the population to recover. In 1999, the Federal Government banned the possession and harvest of sturgeon in the Exclusive Economic Zone (Shepherd 2006c; ASMFC 2007c). Using a Petersen mark-recapture population estimator, Peterson et al. (2000) estimated that the Hudson River population of age 1 Atlantic sturgeon had declined about 80 percent between 1977 and 1985. The authors suggested that the then-current recruitment could be too low to sustain the population. As of October 2006, NMFS has listed Atlantic sturgeon as a candidate species for listing under the Endangered Species Act (71 *Federal Register* (FR) 61022). Threats such as bycatch, water quality, and dredging continue to affect Atlantic sturgeon (ASMFC 2007c). In the Hudson River, the Federal Dam (the southernmost obstruction in the river) is upstream of the northern extent of the Atlantic sturgeon spawning habitat and therefore is not a limiting factor (ASSRT 2007).

Average levels of PCBs in Hudson River sturgeon tissue exceeded FDA guidelines for human consumption in the 1970s and 1980s; since then, levels of PCBs have dropped below FDA guidelines (ASSRT 2007). Although the State placed a moratorium on harvesting Atlantic sturgeon in 1996 when it became apparent that the Hudson River stock was overfished, the American shad gill net fishery continues to take subadult sturgeon as bycatch. The Status Review Team for Atlantic Sturgeon concluded in 2007 (ASSRT 2007) that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years as a result of the threat of commercial bycatch. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and some long-term surveys indicate that the abundance has been stable since 1995 or is even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) has suggested that a substantial population of juvenile Atlantic sturgeon are present in Haverstraw Bay and that future population monitoring should focus on this area to obtain the greatest statistical power for assessing population trends.

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*, family Acipenseridae) is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater, moving to saltwater periodically, without relation to spawning (Collette and Klein-MacPhee 2002). From colonial times, shortnose sturgeons have rarely been the target of commercial fisheries but have frequently been taken as incidental bycatch in Atlantic sturgeon and shad gillnet fisheries (Shepherd 2006c; Dadswell et al. 1984). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998) not in list. The threats to the species include dams, water pollution, and destruction or degradation of habitat (Shepherd 2006c).

Shortnose sturgeon can grow up to 143 cm (56 in.) in total length, and can weigh up to 23 kg (51 lb). Females are known to live up to 67 years, while males typically do not live beyond 30 years (Dadswell et al. 1984). As young adults, the sex ratio is 1:1; however, among fish larger than 90 cm (35 in.), measured from nose to the fork of the tail, the ratio of females to males increases to 4:1. Throughout the range of the shortnose sturgeon, males and females mature at 45 to 55 cm (18 to 22 in.) fork length, but the age at which this length is achieved varies by geography. At the southern extent of the sturgeon's range, males reach maturity at age 2, and females reach maturity at 6 years or younger; in Canada, males can reach maturity

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as late as age 11, and females at age 13 (Dadswell et al. 1984; OPR undated). One to two years after reaching maturity, males begin to spawn at 2-year intervals, while females may not spawn for the first time until 5 years after maturing, and thereafter spawn at 3- to 5-year intervals (Dadswell et al. 1984; OPR undated). Shortnose sturgeon migrate into freshwater to spawn during late winter or early summer. Eggs adhere to the hard surfaces on the river bottom before hatching after 4 to 6 days. Larvae consume their yolk sac and begin feeding in 8 to 12 days, as they migrate downstream away from the spawning site (Kynard 1997; Collette and Klein-MacPhee 2002). The juveniles, which feed on benthic insects and crustaceans, do not migrate to the estuaries until the following winter, where they remain for 3 to 5 years. As adults, they migrate to the nearshore marine environment, where their diet consists of mollusks and large crustaceans (Shepherd 2006c; OPR undated).

In the Hudson River, shortnose sturgeon use the lower Hudson and are dispersed throughout the river estuary from late spring to early fall and then congregate to winter near Sturgeon Point (RKM 139 (RM 86)). They then spawn in the spring, just downstream of the Federal Dam at Troy. The population of shortnose sturgeons in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Recent work by Woodland and Secor (2007) estimates a fourfold increase in sturgeon abundance over the past three decades, but reports that the population growth slowed in the late 1990s, as evidenced by the nearly constant recruitment pattern at depressed levels relative to the 1986–1992 year classes. Although the Hudson River appears to support the largest population of shortnose sturgeons, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing, and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continues.

2.2.5.6 Other Potentially Affected Aquatic Resources

Phytoplankton and Zooplankton

Phytoplankton and zooplankton communities often form the basis of the food web in rivers and estuaries. The phytoplankton in the Hudson River generally fall into three major categories—diatoms, green algae, and blue-green algae. Diatoms are abundant through most of the year, but reach peak densities when water temperatures are low and watershed runoff and river flows are high. Green algae are present in highest abundances during the summer, when river flows are low and water temperatures are relatively high. Blue-green algae are generally present in late summer and early fall (CHGEC 1999).

Zooplankton populations in the Hudson River are divided into two major categories—holoplankton, which spend their entire live cycle as plankton, and meroplankton, which include the eggs and larvae of fish and shellfish that spend only a part of their life cycle in the planktonic community. Holoplankton in the brackish areas of the Hudson River from approximately IP2 and IP3 downstream (RM 40 (RKM 64)) are generally dominated by marine species; holoplankton from Poughkeepsie north (RM 68 (RKM 109)) are generally dominated by freshwater forms (Figure 2-6). Zooplankton sampling from Haverstraw Bay to Albany from April to December 1987–1989 identified five numerically dominant taxa—the cyclopoid copepod, *Diacyclops bicuspidatus thomasi*; the cladoceran, *Bosmina longirostris*; and the rotifers *Keratella* spp., *Polyarthra* spp., and *Trichocera* spp. (CHGEC 1999). Work by Lonsdale et al. (1996) suggests that larger (greater than 64 microns (0.0025 in.)) zooplankton species that include both mesozooplankton and micrometazoa have a minimal role in controlling total

1 phytoplankton biomass in the lower Hudson River estuary. Grazing pressure sufficient to
2 contribute to the decline of the phytoplankton standing crop occurred only during the month of
3 October.

4 Phytoplankton communities in the freshwater portion of the Hudson River are susceptible to
5 predation by the zebra mussel, *Dreissena polymorpha*. Work by Roditi et al. (1996) suggests
6 that the mussels are able to remove Hudson River phytoplankton effectively in the presence of
7 sediment and can do so at rapid rates. The authors indicate that, based on their measurements
8 and unpublished estimates of the size of the zebra mussel population, the mussels present in
9 the upper stretches of the river can filter a volume equivalent to the entire freshwater portion of
10 the Hudson River every 2 days. Strayer suggests that they filter a volume of water equal to all
11 of the water in the estuarine Hudson every 1–4 days during the summer (2007). Significant
12 declines in zooplankton biomass were also reported after the introduction of the mussel (Pace
13 et al. 1998). Work by Strayer et al. (2004) suggests that the long-term impacts of zebra mussel
14 removal of phytoplankton and zooplankton have profoundly affected the food web in the Hudson
15 River, resulting in a shift of open-water species to downriver locations away from the mussels
16 and a shift of littoral species upriver. The resulting changes affected a variety of commercially
17 and recreationally important species, including American shad and black bass, illustrating the
18 importance of zooplankton and phytoplankton in food webs associated with the freshwater
19 portion of the Hudson River (Strayer et al. 2004).

20 Aquatic Macrophyte Communities

21 Aquatic macrophyte communities provide food and shelter to a variety of fish and invertebrate
22 communities and are an important component of the Hudson River ecosystem. Macrophyte
23 communities are generally divided into three broad groups that include emergent macrophytes,
24 floating-leaved macrophytes, and submerged macrophytes (also known as SAV). Emergent
25 macrophytes in the Hudson River generally occur near the shoreline to a water depth of about
26 5 ft (1.5 m) and have leaves that rise out of the water. Floating leaved macrophytes are
27 attached to the bottom and have floating leaves and long, flexible stems. Submerged
28 macrophytes are found beneath the water surface at a depth related to the clarity of the water
29 (CHGEC 1999). The composition and distribution of aquatic macrophyte communities vary
30 along the river and is controlled by physical characteristics and season. Work by Findlay et al.
31 (2006) shows that the densities of macroinvertebrates in SAV beds were more than three times
32 as high as densities on unvegetated sediments, suggesting that SAV beds may be the richest
33 feeding grounds in the Hudson River estuary for fish. Further, the authors also noted that many
34 species of macroinvertebrates that are common in aquatic macrophyte beds are rare or absent
35 from unvegetated sites.

36 SAV beds in the Hudson are represented by two predominant species—the native submerged
37 eel grass *Vallisneria americana* and the introduced water chestnut, *Trapa natans* (Findlay et al.
38 2006). CHGEC (1999) identified 18 species of submergent aquatic vegetation between
39 Kingston and Nyack, including nine species of *Potamogeton* (pondweed), and *Elodea* sp.
40 (common pondweeds used in aquaria), and a variety of other species. Historical and recent
41 work has shown that SAV occupies major portions of some reaches of the Hudson River, when
42 present, and can cover as much as 25 percent of the river bottom (Findlay et al. 2006). New
43 York State has been studying the SAV in the Hudson River estuary from the Troy Dam south to
44 Yonkers since 1995. Using true color aerial photography, researchers from Cornell University
45 and the New York Sea Grant Extension inventoried the spatial extent of the SAV and water

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chestnut (*T. natans*) beds from 1995 to 1997 and in 2002. They determined that vegetated area constitutes roughly 8 percent of total river surface area with *V. americana* three times as abundant as *T. natans*. Plant coverage over the entire study area from the Troy Dam to Yonkers was about 6 percent of the river bottom area for *V. americana* and 2 percent for *T. natans*, although the distribution of both plants varies greatly among reaches of the tidal freshwater Hudson River (Nieder et al. 2004). According to NYSDEC (2007a), there has been a 9-percent decline in all SAV and a 7-percent gain in water chestnut.

Coastal Marshes, Wetlands, and Riparian Zones

Coastal marshes, tidal wetlands, and associated riparian zones are found along the lower Hudson River. Vegetation in these areas includes emergent grasses, sedges, and other plants adapted to nearshore conditions that often experience changes in runoff, salinity, and temperature. FWS has identified the area extending from the Battery north to Stony Point at the northern end of Haverstraw Bay as Lower Hudson River Estuary Complex #21 (FWS 2008a). Within this complex there are many significant wetland habitats, including a regionally significant nursery and wintering habitat for a variety of anadromous, estuarine, and marine fish, as well as a migratory area for birds and fish that feed on abundant prey items.

Recognizing the importance of coastal wetlands, tidal marshes, and riparian zones, NOAA, partnering with NYSDEC, identified four locations along the lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in 1982 (NOAA 2008a). The areas, from north to south, are Stockport Flats, Tivoli Bay, Iona Island, and Piermont Marsh; they collectively represent over 4800 acres (1900 ha) of protected habitat.

Stockport Flats is the northernmost site in the Hudson River Reserve and is located on the east shore of the river in Columbia County near the city of Hudson. This site is a narrow, 5-mi-long landform that includes Nutten Hook, Gay's Point, Stockport Middle Ground Island, the Hudson River Islands State Park, a portion of the upland bluff south of Stockport Creek, and dredge spoils and tidal wetlands between Stockport Creek and Priming Hook. The dominant features of Stockport Flats include freshwater tidal wetlands that contain subtidal shallows, intertidal mudflats, intertidal shores, tidal marshes, and floodplain swamps (NOAA 2008a).

Tivoli Bay extends for 2 mi along the east shore of the Hudson River between the villages of Tivoli and Barrytown, in the Dutchess County town of Red Hook. The site includes two large coves on the east shore—Tivoli North Bay, a large intertidal marsh, and Tivoli South Bay, a large, shallow cove with mudflats. The site also includes an extensive upland buffer area bordering North Tivoli Bay. Habitats at this site include freshwater intertidal marshes, open waters, riparian areas, shallow subtidal areas, mudflats, tidal swamps, and mixed forest uplands (NOAA 2008a).

Iona Island is located near the Town of Stony Point in Rockland County, 6 mi south of West Point. This bedrock island is located in the vicinity of the Hudson Highlands and is bordered to the west and the southwest by Salisbury and Ring Meadows. In the early 20th century, filling activities connected Round Island to the south end of Iona Island. There is approximately 1 mi of marsh and shallow water habitat between Iona Island and the west shore of the Hudson River, and the area includes brackish intertidal mudflats, brackish tidal marsh, freshwater tidal marsh, and deciduous forested uplands.

Piermont Marsh lies at the southern edge of the village of Piermont, 4 mi south of Nyack. The marsh is located on the west shore of the Tappan Zee region near the town of Orangetown in

1 Rockland County. The site includes 2 mi of shoreline south of the mile-long Erie Pier and the
2 mouth of Sparkill Creek. Habitats at this location include brackish tidal marshes, shallows, and
3 intertidal mud flats.

4 **2.2.5.7 Nuisance Species**

5 Zebra Mussel

6 In the early 1990s, the nonnative zebra mussel, *Dieissena polymorpha*, made its first
7 appearance in the freshwater portions of the Hudson River estuary. Beginning in early fall
8 1992, zebra mussels have been dominant in the freshwater tidal Hudson, constituting more than
9 half of heterotrophic biomass, and filtering a volume of water equal to all of the water in the
10 estuary every 1-4 days during the summer (Strayer 2007). The mussel's range extends from
11 Poughkeepsie to the Troy Dam, with the highest densities occurring between Saugerites and
12 Albany (CHGEC 1999; Strayer et al. 2004; Caraco et al. 1997). The presence of the mussels
13 resulted in a decrease in phytoplankton biomass of 80 percent (Caraco et al. 1997) and a
14 decrease of zooplankton abundance of 70 percent (Pace et al. 1998). Water chemistry was
15 also altered, as phosphate and nitrate concentrations increased and DO concentrations
16 decreased after the mussels were established (CHGEC 1999; Caraco et al. 2000). Caraco et
17 al. (2000) indicated that these effects fundamentally changed food web relationships in the river
18 and may have had a significant impact on many fish species.

19 Work by Strayer et al. (2004) found that open-water species such as *Alosa* spp. (shad and
20 herring) exhibited a decreased abundance in response to Zebra mussel introduction, while the
21 abundance of littoral species such as centrarchids (sunfish) increased. The median decrease in
22 abundance of open-water species was 28 percent, and the median increase in abundance of
23 littoral species was 97 percent. The authors also noted that populations of open-water species
24 shifted downriver, away from the zebra mussel population, while littoral species shifted upriver.

25 Growth rates of open-water and littoral species were also affected by the mussels. Strayer and
26 Smith (1996) found impacts to unionid bivalve mussels (*Elliptio complanata*, *Anodonta imbecilis*,
27 *Leptodea ochracea*) such as decreasing densities and incidences of infestations. After the
28 arrival of the zebra mussel, the authors reported that densities of these three unionid clam
29 species fell by 56 percent, recruitment of YOY unionids fell by 90 percent, and the biological
30 condition of unionids fell by 20–50 percent, with *E. complanata* less severely affected than the
31 other two. Strayer and Smith (1996) suggest that the impacts to these species may be
32 associated with both competition for food and biofouling by zebra mussels.

33 The work of Strayer, Caraco, Pace, and others has raised important questions and issues
34 concerning the nature of impacts to fish communities from exotic or introduced species, the
35 management of fish populations affected by these species, and the need to carefully consider
36 all potential environmental stressors present when assessing the reasons for fish or invertebrate
37 population declines. Changes in abundance and distribution in the freshwater portion of the
38 Hudson River estuary involved many recreationally and commercially important species,
39 including striped bass (*M. saxatilis*), American shad (*A. sapidissima*), redbreast sunfish, and
40 black bass (*Micropterus* spp.). The changes Strayer et al. (2004) documented since 1992
41 include overall decreases in abundance, redistribution of species up- or downriver in relation to
42 the mussels and fundamental changes to food webs because of the filtration activity of the
43 mussels.

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Recent work by Strayer and Malcom (2006) suggests that there are still significant gaps in understanding about the biology and life cycle of the zebra mussel in the Hudson River. The researchers used a combination of long-term data and simulation modeling. The authors evaluated mussel population size, adult growth, and body condition and found considerable interannual variation in these factors that was not strongly correlated with phytoplankton population. The data suggested a 2- to 4-year population cycle that was driven by large interannual variations in recruitment. Strayer and Malcolm's (2006) work indicates that a complete understanding of the potential effects of this species on aquatic food webs, and thus recreationally, commercially, or ecologically important fish and invertebrate species and communities requires a better understanding of the factors affecting the zebra mussel life cycle in the Hudson River than currently exists.

Water Chestnut

The water chestnut, *Trapa natans*, was first observed in North America in 1859 near Concord, Massachusetts (FWS 2004). Currently, the plant is found in Maryland, Massachusetts, New York, and Pennsylvania. The most problematic populations are found in the Connecticut River Valley, Lake Champlain region, and the Hudson, Potomac and Delaware Rivers (FWS 2004). Water chestnut impacts to water bodies can include increasing sedimentation and reducing DO, as well as developing dense mats that cause competition for nutrients and space with other species (IPCNY 2008).

According to CHGEC (1999), the water chestnut was introduced into the upper Hudson River in the late 1880s and was established by the 1930s. An eradication program was begun by the NYSDEC using the herbicide 2,4-D, but the program was discontinued in 1976. Since 1976, the water chestnut beds have expanded into dense stands in available habitat in the fresh and low-salinity brackish areas of the estuary, and as of 1999, the exotic water chestnut was the dominant form of rooted vegetation in shallow areas of the estuary upstream of Constitution Island (RM 53 (RKM 85)). CHGEC (1999) indicates that water chestnut beds in some parts of the Hudson River are now so dense that they have adversely affected water circulation, lowered DO concentrations, and altered fish communities.

Ctenophores

Members of the phylum Ctenophora, variously known as comb jellies, sea gooseberries, sea walnuts, or Venus's girdles, are gelatinous marine carnivores that are present in marine and estuarine waters from the sea surface to depths of several thousand meters. Ctenophores are characterized by eight rows of cilia that are used for locomotion. Cilia rows are organized into stacks of "combs" or "ctenes"; hence the name comb jellies. Ctenophore morphology can range from simple sac-like shapes without tentacles, to large, multilobed individuals equipped with adhesive cells called colloblasts. Worldwide, there are probably 100 to 150 species, but most are poorly known and are challenging to collect and study because of their fragility. (Haddock 2007)

As members of the zooplankton community, ctenophores influence marine and estuarine food webs by preying on a variety of eggs and larvae. Predator-prey relationships between the ctenophore *Mnemiopsis leidyi* and eggs of the bay anchovy (*A. mitchelli*) have been described by Purcell et al. (1994) in the Chesapeake Bay, and Deason (1982) described a similar relationship between *M. leidyi* and *Acartia tonsa*, a copepod prey species. Similarly, the NRC staff finds it possible that during certain times of the year, ctenophore predation may influence

zooplankton abundance in the higher salinity portions of the Hudson River. Laboratory studies evaluating the feeding and functional morphology of *M. mccradyi* by Larson (1988) provided new information concerning how prey are captured by ctenophores, but there is little field information available on predator-prey dynamics in natural systems, primarily because of the difficulties associated with field collections. At present, the impact of ctenophores on zooplankton, eggs, and larvae in the lower portions of the Hudson River is unknown.

2.2.6 Terrestrial Resources

This section describes the terrestrial resources of the IP2 and IP3 site and its immediate vicinity, including plants and animals of the upland areas, an onsite freshwater pond, and riparian areas along the river shoreline.

2.2.6.1 Description of Site Terrestrial Environment

As mentioned at the beginning of this chapter, the IP2 and IP3 site includes 239 acres (96.7 ha) on the east bank of the Hudson River. The property is bordered by the river on the west and the north (Lents Cove), a public road (Broadway) on the east, and privately owned industrial property on the south. The site is hilly, with elevations rising to about 150 ft (46 m) above the level of the river at the highest point. The site is enclosed by a security fence that follows the property line. Developed areas covered by facilities and pavement occupy over half of the site (134 acres (54.2 ha)), predominantly in the central and southern portions. Outside the central portion of the site where the reactors and associated generator buildings are located, small tracts of forest totaling approximately 25 acres (10 ha) are interspersed among the paved areas and facilities. Maintained areas of grass cover about 7 acres (2.8 ha) of the site. The northern portion of the site is covered by approximately 70 acres (28 ha) of forest (Entergy 2007a). Within this forested area is a 2.4-acre (0.97-ha) freshwater pond (Entergy 2007a; NRC 1975). The New York State Freshwater Wetlands Map for Westchester County indicates that there are no streams or wetlands on the site (NYSDEC 2004c).

The site is within the northeastern coastal zone of the eastern temperate forest ecoregion (EPA 2007). The forest vegetation of the site and adjacent areas was characterized by a survey performed in the early 1970s, before the completion of construction of IP3 (NRC 1975). At that time, the canopy of this forest included a mixture of hardwoods such as red oak (*Quercus rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), chestnut oak (*Q. prinus*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), tulip tree (*Liriodendron tulipifera*), river birch (*Betula nigra*), and maple (*Acer* spp.), as well as conifers such as eastern hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*). The subcanopy included sassafras (*Sassafras albidum*) and sumac (*Rhus* spp.). The shrub layer included swamp junberry (*Amelanchier intermedia*), summer grape (*Vitis aestivalis*), poison ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*); and the herbaceous layer included forbs such as wildflowers and ferns (NRC 1975). This forest community covers the riverfront north of the reactor facilities, surrounds the pond in the northeast corner of the site, and exists in fragmented stands in the eastern and southern areas of the site. The vegetation in the developed areas of the site consists mainly of turf grasses and planted shrubs and trees around buildings, parking areas, and roads.

The animal community of the site has not been surveyed but likely consists of fauna typical of mixed hardwood forest habitats in the region. Birds that have been observed breeding in the

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area of northwestern Westchester County and that utilize habitats such as the forest, pond, and riverfront habitats present on and adjacent to the site include the great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), wild turkey (*Meleagris gallopavo*), Cooper's hawk (*Accipiter cooperii*), pileated woodpecker (*Dryocopus pileatus*), blue jay (*Cyanocitta cristata*), American robin (*Turdus migratorius*), and scarlet tanager (*Piranga olivacea*) (NYSDEC 2005, Dunn and Alderfer 2006). Numerous waterfowl utilize the lower Hudson River in winter. In the region of southeastern New York that includes Westchester County, waterfowl counts in January 2007 identified at least 22 species of ducks and geese, as well as loons, grebes, and cormorants (NYSOA 2007). In addition to the waterfowl that use the Hudson River, raptors also forage and nest along the river. For example, the bald eagle (*Haliaeetus leucocephalus*), which preys on fish and waterfowl, congregates along the lower Hudson River in winter (NYSDEC 2008b, 2008c), and the peregrine falcon (*Falco peregrinus*), which preys on waterfowl and other birds, nests on bridges over the lower Hudson (NYSDEC 2008d, 2008e).

Mammals likely to occur in the forest habitats on and adjacent to the site include the gray fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), red squirrel (*Tamiasciurus hudsonicus*), white-footed mouse (*Peromyscus leucopus*), and northern short-tailed shrew (*Blarina brevicauda*). Aquatic mammals that may occur along and within the river include the river otter (*Lutra canadensis*) and muskrat (*Ondatra zibethicus*) (NYSDEC 2007b; Whitaker 1980).

Reptiles and amphibians likely to occur on and in the vicinity of the site include species that typically inhabit upland forest habitats of the region, including the black rat snake (*Elaphe obsoleta*), eastern box turtle (*Terrapene carolina*), and American toad (*Bufo americanus*). Species likely to inhabit aquatic habitats such as the 2.4-acre (0.97-ha) pond and river shoreline include the northern water snake (*Nerodia sipedon*) and bullfrog (*Rana catesbeiana*) (NYSDEC 2007b, Conant and Collins 1998). The pond historically was used for fishing and is likely to contain minnows (family Cyprinidae) and sunfishes (family Centrarchidae).

There are no State or Federal parks, wildlife refuges, wildlife management areas, or other State or Federal lands adjacent to the site. The closest such lands to the site are two State parks, Bear Mountain State Park and Harriman State Park, which are located across the Hudson River approximately 1 mi and 2 mi, respectively, northwest of the site at their closest points (Entergy 2007a). In addition, a Significant Coastal Fish and Wildlife Habitat, referred to as "Hudson RM 44–56," begins approximately 1 mi north of the site and extends upriver. Significant Coastal Fish and Wildlife Habitats are designated by the New York Department of State, Division of Coastal Resources. Hudson RM 44–56 provides important habitat for wintering bald eagles as well as waterfowl (NYSDOS 2004).

Of the total 4000 ft (1220 m) of transmission line, approximately 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. As a result, the total length of the ROWs that is vegetated is only about 500 ft (150 m). The ROWs are approximately 150 ft (46 m) wide, and the vegetation within the ROWs is mainly grasses and forbs. The transmission lines included in this draft SEIS are those that were originally constructed for the purpose of connecting IP2 and IP3 to the existing transmission system. These two lines are described in more detail in Section 2.1.7. Each line is approximately 2000 ft (610 m) in length, all of which is within the site except for a terminal, 100-ft (30-m) segment of each that crosses

the facility boundary and Broadway to connect to the Buchanan substation (Entergy 2005b; NRC 1975).

2.2.6.2 Threatened and Endangered Terrestrial Species

Two species that are federally listed as threatened or endangered and one candidate species have been identified by FWS as known or likely to occur in Westchester County. These are the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the candidate New England cottontail (*Sylvilagus transitionalis*) (FWS 2008b). In addition, 194 species that are listed by the State of New York as endangered, threatened, species of special concern (animals), or rare (plants) have a potential to occur in Westchester County based on recorded observations or their geographic ranges. The identities, listing status, and preferred habitats of these federally and State-listed species are provided in Table 2-6.

Federally Listed Species

The three federally listed species are discussed below. In addition to these species that currently have a Federal listing status, a recently delisted species, the bald eagle, also occurs in Westchester County. On July 9, 2007, FWS issued a rule in the *Federal Register* (72 FR 37346) removing the bald eagle from the Federal List of Endangered and Threatened Wildlife, effective August 8, 2007. As discussed above, bald eagles winter in substantial numbers in the vicinity of the site, particularly in a Significant Coastal Fish and Wildlife Habitat area upstream of the site from RM 44 to 56 (RKM 70 to 90) (NYSDOS 2004). Bald eagles also have nested in recent years at locations along the Hudson River in the vicinity of the site. In New York, the breeding season generally extends from March to July, and in the southeastern part of the state, wintering eagles begin to arrive in November and congregate in greatest numbers in February. Adult bald eagles are dark brown with a white head and tail and a yellow bill. Juveniles are completely brown with a gray bill until they are mature at about 5 years of age. The bald eagle feeds primarily on fish but also preys on waterfowl, shorebirds, small mammals, and carrion (NYSDEC 2008b).

Indiana Bat

The Indiana bat (*Myotis sodalis*) currently is listed as endangered under the Endangered Species Act of 1973 as amended (16 U.S.C. 1531 *et seq.*). Critical habitat for the Indiana bat was designated in 1976 (41 FR 41914) at eleven caves and two mines in six States (Missouri, Illinois, Indiana, Kentucky, Tennessee, and West Virginia). There is no designated critical habitat in New York.

The Indiana bat is a medium-sized bat with a head and body length slightly under 2 in. (5.1 cm), a wing span of 9 to 11 in. (23 to 28 cm), a weight of approximately 0.3 ounces (8.5 g), and a life span of about 10 years (FWS 2002, FWS 2007a). It feeds on flying insects captured in flight at night as it forages in forested areas, forest edges, fields, riparian areas, and over water. Indiana bats are migratory and hibernate in large colonies in caves or mines (hibernacula). Hibernacula may support from fewer than 50 to more than 10,000 Indiana bats (FWS 2007a). In New York, hibernation may last from September to May. After emerging in spring, the bats may migrate hundreds of miles to summer habitats, where they typically roost during the day under bark separating from the trunks of dead trees or in other tree crevices (FWS 2007a). Reproductive females congregate in maternity colonies of up to 100 or more bats, where they give birth and care for their single young until it can fly, usually at 1 to 2 months of age (FWS 2007a). Males

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1 and nonreproductive females generally roost individually or in small colonies and may remain
2 near their hibernaculum rather than migrating (FWS 2007a).

3 The Indiana bat occurs in 20 States in the eastern United States from New England to the
4 Midwest, mainly within the central areas of this region from Vermont to southern Wisconsin,
5 eastern Oklahoma, and Alabama. In summer, Indiana bat maternity colonies and individuals
6 may occur throughout this range. In winter, populations are distributed among approximately
7 280 hibernacula in 19 States (FWS 2007a). New York has a total of 10 known hibernacula in
8 caves and mines in Albany, Essex, Jefferson, Onondaga, Ulster, and Warren Counties (NYNHP
9 2008a). The nearest of these counties to the site is Ulster County, which is about 20 mi (32 km)
10 to the north of the site at its closest point. The two largest hibernating colonies in New England
11 (estimated populations in 2005 of over 11,300 and 15,400) are in two abandoned mines located
12 in Ulster County approximately 45 mi (72 km) north of the site near the Town of Rosendale
13 (FWS 2007a; Sanders and Chengler 2001). The larger of these is among the 10 largest Indiana
14 bat hibernacula in the country (NYNHP 2008a). There are 13 general areas in the State where
15 maternity and bachelor colonies are known to occur in summer. Hibernacula, maternity
16 colonies, and bachelor colonies are not known to be present in Westchester County or the
17 vicinity of the site, although Westchester County is within the potential range of the Indiana bat
18 in New York (NYNHP 2008a). Given the presence of large hibernacula within migration
19 distance of the site and the presence of suitable foraging habitat and possible roosting trees in
20 the forest at the north end of the site, the NRC staff finds it possible that Indiana bats may use
21 this area as summer habitat.

22 Bog Turtle

23 The northern population of the bog turtle (*Clemmys muhlenbergii*), which occurs in Connecticut,
24 Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania, was federally
25 listed as threatened in 1997 under the ESA (16 U.S.C. 1531 *et seq.*). The southern population
26 was listed as threatened because of its similarity of appearance to the northern population. The
27 two populations are discontinuous. The southern population occurs mainly in the Appalachian
28 Mountains from southern Virginia through the Carolinas to northern Georgia and eastern
29 Tennessee (FWS 2001). In New York, the bog turtle occurs in the central and southeastern
30 parts of the State, primarily in the Hudson Valley region (NYSDEC 2008f, 2008g).

31 The bog turtle is one of the smallest turtles in North America. Its upper shell is 3 to 4 in. (7.6 to
32 10 cm) long and light brown to black in color, and each side of its black head has a distinctive
33 patch of color that is bright orange to yellow. Its life span may be 40 years or longer. The bog
34 turtle is diurnal and semiaquatic; it forages on land and in water for its varied diet of insects and
35 other invertebrates, frogs, plants, and carrion (FWS 2001; NYNHP 2008b). In southeastern
36 New York, the bog turtle usually is active from the first half of April to the middle of September
37 and hibernates the remainder of the year underwater in soft mud and crevices (FWS 2001).
38 Northern bog turtles primarily inhabit wetlands fed by ground water or associated with the
39 headwaters of streams and dominated by emergent vegetation. These habitats typically have
40 shallow, cool water that flows slowly and vegetation that is early successional, with open
41 canopies and wet meadows of sedges (*Carex* spp.). Other herbs commonly present include
42 spike rushes (*Eleocharis* spp.) and bulrushes (*Juncus* spp. and *Scirpus* spp.) (FWS 2001). Bog
43 turtle habitats in the Hudson River Valley also frequently include sphagnum moss (*Sphagnum*
44 spp.) and horsetail (*Equisetum* spp.) (NYNHP 2008b). Commonly associated woody plants
45 include alders (*Alnus* spp.) and willows (*Salix* spp.) (FWS 2001; NYNHP 2008b).

1 Of the 74 historic bog turtle locations recorded in New York, over half still may provide suitable
2 habitat. However, populations are known to exist currently at only one-fourth of these locations,
3 principally in southeastern New York (NYSDEC 2008f). The New York Natural Heritage
4 Program (NYNHP) database contains locations in northwestern Westchester County where the
5 bog turtle has been recorded as occurring historically. Although there were a few records
6 during the 1990s of bog turtles in Westchester County, the NYNHP states that "it is not known if
7 any extant populations remain in this county" (NYNHP 2008b). According to the data collected
8 for the New York State Reptile and Amphibian Atlas for the period 1990 to 2007, the only
9 reported occurrence of the bog turtle in Westchester County was near the eastern border of the
10 State (NYSDEC 2008g). The New York State Freshwater Wetlands Map for Westchester
11 County (NYSDEC 2004c) indicates that there are no wetlands on the IP2 and IP3 site. The
12 nearest offsite wetland, which is adjacent to the north end of the site, is located on the east side
13 of Broadway and drains under the roadway to Lent's Cove. Its potential to provide bog turtle
14 habitat was not evaluated. The 2.4-acre (0.97-ha) pond in the northern portion of the site is
15 surrounded by mature forest with a closed canopy and does not provide the highly specialized
16 wetland habitat (early successional wet meadows) required by the bog turtle. While
17 acknowledging that the wetland nearest to the site has not been evaluated for the presence of
18 the bog turtle, the NRC staff notes that there is no suitable habitat on the site and there are no
19 recently recorded occurrences of the bog turtle in portions of Westchester County near the plant
20 site. Thus, the NRC staff finds that the bog turtle is unlikely to occur on the site or in the
21 immediate vicinity of the site.

22 New England Cottontail

23 The New England cottontail (*Sylvilagus transitionalis*) is a Federal candidate for listing as an
24 endangered or threatened species (72 FR 69034) and is State-listed as a species of special
25 concern in New York (NYSDEC 2008h). It is similar in appearance to the more common and
26 widespread eastern cottontail (*S. floridanus*). The New England cottontail can often be
27 distinguished from the eastern cottontail by its slightly smaller size, shorter ears, darker fur,
28 black spot between the ears, and black line at the front edge of the ears (NYNHP 2008c).
29 Cottontails have short life spans and reproduce at an early age. Breeding season for the New
30 England cottontail typically is from March to September (NYNHP 2008c). There may be two to
31 three litters per year, with a usual litter size of five young and a range from three to eight (FWS
32 2007b). The diet of the species consists mainly of grasses and other herbaceous plants in
33 spring and summer and the bark, twigs, and seedlings of shrubs and other woody plants in
34 autumn and winter (NYNHP 2008c).

35 The New England cottontail is native only to the northeastern United States. Populations
36 historically were found throughout New England. The range of this species has become
37 fragmented and currently is approximately 14 percent of its historical extent (72 FR 69034). In
38 New York, the New England cottontail currently is thought to occur only in separate populations
39 east of the Hudson River within Columbia, Dutchess, Putnam, and Westchester Counties
40 (NYNHP 2008c). The dramatic decreases in population and range are primarily the result of
41 loss of suitable habitat. The New England cottontail requires a specialized habitat of early
42 successional vegetative growth such as thickets, open wooded areas with a dense understory,
43 and margins of agricultural fields (NYNHP 2008c). Land development associated with the
44 growth of urban and suburban areas and the maturation of early successional forests have been
45 the primary causes of the loss of these types of habitat (69 FR 39395).

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1 The known locations of the New England cottontail in Westchester County are in the central and
2 northeastern areas of the county (NYNHP 2008c), not in the northwestern area where the IP2
3 and IP3 site is located. The forests on the site consist mainly of mature hardwoods and do not
4 contain early successional habitats, such as thickets, that are required by the New England
5 cottontail. Therefore, the New England cottontail is considered unlikely to occur on or in the
6 immediate vicinity of the site.

7 State-Protected Species

8 The only State-listed terrestrial species identified by NYNHP as currently occurring in the vicinity
9 of the IP2 and IP3 site is the bald eagle (NYSDEC 2007c). The only other documented
10 occurrences in the NYNHP database for the site vicinity were historical records for four plant
11 species that have not been documented in the site vicinity since 1979 or earlier (NYSDEC
12 2007c). None of the State-listed species potentially occurring in Westchester County
13 (Table 2-6) are known to occur on the site currently or to have occurred there historically.

Table 2-6. Federally and State-Listed Terrestrial Species Potentially Occurring in Westchester County

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
Amphibians				
<i>Ambystoma jeffersonianum</i>	Jefferson salamander	-	SSC	Deciduous woodlands with a closed canopy and riparian habitats ⁽¹⁾
<i>Ambystoma laterale</i>	blue-spotted salamander	-	SSC	Marshes, swamps, and adjacent upland areas with loose soils ⁽¹⁾
<i>Ambystoma opacum</i>	marbled salamander	-	SSC	Near swamps and shallow pools, rocky hillsides and summits, and wooded sandy areas ⁽¹⁾
<i>Rana sphenoccephala utricularius</i>	southern leopard frog	-	SSC	Wet, open areas such as grasslands, marshes, and swales with slow-flowing water ⁽²⁾
Reptiles				
<i>Carphophis amoenus</i>	eastern worm snake	-	SSC	Mesic, wooded or partially wooded areas, often near wetlands or farm fields ⁽¹⁾
<i>Clemmys guttata</i>	spotted turtle	-	SSC	Small ponds surrounded by undisturbed vegetation, marshes, swamps, and other small bodies of water ⁽¹⁾
<i>Clemmys insculpta</i>	wood turtle	-	SSC	Hardwood forests, fields, wet pastures, woodland marshes, and other areas adjacent to streams ⁽¹⁾
<i>Clemmys muhlenbergii</i>	bog turtle	FT	SE	Wet meadows with an open canopy or open boggy areas ⁽²⁾
<i>Crotalus horridus</i>	timber rattlesnake	-	ST	Mountainous or hilly areas with rocky outcrops and steep ledges in deciduous or deciduous-coniferous forests ⁽²⁾
<i>Heterodon platyrhinos</i>	eastern hognose snake	-	SSC	Open woods and margins, grasslands, agricultural fields, and other habitats with loose soils ⁽¹⁾
<i>Sceloporus undulatus</i>	northern fence lizard	-	ST	Open, rocky areas on steep slopes surrounded by oak-dominated forests ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Terrapene carolina</i>	eastern box turtle	-	SSC	Forests, grasslands, and wet meadows ⁽¹⁾
Birds				
<i>Accipiter cooperii</i>	Cooper's hawk	-	SSC	Mixed hardwood-coniferous forests, commonly near water ⁽¹⁾
<i>Accipiter gentilis</i>	northern goshawk	-	SSC	Mature mixed hardwood-coniferous forests ⁽¹⁾
<i>Accipiter striatus</i>	sharp-shinned hawk	-	SSC	Forests, open woods, and old fields ⁽¹⁾
<i>Ammodramus maritimus</i>	seaside sparrow	-	SSC	Coastal tidal marshes with emergent vegetation ⁽²⁾
<i>Ammodramus savannarum</i>	grassshoppe r sparrow	-	SSC	Grasslands and abandoned fields ⁽¹⁾
<i>Buteo lineatus</i>	red-shouldered hawk	-	SSC	Open, moist forests and swamp margins ⁽³⁾
<i>Caprimulgus vociferous</i>	whip-poor-will	-	SSC	Dry to moist open forests ⁽¹⁾
<i>Chordeiles minor</i>	common nighthawk	-	SSC	Open coniferous woods, grasslands, and near populated areas ⁽¹⁾
<i>Circus cyaneus</i>	northern harrier	-	ST	Salt and freshwater marshes, shrubland, and open grassy areas ⁽²⁾
<i>Cistothorus platensis</i>	sedge wren	-	ST	Moist meadows with small bushes, boggy areas, and coastal brackish marshes ⁽²⁾
<i>Dendroica cerulea</i>	cerulean warbler	-	SSC	Wet, mature hardwood forests with a dense canopy ⁽¹⁾
<i>Falco peregrinus</i>	peregrine falcon	-	SE	Holes or ledges in the rock on cliff faces, and on top of bridges or tall buildings in urban areas ⁽²⁾
<i>Haliaeetus leucocephalus</i>	bald eagle	-	ST	Shorelines of large water bodies, such as lakes, rivers, and bays ⁽²⁾

Table 2-6. (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Icteria virens</i>	yellow-breasted chat	-	SSC	Thickets, overgrown pastures, woodland understory, margins of ponds and swamps, and near populated areas ⁽¹⁾
<i>Ixobrychus exilis</i>	least bittern	-	ST	Large marshes with stands of emergent vegetation ⁽²⁾
<i>Melanerpes erythrocephalus</i>	red-headed woodpecker	-	SSC	Open forests and developed areas with trees, such as parks and gardens ⁽¹⁾
<i>Pandion haliaetus</i>	Osprey	-	SSC	Large bodies of water such as lakes, rivers, and seacoasts ⁽¹⁾
<i>Podilymbus podiceps</i>	pie-billed grebe	-	ST	Marshes and shorelines of ponds, shallow lakes or slow-moving streams in areas with emergent vegetation and open water ⁽²⁾
<i>Rallus elegans</i>	king rail	-	ST	Shallow fresh to salt marshes with substantial emergent vegetation ⁽²⁾
<i>Vermivora chrysoptera</i>	golden-winged warbler	-	SSC	Recently abandoned agricultural fields surrounded by trees, open areas of dense herbaceous vegetation ⁽¹⁾
Mammals				
<i>Myotis sodalis</i>	Indiana bat	FE	SE	Wooded areas with living, dying, and dead trees during the summer; caves and mines in the winter ⁽²⁾
<i>Sylvilagus transitionalis</i>	New England cottontail rabbit	FC	SSC	Disturbed areas, open woods, areas with shrubs and thickets, marshes ⁽²⁾
Insects				
<i>Callophrys henrici</i>	Henry's elfin	-	SSC	Borders and clearings of pine-oak woods ⁽⁴⁾
<i>Erynnis persius</i>	Persius duskywing	-	SE	Stream banks, marshes, bogs, mountain prairies, and sand plains ⁽⁴⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Pontia protodice</i>	checkered white	-	SSC	Dry, open habitats such as fields, roads, railroad tracks, weedy vacant lots, and sandy areas ⁽⁴⁾
<i>Speyeria idalia</i>	regal fritillary	-	SE	Wet fields and meadows, marshes ⁽⁴⁾
<i>Tachopteryx thoreyi</i>	gray petaltail	-	SSC	Rocky gorges in forests with small streams fed by seepage areas or fens ⁽²⁾
Plants				
<i>Acalypha virginica</i>	Virginia three-seeded mercury	-	SE	Dry upland forests, thickets, and prairies ⁽⁵⁾
<i>Agastache nepetoides</i>	yellow giant hyssop	-	ST	Open wooded areas, roadsides, railroads, thickets, and fencerows ⁽²⁾
<i>Ageratina aromatica</i> var. <i>aromatica</i>	small white snakeroot	-	SE	Upland forests, roadsides, fencerows, and old fields ⁽⁶⁾
<i>Agrimonia rostellata</i>	woodland agrimony	-	ST	Slopes, streambanks, and thickets in rich, mesic forests and wooded pastures ⁽²⁾
<i>Amaranthus pumilus</i>	seabeach amaranth	-	SE	Sparsely vegetated areas of barrier island beaches and inlets ⁽¹⁾
<i>Aplectrum hyemale</i>	Puttyroot	-	SE	Upland to swampy forests ⁽²⁾
<i>Arethusa bulbosa</i>	dragon's mouth orchid	-	ST	Sphagnum swamps and wet meadows ⁽²⁾
<i>Aristolochia serpentaria</i>	Virginia snakeroot	-	SE	Well-drained, rocky slopes of rich wooded areas ⁽²⁾
<i>Asclepias variegata</i>	white milkweed	-	SE	Open wooded areas and thickets ⁽⁷⁾
<i>Asclepias viridiflora</i>	green milkweed	-	ST	Dry, rocky hillsides, grasslands, and open areas ⁽²⁾
<i>Bidens beckii</i>	water marigold	-	ST	Slow-moving or still waters ⁽⁶⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Bidens bidentoides</i>	Delmarva beggar-ticks	-	SR	Borders of freshwater tidal marshes and mudflats ⁽²⁾
<i>Bidens laevis</i>	smooth bur-marigold	-	ST	Freshwater to brackish tidal marshes and mudflats ⁽²⁾
<i>Blephilia ciliata</i>	downy wood mint	-	SE	Shallow soils of disturbed areas such as fields and powerline ROWs ⁽²⁾
<i>Bolboschoenus maritimus paludosus</i>	seaside bulrush	-	SE	Alkaline or saline marshes, pond edges, and transient wet areas ⁽⁸⁾
<i>Bolboschoenus novae-angliae</i>	saltmarsh bulrush	-	SE	Brackish tidal marshes ⁽²⁾
<i>Botrychium oneidense</i>	blunt-lobed grape fern	-	SE	Rich, moist soils of deciduous forests ⁽²⁾
<i>Bouteloua curtipendula</i> var. <i>curtipendula</i>	side-oats grama	-	SE	Dry, open areas and disturbed lands such as powerline ROWs, pastures, and bluffs along rivers ⁽²⁾
<i>Callitriche terrestris</i>	terrestrial starwort	-	ST	Exposed, muddy ground in pastures, forests, and on the banks of ponds ⁽²⁾
<i>Cardamine longii</i>	Long's bittercress	-	ST	Shady tidal creeks, swamps, and mudflats ⁽²⁾
<i>Carex abscondita</i>	thicket sedge	-	ST	Swamps, wooded streambanks, mesic forests, and shrublands ⁽²⁾
<i>Carex arcta</i>	northern clustered sedge	-	SE	Edges of reservoirs and rivers, wooded swamps, swales, and wet meadows ⁽²⁾
<i>Carex bicknellii</i>	Bicknell's sedge	-	ST	Open woods, dry to mesic prairies, rocky areas with sparse vegetation ⁽⁶⁾
<i>Carex conjuncta</i>	soft fox sedge	-	SE	Edges of streams, thickets, swales, and wet meadows ⁽²⁾
<i>Carex cumulata</i>	clustered sedge	-	ST	Open rocky areas with shallow soils, such as powerline ROWs, recently burned areas, or other successional habitats ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Carex davisii</i>	Davis' sedge	-	ST	Near rivers, on open gravel bars of large rivers, in wet meadows, and disturbed areas ⁽²⁾
<i>Carex hormathodes</i>	marsh straw sedge	-	ST	Coastal salt and brackish tidal marshes, swales on beaches, edges of swamps, and wet forests near the coast ⁽²⁾
<i>Carex lupuliformis</i>	false hop sedge	-	SR	Swamps, marshes, and floodplain forests ⁽²⁾
<i>Carex mesochorea</i>	midland sedge	-	SE	Dry prairies, oak forests, and roadsides ⁽²⁾
<i>Carex mitchelliana</i>	Mitchell's sedge	-	ST	Edges of streams and ponds, swamps, and wet meadows ⁽²⁾
<i>Carex molesta</i>	troublesome sedge	-	ST	Open wooded areas and fields ⁽²⁾
<i>Carex nigromarginata</i>	black edge sedge	-	SE	Dry to mesic rocky areas in deciduous forests ⁽²⁾
<i>Carex retroflexa</i>	reflexed sedge	-	SE	Rocky ledges, openings and edges of dry to mesic deciduous forests, and along paths and railroads ⁽²⁾
<i>Carex seorsa</i>	weak stellate sedge	-	ST	Hardwood or conifer swamps and thickets ⁽⁶⁾
<i>Carex straminea</i>	straw sedge	-	SE	Edges of swamps and marshes ⁽²⁾
<i>Carex styloflexa</i>	bent sedge	-	SE	Wet areas of streambanks, thickets, and pine barrens; swampy woods ⁽²⁾
<i>Carex typhina</i>	cattail sedge	-	ST	Wetlands, floodplain forests, sedge meadows, and flats along rivers ⁽²⁾
<i>Carya laciniosa</i>	big shellbark hickory	-	ST	Rich soils in floodplains and along the banks of rivers and marshes ⁽²⁾
<i>Castilleja coccinea</i>	scarlet Indian paintbrush	-	SE	Open areas, including on limestone bedrock in prairies, and fields with moist, sandy soils ⁽²⁾
<i>Ceratophyllum echinatum</i>	prickly hornwort	-	ST	Quiet lakes, ponds, streams, and swamps ⁽¹⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Chamaelirium luteum</i>	fairy wand	-	ST	Moist woodlands, thickets, meadows, and swamps ⁽²⁾
<i>Cheilanthes lanosa</i>	woolly lip fern	-	SE	Dry areas on rock outcrops and ledges ⁽²⁾
<i>Chenopodium berlandieri</i> var. <i>macrocalycium</i>	large calyx goosefoot	-	SE	Coastal sands and beaches ⁽⁶⁾
<i>Chenopodium rubrum</i>	red pigweed	-	ST	Brackish marshes and developed lands ⁽⁵⁾
<i>Crassula aquatica</i>	water pigmyweed	-	SE	Rocky shores of rivers, marshes, and tidal mudflats ⁽²⁾
<i>Crotalaria sagittalis</i>	Rattlebox	-	SE	Sandy soils in pastures and pine plantations ⁽²⁾
<i>Cyperus echinatus</i>	globose flatsedge	-	SE	Inland disturbed areas such as roadsides and pastures ⁽⁶⁾
<i>Cyperus flavescens</i>	yellow flatsedge	-	SE	Wet, sandy soils of roadsides, coastal pond margins, and salt marshes ⁽²⁾
<i>Cyperus retrorsus</i> var. <i>retrorsus</i>	retorse flatsedge	-	SE	Moist to dry sandy soils in open woods and thickets ⁽⁶⁾
<i>Cypripedium parviflorum</i> var. <i>parviflorum</i>	small yellow ladyslipper	-	SE	Rich humus and decaying leaves on wooded slopes and river bluffs, moist swales, and creek margins ⁽¹⁾
<i>Desmodium ciliare</i>	little leaf tick-trefoil	-	ST	Dry upland forests and glades ⁽⁵⁾
<i>Desmodium humifusum</i>	spreading tick-trefoil	-	SE	Dry, sandy soils in open pine and oak forests ⁽⁹⁾
<i>Desmodium laevigatum</i>	smooth tick-trefoil	-	SE	Dry, upland forests ⁽⁵⁾
<i>Desmodium nuttallii</i>	Nuttall's tick-trefoil	-	SE	Dry, upland forests; acidic gravel seeps; and dry to mesic grasslands ⁽⁵⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Desmodium obtusum</i>	stiff tick-trefoil	-	SE	Open woods, old fields, and grasslands ⁽²⁾
<i>Desmodium pauciflorum</i>	small-flowered tick-trefoil	-	SE	Upland forests ⁽⁵⁾
<i>Dichanthelium oligosanthes</i> var. <i>oligosanthes</i>	few-flowered panic grass	-	SE	Upland forests, prairies, lake margins, and glades ⁽⁵⁾
<i>Digitaria filiformis</i>	slender crabgrass	-	ST	Sandy soils in dry forests and prairies, sandstone glades, and agricultural fields ⁽⁵⁾
<i>Diospyros virginiana</i>	Persimmon	-	ST	Rocky slopes, dry woodlands, open pastures, and swamp margins ⁽⁸⁾
<i>Draba reptans</i>	Carolina whitlow grass	-	ST	Open areas with limestone outcrops, dry sandy soils, and cedar glades ⁽²⁾
<i>Eclipta prostrata</i>	false daisy	-	SE	Lake margins, mesic to wet prairies, and fields and other developed lands ⁽⁵⁾
<i>Eleocharis equisetoides</i>	knotted spikerush	-	ST	Shallow ponds in coastal areas ⁽²⁾
<i>Eleocharis ovata</i>	blunt spikerush	-	SE	Marshy areas near rivers, shallow ponds ⁽²⁾
<i>Eleocharis quadrangulata</i>	angled spikerush	-	SE	Lake margins and shallow ponds ⁽²⁾
<i>Eleocharis tricostata</i>	three-ribbed spikerush	-	SE	Wet depressions, edges of ponds, pine barrens, and grasslands ⁽⁶⁾
<i>Eleocharis tuberculosa</i>	long-tubercled spikerush	-	ST	Lake margins, ponds, streams, marshes, grasslands, and disturbed lands ⁽⁶⁾
<i>Equisetum palustre</i>	marsh horsetail	-	ST	Wet areas such as marshes, stream margins, meadows, and wooded areas ⁽²⁾
<i>Equisetum pratense</i>	meadow horsetail	-	ST	Rocky soils, riverbanks, roadsides, and railroad ditches ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Euonymus americanus</i>	American strawberry bush	-	SE	Wooded areas, stream banks, and thickets in sandy soils ⁽⁸⁾
<i>Fimbristylis castanea</i>	marsh fimbry	-	ST	Brackish and salt marshes ⁽⁶⁾
<i>Fuirena pumila</i>	dwarf umbrella sedge	-	SR	Pond margins, seeps, and wet grasslands and swales ⁽⁶⁾
<i>Gamochaeta purpurea</i>	purple everlasting	-	SE	Open, disturbed areas such as fields, roadsides, and edges of forests ⁽⁶⁾
<i>Geranium carolinianum</i> var. <i>sphaerospermum</i>	Carolina cranesbill	-	ST	Dry upland forests and prairies, limestone glades, agricultural fields, and pastures ⁽⁵⁾
<i>Geum vernum</i>	spring avens	-	SE	Organic soils of forested hillsides, thickets, and floodplains ⁽¹⁾
<i>Geum virginianum</i>	rough avens	-	SE	Hardwood forests, roadsides, wooded swamps, and riverbanks ⁽²⁾
<i>Hottonia inflata</i>	Featherfoil	-	ST	Ponds and swales in coastal areas ⁽²⁾
<i>Houstonia purpurea</i> var. <i>purpurea</i>	purple bluets	-	SE	Well-drained hillsides in mesic forests ⁽¹⁰⁾
<i>Hylotelephium telephioides</i>	live forever	-	SE	Rocky cliffs and outcrops ⁽⁷⁾
<i>Hypericum prolificum</i>	shrubby St. John's wort	-	ST	Disturbed areas such as roadsides and powerline ROWs, fields, thickets, and margins of swamps ⁽²⁾
<i>Iris prismatica</i>	slender blue flag	-	ST	Rich, mucky soils ⁽⁶⁾
<i>Jeffersonia diphylla</i>	twin leaf	-	ST	Calcareous soils in mesic forests, semishaded rocky hillsides, and exposed limestone ⁽²⁾
<i>Lechea pulchella</i> var. <i>moniliformis</i>	bead pinweed	-	SE	Dry to mesic upland forests ⁽⁵⁾
<i>Lechea racemulosa</i>	Illinois pinweed	-	SR	Infertile or sandy soils ⁽¹¹⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Lechea tenuifolia</i>	slender pinweed	-	ST	Dry, open, grassy areas, wooded areas with pines or oaks, rocky hillsides, and disturbed areas ⁽²⁾
<i>Lemna perpusilla</i>	minute duckweed	-	SE	Still waters in ponds and lakes ⁽⁶⁾
<i>Lespedeza angustifolia</i>	narrow-leaved bush clover	-	SR	Dry sandy soil ⁽¹²⁾
<i>Lespedeza repens</i>	trailing bush clover	-	SR	Dry upland forests and dry to mesic grasslands ⁽⁵⁾
<i>Lespedeza stuevei</i>	velvety bush clover	-	ST	Dry, rocky areas in woodlands and clearings, old fields, and roadsides ⁽¹⁾
<i>Lespedeza violacea</i>	violet bush clover	-	SR	Dry to mesic grasslands, thickets, and upland forests ⁽⁵⁾
<i>Liatris scariosa</i> var. <i>novae-angliae</i>	northern blazing star	-	ST	Dry, sandy grasslands, rocky hilltops, and sandy roadsides ⁽²⁾
<i>Lilaeopsis chinensis</i>	eastern grasswort	-	ST	Margins of peaty or rocky intertidal and brackish marshes ⁽²⁾
<i>Limosella australis</i>	Mudwort	-	SR	Edges of freshwater pools and intertidal fresh to brackish water bodies ⁽¹⁾
<i>Linum striatum</i>	stiff yellow flax	-	SR	Sandy soils in mesic to wet forests, swamps, seeps, and lake margins ⁽⁵⁾
<i>Liparis liliifolia</i>	large twayblade	-	SE	Peaty soils in hardwood swamps, dry wooded slopes, and railroad ditches ⁽²⁾
<i>Lipocarpa micrantha</i>	dwarf bulrush	-	SE	Sandy soils along pond margins and riverbanks ⁽²⁾
<i>Listera convallarioides</i>	broad-lipped twayblade	-	SE	Wet sandy soils in white cedar swamps ⁽²⁾
<i>Ludwigia sphaerocarpa</i>	globe-fruited ludwigia	-	ST	Margins of shallow ponds and wetland channels in pine barrens, clearings in shrub swamps ⁽²⁾
<i>Lycopus rubellus</i>	gypsy wort	-	SE	Marshes and inundated swamps ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Lysimachia hybrida</i>	lance-leaved loosestrife	-	SE	Wet upland and floodplain forests, wet prairies, lake margins, swamps, and seeps ⁽⁵⁾
<i>Magnolia virginiana</i>	sweetbay magnolia	-	SE	Along bays; in swamps; in wet, forested lowlands; and in grasslands ⁽⁶⁾
<i>Melanthium virginicum</i>	Virginia bunchflower	-	SE	Railroad ditches, grasslands, marshes, and wet wooded areas ⁽⁶⁾
<i>Mimulus alatus</i>	winged monkey-flower	-	SR	Muddy shores of lakes, swamps, and wet forests ⁽⁵⁾
<i>Monarda clinopodia</i>	basil balm	-	SE	Ravines in mesic forests, thickets, and lakeshores ⁽⁵⁾
<i>Oldenlandia uniflora</i>	clustered bluets	-	SE	Sandy soils in swamps, bogs, and margins of streams and reservoirs ⁽¹³⁾
<i>Oligoneuron rigidum</i> var. <i>rigidum</i>	stiff leaf goldenrod	-	ST	Dry open areas such as rocky slopes, thickets, edges of forests, and grasslands ⁽²⁾
<i>Onosmodium virginianum</i>	Virginia false gromwell	-	SE	Open coastal uplands, inland rocky wooded areas in dry soils ⁽²⁾
<i>Orontium aquaticum</i>	golden club	-	ST	Freshwater swamps and tidal marshes, and sphagnum swamps, fens, and coastal ponds ⁽²⁾
<i>Oxalis violacea</i>	violet wood sorrel	-	ST	Rich, rocky soils on steep hillsides and open summits ⁽²⁾
<i>Panicum rigidulum</i> var. <i>elongatum</i>	tall flat panic grass	-	SE	Mesic flatwoods and forested lowlands, prairies, and edges of lakes ⁽⁵⁾
<i>Paspalum laeve</i>	field beadgrass	-	SE	Sandy soils in open woodlands and prairies ⁽¹⁾
<i>Pinus virginiana</i>	Virginia pine	-	SE	Areas of poor soils such as maritime oak forests, pine/oak barrens, and rocky summits ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Platanthera ciliaris</i>	orange fringed orchid	-	SE	Wide range of habitats from wet, rich soils to dry, rocky mountainous areas ⁽¹⁾
<i>Platanthera hookeri</i>	Hooker's orchid	-	SE	Pine or poplar forests with open understories in dry to moist soils ⁽²⁾
<i>Podostemum ceratophyllum</i>	Riverweed	-	ST	In fast-flowing streams and rivers with rocky bottoms ⁽²⁾
<i>Polygala lutea</i>	orange milkwort	-	SE	Wet, sandy soils and marshes in pine barrens ⁽¹⁴⁾
<i>Polygonum douglasii douglasii</i>	Douglas' knotweed	-	ST	Disturbed, dry areas such as rocky outcrops with sandy soils ⁽⁶⁾
<i>Polygonum erectum</i>	erect knotweed	-	SE	Developed areas such as roadsides, sidewalks, and lawns and floodplain forests ⁽⁵⁾
<i>Polygonum glaucum</i>	seabeach knotweed	-	SR	Coastal beaches ⁽⁶⁾
<i>Polygonum tenue</i>	slender knotweed	-	SR	Dry, acidic soils in open areas such as rocky summits, scrubby wooded sites, and abandoned agricultural fields ⁽⁵⁾
<i>Potamogeton diversifolius</i>	water thread pondweed	-	SE	Marshes and pond margins ⁽²⁾
<i>Potamogeton pulcher</i>	spotted pondweed	-	ST	Ponds, marshes, and slow-moving streams and rivers ⁽²⁾
<i>Pterospora andromedea</i>	giant pine drops	-	SE	Thick humus of coniferous forests ⁽¹⁴⁾
<i>Pycnanthemum clinopodioides</i>	basil mountain mint	-	SE	Rocky soils in dry forests and grasslands ⁽²⁾
<i>Pycnanthemum muticum</i>	blunt mountain mint	-	ST	Wet sandy soils in coastal swales, pond margins, swamps, and roadside thickets ⁽²⁾
<i>Pycnanthemum torrei</i>	Torrey's mountain mint	-	SE	Dry, open areas of rocky hilltops, roadside ditches, and red cedar barrens ⁽²⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Ranunculus micranthus</i>	small-flowered crowfoot	-	ST	Partially shaded summits in forests ⁽²⁾
<i>Rhynchospora scirpoides</i>	long-beaked beakrush	-	SR	Wet, sandy soils of pond margins in coastal pine barrens ⁽²⁾
<i>Sabatia angularis</i>	rose pink	-	SE	Rocky soils in open woods, sandy soils, and pond margins ⁽⁵⁾
<i>Sagittaria montevidensis</i> var. <i>spongiosa</i>	spongy arrowhead	-	ST	Mudflats in freshwater to brackish tidal marshes ⁽²⁾
<i>Salvia lyrata</i>	lyre leaf sage	-	SE	Rich, rocky soils in open forests; pastures with sandy soils ⁽¹⁴⁾
<i>Scirpus georgianus</i>	Georgia bulrush	-	SE	Moist grasslands and borders of wet forests and marshes ⁽²⁾
<i>Scleria pauciflora</i> var. <i>caroliniana</i>	few-flowered nutrush	-	SE	Mesic to wet woods, grasslands, and bogs ⁽⁶⁾
<i>Scutellaria integrifolia</i>	hyssop skullcap	-	SE	Fields and clearings in upland forests, roadside ditches, swamps, and pond margins ⁽²⁾
<i>Sericocarpus linifolius</i>	flax leaf whitetop	-	ST	Open woods, roadside ditches, and fields ⁽⁶⁾
<i>Sisyrinchium mucronatum</i>	Michaux's blue-eyed grass	-	SE	Fields, roadside ditches, edges of forests, and coastal grasslands ⁽²⁾
<i>Smilax pulverulenta</i>	Jacob's ladder	-	SE	Rich, limestone soils in woods and thickets ⁽⁶⁾
<i>Solidago latissimifolia</i>	coastal goldenrod	-	SE	Coastal freshwater to brackish swamps and thickets ⁽⁶⁾
<i>Solidago sempervirens</i> var. <i>mexicana</i>	seaside goldenrod	-	SE	Sand dunes and brackish marsh margins ⁽⁶⁾
<i>Sporobolus clandestinus</i>	rough rush grass	-	SE	Sandy soils in open forests, prairies, and limestone bluffs ⁽⁵⁾
<i>Suaeda linearis</i>	narrow leaf sea blite	-	SE	Beaches and salt marshes ⁽⁶⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Symphytotrichum boreale</i>	northern bog aster	-	ST	Fens, clearings within coniferous swamps, meadows, shores of ponds and lakes ⁽²⁾
<i>Symphytotrichum subulatum</i> var. <i>subulatum</i>	saltmarsh aster	-	ST	Saltwater marshes, margins of tidal creeks and salt ponds, and brackish swales among sand dunes ⁽²⁾
<i>Trichomanes intricatum</i>	Appalachian bristle fern	-	SE	Protected cracks and crevices in rock ⁽¹⁾
<i>Trichostema setaceum</i>	tiny blue curls	-	SE	Dry forests, old fields, rocky outcrops, and coastal sandy soils ⁽¹³⁾
<i>Tripsacum dactyloides</i>	northern gamma grass	-	ST	Mesic grasslands and margins of streams and salt marshes ⁽⁸⁾
<i>Trollius laxus</i>	spreading globeflower	-	SR	Limestone soils in meadows and open swamps ⁽⁶⁾
<i>Utricularia minor</i>	lesser bladderwort	-	ST	Wet meadows and still waters of shallow ponds ⁽⁵⁾
<i>Utricularia radiata</i>	small floating bladderwort	-	ST	Ponds and slow-moving waters ⁽²⁾
<i>Veronicastrum virginicum</i>	Culver's root	-	ST	Moist prairies and woods, meadows, and banks of streams ⁽¹⁾
<i>Viburnum dentatum</i> var. <i>venosum</i>	southern arrowwood	-	ST	Moist soils in open woods and edges of streams ⁽⁸⁾
<i>Viburnum nudum</i> var. <i>nudum</i>	possum haw	-	SE	Hardwood swamps ⁽¹³⁾
<i>Viola brittoniana</i>	coast violet	-	SE	Wet soils in borders of woodlands, meadows, and near coastal streams and rivers ⁽¹⁾
<i>Viola hirsutula</i>	southern wood violet	-	SE	Shallow, rocky soils in rich woods ⁽¹⁵⁾
<i>Viola primulifolia</i>	primrose leaf violet	-	ST	Sandy soils in marsh edges, meadows ⁽⁵⁾

Table 2-6 (continued)

Scientific Name	Common Name	Federal Status ^(a)	New York State Status ^(b)	Habitat ^(c)
<i>Vitis vulpine</i>	winter grape	-	SE	Mesic to wet forests, lakeshores, agricultural fields ⁽⁵⁾

^(a)Federal listing status definitions: FC = Federal Candidate Species, FE = Federally Endangered, FT = Federally Threatened (FWS 2008b)

^(b)State listing status definitions: SE = State Endangered, SC = Species of Special Concern in New York, SR = State Rare, ST = State Threatened (NYSDEC 2008h; NYNHP 2007)

^(c) Habitat information sources:

1 NatureServe 2007

2 NYNHP 2008d

3 NYSDEC 2008i

4 Opler et al. 2006

5 Iverson et al. 1999

6 FNA Editorial Committee 1993+

7 Niering and Olmstead 1979

8 NRCS 2008

9 CPC 2008

10 NCSU 2008

11 Nearctica 2008

12 Britton and Brown 1913

13 KSNPC 2008

14 Lady Bird Johnson Wildflower Center Native Plant Information Network (NPIN) 2008

15 Pullen Herbarium 2008

2.2.7 Radiological Impacts

The following discussion focuses on the radiological environmental impacts and the dose impacts to the public from normal plant operations at the IP2 and IP3 site. Radiological releases, doses to members of the public, and the resultant environmental impacts, are summarized in two IP2 and IP3 reports—the Annual Radioactive Effluent Release Report and the Annual Radiological Environmental Operating Report. Limits for all radiological releases are specified in the IP2 and IP3 ODCM and are used by Entergy to meet Federal radiation protection limits and standards.

Radiological Environmental Impacts

Entergy conducts a radiological environmental monitoring program (REMP) in which radiological impacts to the environment and the public around the IP2 and IP3 site are monitored, documented, and compared to NRC standards. Entergy summarizes the results of its REMF in an Annual Radiological Environmental Operating Report (Entergy 2007d; all items in this section also from Entergy 2007d). The objectives of the IP2 and IP3 REMFs are the following:

- to enable the identification and quantification of changes in the radioactivity of the area
- to measure radionuclide concentrations in the environment attributable to operations of the IP2 and IP3 site

Environmental monitoring and surveillance have been conducted at IP2 and IP3 since 1958, 4 years before the startup of IP1. The preoperational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from

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1 natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The
2 preoperational radiological data include both natural and manmade sources of environmental
3 radioactivity. These background environmental data permit the detection and assessment of
4 current levels of environmental activity attributable to plant operations.

5 The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs
6 around the site to analyze and measure the radioactivity levels that may be present. The REMP
7 designates sampling locations for the collection of environmental media for analysis. These
8 sampling locations are divided into indicator and control locations. Indicator locations are
9 established near the site, where the presence of radioactivity of plant origin is most likely to be
10 detected. Control locations are established farther away (and upwind/upstream, where
11 applicable) from the site, where the level would not generally be affected by plant discharges or
12 effluents. The use of indicator and control locations enables the identification of potential
13 sources of detected radioactivity as either background or from plant operations. The media
14 samples are representative of the radiation exposure pathways to the public from all plant
15 radioactive effluents. A total of 1342 analyses was performed in 2006. This amount is higher
16 than required because of the inclusion of additional sample locations and media.

17 The REMP is used to measure the direct radiation and the airborne and waterborne pathway
18 activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from
19 buildings and plant structures, airborne material that may be released from the plant, or from
20 cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water.
21 Analysis of thermoluminescent dosimeters (TLDs), which measure direct radiation, indicated
22 that there were no increased radiation levels attributable to plant operations.

23 The airborne pathway includes measurements of air, precipitation, drinking water, and broadleaf
24 vegetation samples. The airborne pathway measurements indicated that there was no
25 increased radioactivity attributable to 2006 IP2 and IP3 station operation.

26 The waterborne pathway consists of Hudson River water, fish and invertebrates, aquatic
27 vegetation, bottom sediment, and shoreline soil. Measurements of the media constituting the
28 waterborne pathway indicated that, while some very low levels of plant discharged radioactivity
29 were detected, there was no adverse radiological impact to the surrounding environment
30 attributed to IP2 and IP3 operations (Entergy 2007d).

31 2006 REMP Results

32 The following is a detailed discussion of the radionuclides detected by the 2006 REMP that may
33 be attributable to current plant operations (all information summarized from Entergy 2007d).

34 During 2006, cesium-137, strontium-90, and tritium were the only potentially plant-related
35 radionuclides detected in some environmental samples. Tritium may be present in the local
36 environment because of either natural occurrence, other manmade sources, or plant operations.
37 Small amounts of tritium were detected in one of four quarterly composite samples from the
38 discharge mixing zone (386 picocuries per liter (pCi/L) (14.28 becquerel per liter (Bq/L)). This
39 composite sample was detected at a value much lower than the required lower limit of detection
40 of 3000 pCi/L (111 Bq/L).

41 In 2006, the detected radionuclide(s) attributable to past atmospheric weapons testing consisted
42 of cesium-137 and strontium-90 in some media. The levels detected for cesium-137 were
43 consistent with the historical levels of radionuclides resulting from weapons tests as measured

1 in previous years. Before 2006, strontium-90 analysis had not been conducted since 1984, so
2 comparison to recent historical levels is not possible. However, the low levels detected in the
3 environment are consistent with decayed quantities of activity from historic atmospheric
4 weapons testing. Strontium-90 was detected in four fish and invertebrate samples, three in the
5 control samples and one in the indicator samples. Since the levels detected were comparable
6 in the indicator and control location samples, atmospheric weapons testing is the likely cause.
7 Of 18 special water samples, 5 indicated strontium-90 at levels close to the level of detection, at
8 an average of 0.78 pCi/L (0.028 Bq/L). All of these detections are considered to be residual
9 levels from atmospheric weapons tests.

10 Iodine-131 is also produced in fission reactors but can result from nonplant-related manmade
11 sources (e.g., medical administrations). Iodine-131 was not detected in 2006. Cobalt-58 and
12 cobalt-60 are activation/corrosion products also related to plant operations. They are produced
13 by neutron activation in the reactor core. As cobalt-58 has a much shorter half-life, its absence
14 "dates" the presence of cobalt-60 as residual. When significant concentrations of cobalt-60 are
15 detected but no cobalt-58, there is an increased likelihood that the cobalt-60 results from
16 residual cobalt-60 from past operations. There was no cobalt-58 or cobalt-60 detected in the
17 2006 REMP, though cobalt-58 and cobalt-60 have been observed in previous years.

18 Data resulting from analysis of the special water samples for gamma emitters, tritium analysis,
19 and strontium-90 show that 18 samples were analyzed for strontium-90, and 5 of them showed
20 detectable amounts of strontium-90. All of the results were very low (with a range of 0.49–
21 1.26 pCi/L (0.018–0.046 Bq/L)) and within the range considered to be residual levels from
22 atmospheric weapons tests. Other than the above, only naturally occurring radionuclides were
23 detected in the special water samples.

24 The results of the gamma spectroscopy analyses of the monthly drinking water samples and
25 results of tritium analysis of quarterly composites showed that, other than naturally occurring
26 radionuclides, no radionuclides from plant operation were detected in drinking water samples.
27 The data indicate that operation of IP2 and IP3 had no detectable radiological effect on drinking
28 water.

29 The results of the analysis of bottom sediment samples for cesium-137 showed that it was
30 detected at 7 of 10 indicator station samples, and at 1 of 3 control station samples. Cesium-134
31 was not detected in any bottom sediment samples. The lack of cesium-134 suggests that the
32 primary source of the cesium-137 in bottom sediment is from historical plant releases at least
33 several years old and from residual weapons test fallout.

34 While not required by the ODCM, strontium-90 analysis was conducted at three indicator
35 locations and one control location in August 2006. Strontium-90 was not identified in any of the
36 samples. The detection of cesium-137 in bottom sediment has been generally decreasing over
37 the last 10 years, and cesium-134 has not been detected in bottom sediment since 2002. The
38 data for 2006 are consistent with but slightly lower than historical levels.

39 In summary, IP2- and IP3-related radionuclides were detected in 2006; however, residual
40 radioactivity from atmospheric weapons tests and naturally occurring radioactivity were the
41 predominant sources of radioactivity in the samples collected. The 2006 levels of radionuclides
42 in the environment surrounding IP2 and IP3 are well below the NRC's reporting levels as a
43 result of IP2 and IP3 operations. The radioactivity levels in the environment were within the
44 historical ranges (i.e., previous levels resulting from natural and manmade sources for the

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detected radionuclides). Further, IP2 and IP3 operations did not result in an adverse impact to the public greater than environmental background levels. (Entergy 2007d)

New York State Department of Health Monitoring

The New York State Department of Health (NYSDOH) also performs sampling and analysis of selected independent environmental media around IP2 and IP3. The NYSDOH environmental radiation monitoring program collects various types of samples to measure the concentrations of selected radionuclides in the environment. Samples of air, water, milk, sediment, vegetation, animals, and fish are typically obtained. In addition, TLDs are used to measure environmental gamma radiation levels in the immediate proximity of IP2 and IP3. The NRC staff reviewed the published data for the years 1993 and 1994, the most current publicly available reports. The data indicated that the radiation levels observed in the environment around IP2 and IP3 were low, or consistent with background radiation, and some samples were below the detection sensitivity for the analysis. No samples exceeded any of the New York State guidelines.

The following information was reported in the 1993 report (NYSDOH 1994):

- Radioactivity in air samples showed low levels of gross beta activity and levels of iodine-131 were usually below detection levels.
- No milk sample was collected, as the remaining nearby dairy farm had closed.
- Radioactivity in water samples showed low levels of gross beta activity.
- Tritium levels were at typical background levels.
- The levels for other radioisotopes were low with most samples below minimum detectable levels.
- Direct environmental radiation shows that the TLD data are typical of the normal background level in this area.

The following information was reported in the 1994 report (NYSDOH 1995):

- Radioactivity in air samples showed low levels of gross beta activity, and levels of iodine-131 were below detection levels.
- No milk samples were collected in 1994, as the last dairy farm closed in 1992.
- Radioactivity in water samples showed low levels of gross beta activity.
- Tritium levels were at typical background levels.
- The levels for other radioisotopes were low with most samples below minimum detectable levels.
- Radioactivity in fish samples showed that naturally occurring potassium-40 is responsible for most of the activity. All other isotopes are below detectable levels.
- Direct environmental radiation values for the TLD data are typical of the normal background level in this area.

Ground Water Contamination and Monitoring

In August of 2005, Entergy discovered tritium contamination in ground water outside the IP2 spent fuel pool (SFP). As a result, Entergy began an on-site and off-site ground water monitoring program (in September of 2005) in addition to the routine REMP. Entergy used this monitoring program to characterize the on-site contamination, to quantify and determine its on-site and off-site radiological impact to the workers, public and surrounding environment, and to aid in identification and repair of any leaking systems, structures or components (Entergy 2006d).

In Section 5.1 of its ER, Entergy identified release of radionuclides to ground water as a potentially new issue based on NRC staff analysis in a previous license renewal proceeding. In its discussion of the issue, Entergy concluded that the radionuclide release does not affect the onsite workforce, and that Entergy anticipated the leakage would not affect other environmental resources, such as water use, land use, terrestrial or aquatic ecology, air quality, or socioeconomics. In addition, Entergy asserted that no NRC dose limits have been exceeded, and EPA drinking water limits are not applicable since no drinking water exposure pathway exists (Entergy 2007a).

Entergy has taken measures to control releases from the IP1 and IP2 SFPs using waste management equipment and processes. Additional monitoring actions have also been developed as part of the site's ground water monitoring program, which supplements the existing REMP to monitor potential impacts of site operations throughout the license renewal term and to monitor potential impacts of site operations and waste and effluent management programs (Entergy 2007a).

In addition to Entergy's assertions in the IP2 and IP3 ER, Entergy provided the NRC additional information, by report dated January 11, 2008, that included the conclusions of a 2-year investigation of onsite leaks to ground water that it had initiated following the 2005 discovery of SFP leakage. Entergy stated that it had characterized and modeled the affected ground water regime, and that it had identified sources of leakage and determined the radiological impacts resulting from this leakage. In the same letter, Entergy reported that it had begun a long-term ground water monitoring program and initiated a remediation program to address the site ground water conditions. Entergy also stated that it had performed radiological dose impact assessments and that it will continue to perform them, and report results to the NRC in each annual Radiological Effluent Release Report. (Radiological Effluent Release Reports are publically available through the NRC.) Entergy's investigation indicates that the only noteworthy dose pathway resulting from contaminated ground water migration to the river is through the consumption of fish and invertebrates from the Hudson River. According to Entergy, the resultant calculated dose to a member of the public is below 1/100 of the federal limits (Entergy 2008c).

As part of the NRC's ongoing regulatory oversight program, the NRC staff performed an extensive inspection of Entergy's actions to respond to the abnormal leak as well Entergy's ground water monitoring program. This inspection focused on assessing Entergy's ground water investigation to evaluate the extent of contamination, as well as the effectiveness of actions taken or planned to effect mitigation and remediation of the condition. The NRC staff adopts the findings and content of the inspection report, released by letter dated May 13, 2008, in this SEIS (NRC 2008). The inspection findings include the following key points (NRC 2008):

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(1) Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated ground water conditions at the IP2 and IP3 site. Potable water sources in the area of concern are not presently derived from ground water sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken from the Hudson River in the vicinity of Indian Point that has the potential to be affected by radiological effluent releases. However, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations.

(2) The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1 % of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr (0.03 mSv/yr) total body and 10 mrem/yr (0.1 mSv/yr) maximum organ), which is considered to be negligible with respect to public health and safety, and the environment.

Finally, by letter dated May 15, 2008, Entergy reaffirmed its January 11th letter and provided the NRC a list of commitments for further actions to address ground water contamination (Entergy 2008d). Entergy indicated they would remove spent fuel from the IP1 SFP, process remaining water and "bottoms" from the IP1 SFP, and incorporate aspects of the long-term ground water monitoring program in the site's ODCM and associated procedures. To date, NRC staff has observed that Entergy has removed all spent fuel from the IP1 SFP and drained the pool, as well as incorporated aspects of the monitoring program into the ODCM and associated procedures. Entergy has indicated that it would process remaining water and bottoms from the IP1 SFP by April 30, 2009, and inform the NRC if they deviate from the commitment timeline.

New York State Ground Water Investigations

New York State performed its own ground water investigation of the tritium leakage from IP2 and IP3 and reported its findings in a Community Fact Sheet (NYSDEC 2007d) as follows:

The New York State Department of Environmental Conservation (DEC) and the New York State Department of Health (DOH) have been participating in the ongoing groundwater investigation of radionuclide contamination in groundwater under the plant, and the release of that water to the Hudson River. The purpose of our involvement is to protect the interests of the citizens and the environment of the State of New York by helping to ensure that Entergy performs a timely, comprehensive characterization of site groundwater contamination, takes appropriate actions to identify and stop the sources of the leak, and undertakes any necessary remedial actions.

The key findings reported by New York State are listed below:

- There are no residential or municipal drinking water wells or surface reservoirs near the plant.

- There are no known impacts to any drinking water source.
- No contaminated ground water is moving toward surrounding properties.
- Contaminated ground water is moving into the Hudson River.
- Public exposure can occur from the ground water entering the Hudson River through consumption of fish.
- NYSDOH has confirmed Entergy's calculated dose to humans from fish.
- Strontium-90 levels in fish near the site (18.8 pCi/kg (0.69 Bq/kg)) are no higher than in those fish collected from background locations across the State.
- Recent strontium-90 data in fish are limited. (The State plans to conduct additional sampling.)

Dose Impacts to the Public

The results of the IP2 and IP3 radiological releases into the environment are summarized in the IP2 and IP3 Annual Radioactive Effluent Release Reports. Limits for all radiological releases are specified in the IP2 and IP3 ODCMs and used to meet Federal radiation protection standards. A review of historical radiological release data during the period 2002 through 2006 and the resultant dose calculations revealed that the calculated doses to maximally exposed individuals in the vicinity of IP2 and IP3 were a small fraction of the limits specified in the IP2 and IP3 ODCM to meet the dose design objectives in Appendix I to 10 CFR Part 50, as well as the dose limits in 10 CFR Part 20 and EPA's 40 CFR Part 190, as indicated in the following summary list. The current results are described in "Indian Point Units 1, 2, and 3—2006 Annual Radioactive Effluent Release Report" (Entergy 2007c). A breakdown of the calculated maximum dose to an individual located at the IP2 and IP3 site boundary from liquid and gaseous effluents and direct radiation shine from IP1 and the two operating reactor units during 2006 is summarized below:

- The calculated maximum whole-body dose to an offsite member of the general public from liquid effluents was 8.80×10^{-4} mrem (8.80×10^{-6} mSv) for IP1 and IP2 and 1.27×10^{-4} mrem (1.27×10^{-6} mSv) for IP3, well below the 3-mrem (0.03-mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum organ (adult bone) dose to an off-site member of the general public from liquid effluents was 1.26×10^{-3} mrem (1.26×10^{-5} mSv) for IP1 and IP2 and 1.60×10^{-4} mrem (1.60×10^{-6} mSv) for IP3, well below the 10 mrem (0.10 mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum gamma air dose at the site boundary from noble gas discharges was 5.01×10^{-3} millirad (mrad) (5.01×10^{-5} milligray (mGy)) for IP1 and IP2 and 5.36×10^{-5} mrad (5.36×10^{-7} mGy) for IP3, well below the 10 mrad (0.10 mGy) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum beta air dose at the site boundary from noble gas discharges was 1.78×10^{-2} mrad (1.78×10^{-4} mGy) for IP1 and IP2 and 1.57×10^{-4} mrad

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(1.57×10^{-6} mGy), well below the 20 mrad (0.20 mGy) dose design objective in Appendix I to 10 CFR Part 50.

- The calculated maximum organ dose to an offsite member of the general public from gaseous iodine, tritium, and particulate effluents was 1.19×10^{-2} mrem (1.19×10^{-4} mSv) to the child thyroid for IP1 and IP2 and 1.07×10^{-3} mrem (1.07×10^{-5} mSv) to the child liver for IP3, well below the 15 mrem (0.15 mSv) dose design objective in Appendix I to 10 CFR Part 50.
- The calculated maximum total whole-body dose to an offsite member of the general public from the site's combined ground water and storm drain pathways is 1.78×10^{-3} mrem (1.78×10^{-5} mSv).
- The calculated maximum organ (adult bone) dose to an offsite member of the general public from the site's combined ground water and storm drain pathways is 7.21×10^{-3} mrem (7.21×10^{-5} mSv).
- The calculated maximum total body dose to an off-site member of the public from all radioactive emissions (radioactive gaseous and liquid effluents, direct radiation shine, and new liquid effluent release pathway) from the IP2 and IP3 site was 7.07 mrem (7.07×10^{-2} mSv), well below the 25 mrem (0.25 mSv) limit in EPA's 40 CFR Part 190.

The NRC staff reviewed the 2006 Radioactive Effluent Release Report and found that the 2006 radiological data are consistent, with reasonable variation as the result of operating conditions and outages, with the 5-year historical radiological effluent releases and resultant doses. These results, including those from the new issue concerning a new liquid effluent release pathway, confirm that IP2 and IP3 is operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. As noted in Section 2.1.4 of this SEIS, the applicant does not anticipate any significant changes to the radioactive effluent releases or exposure pathways from IP2 and IP3 operations during the license renewal term, and, therefore, the NRC staff expects that impacts to the environment are not likely to change.

Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms during the period of extended operation. Such an action is not expected to change the applicant's ability to maintain radiological doses to members of the public well within regulatory limits. This is based on the absence of any projected significant increases in the amount of radioactive liquid, gaseous, or solid waste as a result of the replacements, as discussed in Section 2.1.4 of this SEIS. Thus, the staff concludes that similar small doses to members of the public and small impacts to the environment are expected during the period of extended operations.

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in IP2 and IP3 operations. IP2 and IP3 and the communities that support them can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by IP2 and IP3 operations. IP2 and IP3 operations, in

turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of IP2 and IP3 depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomic region of influence (ROI) is defined by the areas where IP2 and IP3 employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The IP2 and IP3 ROI consists of a four-county area (Dutchess, Orange, Putnam, and Westchester Counties) where approximately 84 percent of IP2 and IP3 employees reside. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding IP2 and IP3.

Entergy employs a permanent workforce of approximately 1255 employees (Entergy 2007a). Approximately 90 percent live in Dutchess, Orange, Putnam, Rockland, Ulster, and Westchester Counties, New York, and Bergen County, New Jersey (Table 2-7). The remaining 10 percent of the workforce is divided among 36 counties in Connecticut, Pennsylvania, New Jersey, New York, and elsewhere with numbers ranging from 1 to 15 employees per county. Given the residential locations of IP2 and IP3 employees, the most significant impacts of plant operations are likely to occur in Dutchess, Orange, Putnam, and Westchester Counties. The focus of the socioeconomic impact analysis in this draft SEIS is therefore on the impacts of IP2 and IP3 on these four counties.

Refueling outages at IP2 and IP3 occur at 24-month intervals for each unit, which results in an outage each year for one or the other units. During refueling outages, site employment increases by 950 workers for approximately 30 days (Entergy 2007a). During outages, most of these workers are likely to reside in the four-county ROI.

Table 2-7. IP2 and IP3 Employee Residence by County in 2006

County	Number of IP Energy Center Personnel	Percentage of Total
Bergen, NJ	17	1.4
Dutchess, NY	528	42.1
Orange, NY	243	19.4
Putnam, NY	78	6.2
Rockland, NY	28	2.2
Ulster, NY	31	2.5
Westchester, NY	206	16.4
Other	124	9.9
Total	1255	100

Source: Entergy 2007a

2.2.8.1 Housing

Table 2-8 lists the total number of occupied housing units, vacancy rates, and median value in the ROI. According to the 2000 Census, there were over 613,000 housing units in the ROI, of

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which approximately 584,000 were occupied. The median value of owner-occupied units ranged from \$141,500 in Orange County to \$285,800 in Westchester County. The vacancy rate was the lowest in Westchester County (3.5 percent) and highest in Putnam County (6.6 percent).

In 2006, the estimated total number of housing units in Westchester County grew by more than 6000 units to 355,581, and the total number of occupied units declined by 4000 units to 333,114. As a result, the number of available vacant housing units increased by more than 10,200 units to 22,467, or 6.3 percent of the available units. In addition, the estimated number of available housing units also increased in Dutchess, Orange, and Putnam Counties (USCB 2008a).

Table 2-8. Housing in Dutchess, Orange, Putnam and Westchester Counties, New York

	Dutchess	Orange	Putnam	Westchester	ROI
2000					
Total	106,103	122,754	35,030	349,445	613,332
Occupied housing units	99,536	114,788	32,703	337,142	584,169
Vacant units	6,567	7,966	2,327	12,303	29,163
Vacancy rate (percent)	6.2	6.5	6.6	3.5	4.8
Median value (dollars)	150,800	141,500	205,500	285,800	195,900
2006*					
Total	111,507	132,983	36,471	355,581	636,542
Occupied housing units	104,289	121,887	33,544	333,114	592,834
Vacant units	7,218	11,096	2,927	22,467	43,708
Vacancy rate (percent)	6.5	8.3	8.0	6.3	6.9
Median value (dollars)	334,200	319,300	407,800	581,600	410,725

* Estimated

Source: USCB 2008a; 2006 American Community Survey

2.2.8.2 Public Services

This section presents a discussion of public services including water supply, education, and transportation.

Water Supply

IP2 and IP3 do not utilize a public water system for plant circulating and service water purposes, but instead rely on surface water from the Hudson River. Potable water and process water are supplied to the site by the Village of Buchanan water supply system. Based on water bills, IP2 and IP3 utilize approximately 2.3 million ft³ or 17.4 million gal per month (65,000 m³ or 8.7 million L per month) of potable water (VBNY 2006). There are no restrictions on the supply of potable water from the Village of Buchanan. The Village of Buchanan obtains its water from two sources, the City of Peekskill Public Water System and the Montrose Improvement District. While the demand on the City of Peekskill Public Water System currently appears to be near the system design capacity, the contract with the Montrose Improvement District (now consolidated with the Northern Westchester Joint Water Works) appears to NRC staff to be capable of providing an adequate supply of potable water based on treatment capacity upgrades.

1 Public water supply systems in the vicinity of IP2 and IP3 include community and noncommunity
2 (including nontransient noncommunity and transient noncommunity) systems. Community
3 water systems within a 10-mi (16-km) radius of IP2 and IP3 include Westchester, Putnam,
4 Orange, and Rockland County systems. Each of these county systems uses both ground water
5 and surface water sources (EPA 2006b). Although outside the 10-mi (16-km) radius, public
6 water supply systems in Dutchess County were included because Dutchess County provides
7 residence to the largest percentage of the site's permanent full-time employees (42 percent).
8 Approximately 57 percent of the Dutchess County community water systems, including the
9 Poughkeepsie water supply system, obtain water from surface water sources that include the
10 Hudson River (EPA 2006b).

11 The Village of Buchanan purchases water from the City of Peekskill Public Water System and
12 the Montrose Improvement District. The City of Peekskill has two sources of water, both of
13 which are surface waters. The City of Peekskill's year-round major water source originates in
14 the Town of Putnam Valley (Putnam County). The City of Peekskill's second source of water is
15 an emergency source from a neighboring community, via the Catskill Aqueduct. Water is
16 pumped to the Camp Field Reservoir in the City of Peekskill, where it is then filtered and treated
17 (PWD 2005).

18 The Town of Cortlandt purchases 80 percent of its water supply from the Montrose
19 Improvement District, which treats raw water purchased from the New York City Catskill
20 Aqueduct. The town purchases 10 percent from the City of Peekskill, which filters and treats
21 raw water pumped from the Peekskill Hollow Brook to the city's Camp Field Reservoir, and
22 10 percent from the Town of Yorktown, which purchases water filtered and treated by the
23 Westchester County-owned Amawalk treatment plant (CCWD no date).

24 The Cortlandt Consolidated Water District (CCWD) has joined with the Yorktown and Montrose
25 Improvement District in a new corporation known as the Northern Westchester Joint Water
26 Works (NWJWW). The NWJWW has assumed ownership of the Amawalk treatment plant,
27 which has been upgraded to 7-mgd (26,000-m³/day) capacity. A new NWJWW 7-mgd
28 (26,000-m³/day) plant (Catskill water treatment plant) has been in operation since 2000 (CCWD
29 no date).

30 Westchester Joint Water Works (WJWW) serves the municipalities of the Village/Town of
31 Mamaroneck, Town/Village of Harrison, portions of the City of New Rochelle, and the City of
32 Rye. WJWW, which has a capacity of 14.2 mgd (53,800 m³/day) and an average daily demand
33 of 13.1 mgd (49,600 m³/d), obtains its water from the Catskill and Delaware watersheds of the
34 New York City water system, which includes the Delaware Aqueduct, Rye Lake (Delaware
35 watershed), and the Kensico reservoir (WJWW 2006).

36 A majority of Rockland County uses ground water to supply numerous small public water
37 systems, most of which are supplied by a single well (RWS 2006). The large public water
38 systems of Rockland County include United Water New York (UWNY), Nyack Village Public
39 Water System, and Suffern Village Public Water System (RWS 2006). UWNY provides water to
40 approximately 267,000 residents from 53 ground water wells drilled throughout the county, Lake
41 DeForest, and the Letchworth reservoirs (UWNY 2006). The UWNY peak demand in 2006 was
42 estimated at 47.5 mgd (180,000 m³/day) and its peak supply at approximately 48.5 mgd
43 (184,000 m³/day) (RCDH 2006).

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1 The Poughkeepsie Water Treatment Facility, which is owned and operated by the City and
2 Town of Poughkeepsie, provides drinking water in Dutchess County to the City of
3 Poughkeepsie, Town of Poughkeepsie, and Village of Wappingers Falls. The plant is located
4 along and draws water from the Hudson River. The plant was built in 1962 and is currently
5 rated at a maximum capacity of 16 mgd (61,000 m³/day). Average demand is reported to be
6 approximately 8 mgd (31,000 m³/day) (PTWD 2005).

7 The Village of Ossining Water System in Westchester County is supplied from two surface
8 water sources, the Indian Brook Reservoir, located near Fowler Avenue and Reservoir Road,
9 and the Croton Reservoir, which is part of the New York City Water System. The average blend
10 of water is approximately 63 percent from the Croton Reservoir and 37 percent from the Indian
11 Brook Reservoir. The system obtains its water from the Croton watershed in Putnam and
12 Westchester Counties and serves approximately 30,000 people. The Village of Ossining Water
13 System services an average daily demand of approximately 3.7 mgd (14,000 m³/day) (VOWS
14 2005).

15 Many public water supply systems supply only small segments of the population. For example,
16 Orange County has approximately 150 public water systems, but no major public water systems
17 in the county were identified within 10 mi of IP2 and IP3. Ground water is the primary source of
18 both community and noncommunity water supply systems and serves 60 to 85 percent of the
19 population in the area (Entergy 2007a; RCDH 2006). Large areas of Westchester, Putnam,
20 Orange, Rockland, and Dutchess Counties are not served by community water supplies.
21 Private water supplies in these areas draw primarily from ground water sources. The ground
22 water quality in New York is generally good, but contamination can and does occur locally.

23 The Village of Croton-on-Hudson public water system is supplied by a ground water well system
24 located downstream from the New Croton Dam and spillway. Ground water is pumped from the
25 well system directly into the distribution system. The system has a total storage capacity of
26 2.3 mgd (8700 m³/day) and supplies approximately 7600 people an average of 1.1 mgd
27 (4200 m³/day) (VCOH 2005).

28 Table 2-9 lists the major public water supply systems within the vicinity of IP2 and IP3.

Table 2-9. Major Public Water Supply Systems in 2005 (mgd)

Water Supplier ^a	Water Source ^a	Average Daily Production ^b	Design Capacity ^b	Population Served ^a
Northern Westchester Joint Water Works ^c	SW	6.9	14.0	0
Peekskill, NY	SW	3.9	4.0	22,400
Croton-on-Hudson, NY	GW	1.1	2.3	7,100
Westchester Joint Water Works	SW	13.1	14.2	55,200
Ossining, NY	SW	3.7	6.0	30,000
Poughkeepsie, NY	SW	8.9	16.0	28,000
United Water New York	GW & SW	47.5	48.5	270,000
Village of Suffern	GW	2.0	4.0	12,000
Village of Nyack	SW	1.8	3.0	14,700

GW = Ground water; SW = surface water; N/A = Not Applicable or No Information Available

^a EPA 2008b

^b Average daily production and design capacity. Information from 2005 Annual Drinking Water Quality Report for each public water system.

^c Includes the CCWD, Yorktown Improvement District, and the Montrose Improvement District (CCWD 2006).

An estimated 85,000 residents north of Kensico Dam in Westchester County use ground water as their primary water source. Exceptions are residents using surface water or aqueduct sources in Mt. Kisco, parts of the Town of Yorktown, much of the Town of Cortlandt, and most municipalities directly adjoining the Hudson River (WCDP 2003). Approximately 15 percent of the residents of the Town of Cortlandt are estimated to use ground water supplies (WCDP 2003, Table 2).

Education

IP2 and IP3 are located in the Hendrick Hudson Central School District, Westchester County, which had an enrollment of approximately 2800 students in 2003. Including the Hendrick Hudson Central School District, Westchester County has 40 school districts with a total enrollment of approximately 147,000 students. In contrast, Dutchess, Orange, and Putnam Counties have 16, 17, and 6 school districts with a total enrollment of approximately 46,000, 66,000, and 17,000 students, respectively (WCDP 2005).

Transportation

Several major highway routes serve as transportation corridors along either side of the Hudson River Valley. Westchester County and Putnam County are located on the eastern side of the Hudson River. The primary highways in Westchester County include Interstate 684, US 9, US 6, and US 202, as well as the Taconic State and Saw Mill River Parkways (see Figures 2-1 and 2-2). US 9 runs north and south along the Hudson River Valley through both Westchester and Putnam Counties. Further east, the Taconic State Parkway also runs north and south

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1 through both counties. The Taconic State Parkway and the Saw Mill River Parkway connect
2 near Hawthorne, New York, southeast of the site. Interstate 684 runs north and south along the
3 eastern side of Westchester County and connects to Interstate 84 in Putnam County. US 6 runs
4 east and west through the southern end of Putnam County and the northern portion of
5 Westchester County. US 202 runs east and west across northern Westchester County. The
6 Saw Mill River Parkway extends northeast and southwest between US 9 at Riverdale, New
7 York, and Interstate 684. Additional highways within the two counties include State Routes 117,
8 120, 129, 100, 139, and 301.

9 The nearest highway serving the site area is US 9. Using local roads from US 9, the site can be
10 accessed from Broadway. A summary of current New York State Department of Transportation
11 estimates for average annual daily traffic counts on US 9 north and south of the site is
12 presented in Table 2-10.

13 The Palisades Interstate Parkway is the largest highway system in Rockland County, running
14 north and south through the county, and connecting with US 6 and US 9W in southeastern
15 Orange County (see Figure 2-2). US 9W runs north and south along the Hudson River and
16 connects with Interstate 87 to the south at the Village of Nyack, New York. Interstate 87 allows
17 travel north and south through Orange County but then loops toward the east across Rockland
18 County, crosses the Hudson, and intersects US 9, the Saw Mill River Parkway, and the Taconic
19 State Parkway in Westchester County. US 202 runs northeast and southwest through Rockland
20 County till it meets US 9W and then crosses the Hudson River and runs easterly and intersects
21 the Taconic State Parkway. Route 17 (future Interstate 86) runs northwest and southeast
22 across Orange County to where it intersects Interstate 87, and turns south until it intersects
23 Route 3 near New York City. Interstate 84 runs east and west through Orange County, crosses
24 the Hudson River, and travels down Dutchess County and into Putnam County where it meets
25 Interstate 684.

26 Dutchess County is located approximately 13 mi (21 km) north of the site, on the east side of
27 the Hudson River. The major roads in this county are Interstate 84, US 44, US 9, Route 199
28 (Taconic State Parkway), and Route 22. Interstate 84 and US 44 run east and west in the
29 southern and central portions of the county, respectively. Route 199 (Taconic State Parkway),
30 Route 22, and US 9 run north and south in the central, eastern, and western portions of the
31 county, respectively.

Table 2-10. Average Annual Daily Traffic Counts on US 9 Near IP2 and IP3, 2004^a

Roadway and Location	Annual Average Daily Traffic
US 9—from Montrose crossing to Route 9A overlap ^b	50,500
US 9—from Peekskill city line to Montrose crossing	11,800 ^c
US 9—from Montrose crossing to Old Post Road crossing	5,950 ^c

Source: NYSDOT 2005

^a Traffic volume during the average 24-hour day during 2004.^b Readings taken at a continuous count station (accounts for seasonal and daily variation).^c NYSDOT projection from the latest year for which data were available.**2.2.8.3 Offsite Land Use**

This section describes land use conditions in Dutchess, Orange, Putnam, and Westchester Counties in New York, because the majority of the IP2 and IP3 workforce lives in these counties. In addition to payment-in-lieu-of-taxes (PILOT) and property tax payments to Westchester County, the surrounding counties receive property tax payments from the 1255 people employed by the site.

Dutchess County

Dutchess County is distinctly different from its neighboring counties in that it contains a combination of urban and rural settings rather than metropolitan areas. Currently, Dutchess County is conserving open spaces such as farms while increasing the number of housing units available in order to create a mix of urban areas and farmland (Dutchess County Department of Planning and Development 2006).

Dutchess County occupies roughly 802 sq mi (2080 sq km) or approximately 513,000 acres (208,000 ha) (USCB 2008b). The largest category of land use in Dutchess County is agriculture. Evenly distributed throughout the county, land used for agriculture makes up 21.3 percent (112,339 acres (45,462 ha)) of the county's area (USDA 2002a). Major agricultural land uses consist of cropland (52.75 percent), woodland (23.32 percent), pasture (11.12 percent), and other uses (12.81 percent) (USDA 2002a). Residential land areas cover approximately 7.1 percent of Dutchess County, with approximately 1.4 percent being devoted to commercial, industrial, and transportation uses (Entergy 2007a).

Dutchess County is planning to create developments in central locations by developing mass transit systems and waterways. Retail areas are planned to be centralized and within convenient walking distance from these transient terminals. Developments outside the primary growth areas are designed to blend into the natural landscape. In this way, Dutchess County hopes to maintain its open spaces and farming culture (PDCTC 2006; Dutchess County Department of Planning and Development 2006).

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Orange County

Three interstates intersect within Orange County. A byproduct of the county's interstate road access is a clustering of industry and commercial development along these highway corridors. Recently, most new development has occurred in the southeastern corner of the county as a result of the access to major transportation corridors. The largest land development in the southeastern part of the county is the U.S. Military Academy at West Point (see Figure 2-2) (Orange County Department of Planning 2003).

Orange County occupies roughly 816 sq mi (2110 sq km) or approximately 522,000 acres (211,000 ha) (USCB 2008b). Approximately 107,977 acres (43,697 ha) are used for agricultural purposes, with major agricultural land uses consisting of cropland (65.53 percent), woodland (16.50 percent), pasture (8.99 percent), and other uses (8.98 percent) (USDA 2002b). Residential land areas cover approximately 7.5 percent of Orange County, with approximately 1.7 percent devoted to commercial, industrial, and transportation uses (Entergy 2007a).

Orange County's Comprehensive Development Plan continues to reflect the importance of transportation interchanges, crossroads, and corridors (Orange County Department of Planning 2003). The dynamic real estate market and the loss of open spaces has been a challenge for Orange County. The county, along with civic organizations, has been inventorying current open spaces as part of defining and recommending future open space needs. Orange County also plans to initiate a redevelopment program to assist with historical improvements to the cities and villages within Orange County. With the increasing growth of Orange County, nontraditional zoning strategies are expected to help maintain historical and open spaces throughout the county (Orange County Department of Planning 2003).

Putnam County

Putnam County occupies roughly 231 sq mi (598 sq km) or approximately 148,000 acres (59,900 ha) (USCB 2008b) and is one of the fastest growing counties in New York (Putnam County Division of Planning and Development 2003). Approximately 6720 acres (2720 ha) (4.3 percent) are in agricultural use, with major agricultural land uses consisting of woodland (59.87 percent), cropland (26.49 percent), and other uses (13.65 percent) (USDA 2002c). Hilly topography has prevented or slowed development in the more rugged parts of the county. Additionally, there are many wetlands throughout the county. The most significant wetland in the county is the Great Swamp, which is a 4200-acre (1700-ha) wetland. Agricultural land use, undeveloped land, and forest land within the county have been decreasing. Residential land use occurs on large lot subdivisions or in rural areas. Industrial and commercial development can be found around the villages and along the major transportation corridors (Putnam County Division of Planning and Development 2003). Residential land use accounts for approximately 6.9 percent of the county's land, while only 1.1 percent is used for commercial, industrial, or transportation purposes (Entergy 2007a).

Putnam County attempts to integrate development into the natural environment, which includes enhancing, when possible, views of the Hudson River (Putnam County Division of Planning and Development 2003). The county and municipalities are working together by changing the zoning ordinances and subdivision regulations to preserve strategic historic structures and protect open spaces, while providing affordable housing and development throughout the county (Putnam County Division of Planning and Development 2003).

Westchester County

Westchester County occupies roughly 433 sq mi (1121 sq km) or approximately 277,000 acres (112,000 ha) (USCB 2008b). According to the 2002 U.S. Department of Agriculture (USDA) Census of Agriculture, 129 farms were located in Westchester County, which is a 10 percent increase since 1997 (USDA 2002d). Land acreage associated with farms increased 14 percent during this period with total acreage increasing from 8681 acres (3513 ha) to over 9917 acres (4013 ha). The average size of farms also increased 4 percent, from 74 to 77 acres (30 to 31 ha) from 1997 to 2002. Of the approximately 9917 acres (4013 ha) in agricultural land use in 2002, the major agricultural land uses consisted of woodland (48.84 percent), cropland (24.83 percent), pasture (12.81 percent), and other uses (13.53 percent) (USDA 2002d).

Residential land areas cover approximately 30.1 percent of Westchester County, with approximately 3.1 percent devoted to commercial, industrial, and transportation uses (Entergy 2007a). The long-range plan for the physical development of Westchester County concentrates on three distinct physical characteristics—centers, corridors, and open space (Westchester County Department of Planning 2000).

IP2 and IP3 are located in Westchester County in the Village of Buchanan, within the Town of Cortlandt. IP2 and IP3 provide tax revenues and other payments to both the Town of Cortlandt and the Village of Buchanan. The Town of Cortlandt encompasses 34.5 sq mi (89.4 sq km) or 22,080 acres (8935 ha) (TOCNY 2006). Land use is predominately residential zoning with ½-acre to 2-acre plots further protecting environmentally sensitive areas and open spaces (TOCNY 2004). The town's growth was intentionally slowed over the past several decades, allowing the town's leaders to plan its development. Significant commercial development has taken place along major transportation corridors, as well as at new community facilities within the area. From 1992 to 2004, the Town of Cortlandt has increased open space by 65 percent from 2729 acres (1104 ha) to 4502 acres (1822 ha) (TOCNY 2004). The town also has made an effort to increase public access to the Hudson River waterfront and encourage historic preservation (TOCNY 2004).

The Village of Buchanan, located within the Town of Cortlandt, encompasses 1.4 sq mi (3.6 sq km) or 896 acres (363 ha) (VBNY 1998). Land use in the village has changed very little over the last 20 to 30 years. The Village of Buchanan recently began restoring older buildings to beautify the village square. The Village of Buchanan has zoning ordinances, subdivision ordinances, and a development review board (Entergy 2007a).

2.2.8.4 Visual Aesthetics and Noise

IP2 and IP3 can be seen from the Hudson River but are shielded from the land side by surrounding high ground and vegetation. With the exception of Broadway, the site is also shielded from view from the Village of Buchanan. The superheater stack for IP1 (334 ft (102 m) tall), the IP2 and IP3 turbine buildings (each 134 ft (41.8 m) tall), and reactor containment structures (each 250 ft (76 m) tall) dominate the local landscape and can be seen from the Hudson River.

Noise from IP2 and IP3 is detectable off site, and the Village of Buchanan has a sound ordinance (Chapter 211-23 of the Village Zoning Code) that limits allowable sound levels at the property line of the sound generating facility. The combined frequencies of the sound standard equate to an overall level of 48 decibels (dB(A)). An ambient noise level monitoring program was conducted in the vicinity of IP2 and IP3 between September 2001 and January 2002, which

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showed that IP2 and IP3 meet the Village of Buchanan's sound ordinance (Enercon Services 2003).

2.2.8.5 Demography

According to the 2000 census, approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per sq mi (332 persons per sq km) (Entergy 2007a). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mile within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per sq mi (825 persons per sq km). Applying the proximity measures from NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants" (GEIS), IP2 and IP3 are classified as proximity Category 4 (greater than or equal to 190 persons per square mile within 50 mi (80 km)). Therefore, according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of sparseness Category 4 and proximity Category 4 indicate that IP2 and IP3 are located in a high-population area.

Table 2-11 shows population projections and growth rates from 1970 to 2050 in Dutchess, Orange, Putnam, and Westchester Counties. The population growth rate in Westchester County for the period of 1990 to 2000 was the lowest of the four counties at 5.6 percent. County populations are expected to continue to grow in all four counties in the next decades although Westchester County's population is expected to increase at a lower rate. Dutchess, Orange, and Putnam County populations are projected to continue to grow at a rapid rate through 2050.

The 2000 and 2006 (estimate) demographic profiles of the four-county ROI population are presented in Table 2-12 and Table 2-13. Minority individuals (both race and ethnicity) constitute 28.8 percent of the total four-county population. The minority population was composed largely of Hispanic or Latino and Black or African-American residents.

According to the U.S. Census Bureau's 2006 American Community Survey, minority populations in the four-county region were estimated to have increased by nearly 90,000 persons and made up 32.7 percent of the total four-county population in 2006 (see Table 2-13). The largest increases in minority populations were estimated to occur in Hispanic or Latino and Asian populations. The Black or African-American population increased by approximately 5 percent from 2000 to 2006 but remained unchanged as a percentage of the total four-county population.

Table 2-11. Population and Percent Growth in Dutchess, Orange, Putnam, and Westchester Counties, New York, from 1970 to 2000 and Projected for 2010 and 2050

Year	Dutchess		Orange		Putnam		Westchester	
	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)
1970	222,295	—	221,657	—	56,696	—	894,104	—
1980	245,055	10.2	259,603	17.1	77,193	36.2	866,599	-3.1
1990	259,462	5.9	307,647	18.5	83,941	8.7	874,866	1.0
2000	280,150	8.0	341,367	11.0	95,745	14.1	923,459	5.6
2006	295,146	5.4	376,392	10.3	100,603	5.1	949,355	2.8
2010	328,000	17.1	408,900	19.8	110,000	14.9	974,200	5.5
2020	362,900	10.6	467,000	14.2	120,300	9.4	985,800	1.2
2030	431,500	18.9	532,400	14.0	134,300	11.6	1,011,900	2.6
2040	460,450	6.7	584,005	9.7	146,439	9.0	1,054,968	4.3
2050	503,133	9.3	641,518	9.8	158,966	8.6	1,088,609	3.2

— = No data available.

(a) Percent growth rate is calculated over the previous decade.

Sources: Population data for 1970 through 2000 (USCB 2008c); population data for 2006 (estimated) 2006 American Community Survey; population projections for 2010–2030 by New York Metropolitan Transportation Council, September 2004; population projections for 2040 and 2050 (calculated)

Table 2-12. Demographic Profile of the Population in the IP2 and IP3**Four-County ROI in 2000**

	Dutchess	Orange	Putnam	Westchester	Region of Influence
Total Population	280,150	341,367	95,745	923,459	1,640,721
Race (percent of total population, not Hispanic or Latino)					
White	80.3	77.6	89.8	64.1	71.2
Black or African-American	8.9	7.5	1.5	13.6	10.8
American Indian and Alaska Native	0.2	0.2	0.1	0.1	0.1
Asian	2.5	1.5	1.2	4.4	3.3
Native Hawaiian and Other Pacific Islander	0.0	0.0	0.0	0.0	0.0
Some other race	0.2	0.1	0.1	0.3	0.3
Two or more races	1.5	1.4	1.0	1.8	1.6
Ethnicity					
Hispanic or Latino	18,060	39,738	5,976	144,124	207,898
Percent of total population	6.4	11.6	6.2	15.6	12.7
Minority Population (including Hispanic or Latino ethnicity)					
Total minority population	55,237	76,607	9,772	331,683	473,299
Percent minority	19.7	22.4	10.2	35.9	28.8

Source: USCB 2008c

**Table 2-13. Demographic Profile of the Population in the IP2 and IP3
Four-County ROI in 2006 (Estimate)**

	Dutchess	Orange	Putnam	Westchester	Region of Influence
Total Population	295,146	376,392	100,603	949,355	1,721,496
Race (percent of total population, not Hispanic or Latino)					
White	77.2	71.1	85.0	60.8	67.3
Black or African-American	7.8	8.7	2.0	13.5	10.8
American Indian and Alaska Native	0.1	0.3	0.0	0.1	0.1
Asian	3.4	2.5	2.2	5.5	4.3
Native Hawaiian and Other Pacific Islander	0.1	0.0	0.0	0.0	0.0
Some other race	0.2	0.3	0.1	0.5	0.4
Two or more races	2.6	1.7	1.0	1.0	1.5
Ethnicity					
Hispanic or Latino	24,879	57,980	9,692	175,990	268,541
Percent of total population	8.4	15.4	9.6	18.5	15.6
Minority Population (including Hispanic or Latino ethnicity)					
Total minority population	67,160	108,604	15,068	372,414	563,246
Percent minority	22.8	28.9	15.0	39.2	32.7
Source: USCB 2008c					

Transient Population

Within 50 mi (80 km) of IP2 and IP3, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2007, there were approximately 655,000 students attending colleges and universities within 50 mi (80 km) of IP2 and IP3 (IES 2008).

In 2000 in Westchester County, 0.8 percent of all housing units were considered temporary housing for seasonal, recreational, or occasional use. By comparison, seasonal housing accounted for 2.3 percent, 1.8 percent, 4.0 percent, and 3.1 percent of total housing units in Dutchess, Orange, and Putnam Counties, and New York as a whole, respectively (USCB 2008c). Table 2-14 provides information on seasonal housing located within 50 mi (80 km) of IP2 and IP3.

Table 2-14. Seasonal Housing within 50 mi (80 km) of the IP2 and IP3

County ^a	Housing units	Vacant housing units: For seasonal, recreational, or occasional use	Percent
New York	7,679,307	235,043	3.1
Bronx	490,659	962	0.2
Dutchess	106,103	2,410	2.3
Kings	930,866	2,616	0.3
Nassau	458,151	3,086	0.7
New York	798,144	19,481	2.4
Orange	122,754	2,215	1.8
Putnam	35,030	1,417	4.0
Queens	817,250	4,574	0.6
Richmond	163,993	524	0.3
Rockland	94,973	380	0.4
Suffolk	522,323	38,350	7.3
Sullivan	44,730	13,309	29.8
Ulster	77,656	5,238	6.7
Westchester	349,445	2,711	0.8
County Subtotal	5,012,077	97,273	4.1 (avg)
Connecticut	1,385,975	23,379	1.7
Fairfield	339,466	3795	1.1
Litchfield	79,267	4579	5.8
New Haven	340,732	3,245	1.0
County Subtotal	759,465	11619	2.6 (avg)
New Jersey	3,310,275	109,075	3.3
Bergen	339,820	1266	0.4
Essex	301,011	660	0.2
Hudson	240,618	674	0.3
Middlesex	273,637	905	0.3
Morris	174,379	1237	0.7
Passaic	170,048	849	0.5
Somerset	112,023	456	0.4
Sussex	56,528	3575	6.3
Union	192,945	475	0.2
Warren	41,157	361	0.9
County Subtotal	1,902,166	10,458	1.0 (avg)
Pennsylvania	5,249,750	148,230	2.8
Pike	34,681	15350	44.3
County Subtotal	34,681	15,350	44.3 (avg)
County Total	7,708,389	134,700	4.3 (avg)

Source: USCB 2008c

^a Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius
 avg = percent average for counties within the IP2 and IP3 50-mi radius and excludes state percentage

Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers may follow the harvesting of crops, particularly fruit, throughout the northeastern U.S. rural areas. Others may be permanent residents near IP2 and IP3 who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend significant time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncouned, these workers would be underrepresented in U.S. Census Bureau (USCB) minority and low-income population counts.

Information on migrant farm and temporary labor was collected in the 2002 Census of Agriculture. Table 2-15 provides information on migrant farm workers and temporary farm labor (fewer than 150 days) within 50 mi (80 km) of IP2 and IP3. According to the 2002 Census of Agriculture, approximately 9100 farm workers were hired to work for fewer than 150 days and were employed on 1800 farms within 50 mi (80 km) of the IP2 and IP3. The county with the largest number of temporary farm workers (1951 workers on 193 farms) was Suffolk County in New York.

In the 2002 Census of Agriculture, farm operators were asked for the first time whether any hired migrant workers, defined as a farm worker whose employment required travel that prevented the migrant worker from returning to his or her permanent place of residence the same day. A total of 360 farms in the 50-mi (80-km) radius of IP2 and IP3 reported hiring migrant workers. Suffolk County in New York reported the most farms (110) with hired migrant workers, followed by Orange and Ulster Counties in New York with 69 and 55 farms, respectively. Dutchess, Putnam, and Westchester Counties host relatively small numbers of migrant workers compared to those counties.

According to 2002 Census of Agriculture estimates, 275 temporary farm laborers (those working fewer than 150 days per year) were employed on 34 farms in Westchester County, and 435, 1583, and 127 temporary farm workers were employed on 132, 244, and 22 farms, respectively, in Dutchess, Orange, and Putnam Counties (USDA 2002e).

Table 2-15. Migrant Farm Worker and Temporary Farm Labor within 50 mi (80 km) of IP2 and IP3

County^a	Number of farm workers working fewer than 150 days	Number of farms hiring workers for fewer than 150 days	Number of farms reporting migrant farm labor	Number of farms with hired farm labor
New York				
Bronx	0	0	0	0
Dutchess	435	132	18	194
Kings	0	0	0	0
Nassau	91	24	4	31
New York	0	0	0	4
Orange	1583	244	69	349
Putnam	127	22	0	27
Queens	—	1	0	1
Richmond	—	1	0	3
Rockland	69	19	0	21
Suffolk	1951	193	110	313
Sullivan	595	100	1	124
Ulster	550	102	55	163
Westchester	275	34	3	68
Subtotal	5676	872	260	1298
Connecticut				
Fairfield	377	108	1	114
Litchfield	459	174	9	198
New Haven	713	88	25	102
Subtotal	1549	370	35	414
New Jersey				
Bergen	103	32	3	40
Essex	—	3	1	4
Hudson	0	0	0	0
Middlesex	334	71	15	92
Morris	432	69	12	83
Passaic	66	15	4	17
Somerset	160	100	8	114
Sussex	200	158	4	217
Union	—	7	1	8
Warren	549	131	17	178
Subtotal	1844	586	65	753

1

Table 2-15 (continued)

County^a	Number of farm workers working fewer than 150 days	Number of farms hiring workers for fewer than 150 days	Number of farms reporting migrant farm labor	Number of farms with hired farm labor
Pennsylvania				
Pike	—	8	0	10
Subtotal	—	8	0	10
Total	9069	1836	360	2475

Source: USDA 2002e, "Census of Agriculture," County Data, Table 7. Hired Farm Labor—Workers and Payroll: 2002

^a Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius

2.2.8.6 Economy

This section contains a discussion of the economy, including employment and income, unemployment, and taxes.

Employment and Income

Between 2000 and 2006, the civilian labor force in Westchester County increased 3.8 percent from 452,417 to 469,558. The civilian labor force in Dutchess, Orange, and Putnam Counties also grew by 11.9, 16.4, and 9.4 percent, respectively (USCB 2008c).

In 2002, health care and social assistance represented the largest sector of employment in the four-county region followed closely by retail, manufacturing, and the accommodation and food service industry. The health care and social assistance sector employed the most people in Westchester County followed by retail trade and professional, scientific, and technical services sectors. A list of some of the major employers in Westchester County in 2006 is provided in Table 2-16. As shown in the table, the largest employer in Westchester County in 2006 was IBM Corporation with 7475 employees.

Income information for the IP2 and IP3 ROI is presented in Table 2-17. In 1999, the date of the last economic census, the four counties each had median household incomes far above the New York State average. Per capita income, with the exception of Orange County, was also above the New York State average. In 1999, only 8.8 percent of the population in Westchester County was living below the official poverty level, while in Dutchess, Orange, and Putnam Counties, 7.5, 10.5, and 4.4 percent of the respective populations were living below the poverty level. The percentage of families living below the poverty level was about the same for Dutchess, Orange, and Westchester Counties. Putnam County had the smallest percentage of families living below the poverty level (USCB 2008c).

1

Table 2-16. Major Employers in Westchester County in 2006

Firm	Number of Employees
IBM Corporation	7475
County of Westchester	5881
Yonkers Public Schools	4049
Westchester Medical Center	3367
United States Postal Service District Office	3007
Verizon Communications	2733
Sound Shore Health System of Westchester	2515
City of Yonkers	2418
Riverside Health Care (St. John's Riverside Hospital)	2418
PepsiCo Incorporated	2372
White Plains Hospital Center	1923
New York State Department of Correctional Services	1735
Pace University	1620
MTA Metro-North Railroad	1617
Entergy Nuclear Northeast	1500
Morgan Stanley	1475
The Bank of New York Company	1450
Mount Vernon City School District	1450
Con Edison	1400
City School District of New Rochelle	1352
Phelps Memorial Hospital Center	1347
White Plains Public Schools	1285

Source: The Journal News 2006

2

Table 2-17. Income Information for the IP2 and IP3 ROI

	Dutchess	Orange	Putnam	Westchester	New York
Median household income 1999 (dollars)	53,086	52,058	72,279	63,582	43,393
Per capita income 1999 (dollars)	23,940	21,597	30,127	36,726	23,389
Percent of families living below the poverty level (2000)	5.0	7.6	2.7	6.4	11.5
Percent of individuals living below the poverty level (2000)	7.5	10.5	4.4	8.8	14.6

Source: USCB 2008c

Unemployment

In 2006, the annual unemployment averages in Westchester and Dutchess, Orange, and Putnam Counties were 5.3, 5.5, 6.2, and 4.8 percent, respectively, which were lower than the annual unemployment average of 6.5 percent for the State of New York (USCB 2008c).

Taxes

IP2 and IP3 are assessed annual property taxes by the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. PILOT payments, property taxes, and other taxes from the site are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District (see Table 2-18). The payments to the Town of Cortlandt are distributed to the Town of Cortlandt, Westchester County, the Verplanck Fire District, the Hendrick Hudson Central School District, and Lakeland Central Schools.

PILOT payments, property taxes, and other taxes paid by Entergy account for a significant portion of revenues for these government agencies. The remainder is divided between the Village of Buchanan, Westchester County, the Town of Cortlandt, and the Verplanck Fire District.

The Village of Buchanan is the principal local jurisdiction that receives direct revenue from the site. In fiscal year 2006, PILOT payments, property taxes, and other taxes from the site contributed about 40 percent of the Village of Buchanan's total revenue of \$5.07 million, which is used for police, fire, health, transportation, recreation, and other community services for over 2100 residents (NYSOSC 2007). Additionally in fiscal year 2006, PILOT payments, property taxes, and other taxes from the site contributed over 27 percent of the total revenue collected for the Hendrick Hudson Central School District.

Entergy also pays approximately \$1 million dollars per year to New York State Energy Research and Development Authority (NYSERDA) for lease of the discharge canal structure and underlying land (NYSERDA 2007).

From 2003 through 2006, the Town of Cortlandt had between \$31.6 and \$34.5 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT and property tax payments represented 11 to 16 percent of the Town's total revenues (see Table 2-18).

From 2003 through 2006, the Hendrick Hudson Central School District had between \$51 and \$57 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT payments represented 27 to 38 percent of the school district's total revenues (see Table 2-18).

From 2003 to 2006, the Village of Buchanan had between \$5 and \$5.7 million annually in total revenues (NYSOSC 2008). Between 2003 and 2006, IP2 and IP3 PILOT and property tax payments represented between 39 and 43 percent of the Village's total revenues (see Table 2-18).

Table 2-18. IP2 and IP3 PILOT and Property Tax Paid and Percentage of the Total Revenue of the Town of Cortlandt, Hendrick Hudson Central School District, and Village of Buchanan, 2003 to 2006

Entity	Year	PILOT and Property Tax		
		Total Revenue (millions of dollars)	Paid (millions of dollars)	Percent of Total Revenue
Town of Cortlandt	2003	31.6	5.0	16
	2004	31.9	4.7	15
	2005	34.5	3.8	11
	2006	33.8	3.7	11
Hendrick Hudson Central School District	2003	51.1	19.6	38
	2004	52.8	18.9	36
	2005	56.9	16.9	30
	2006	55.9	15.3	27
Village of Buchanan	2003	5.7	2.3	40
	2004	5.0	2.2	43
	2005	5.1	2.0	39
	2006	5.1	2.0	40

Source: NYSOSC 2008; ENN 2007c

2.2.9 Historic and Archeological Resources

This section presents a brief summary of the region's cultural background and a description of known historic and archaeological resources at the IP2 and IP3 site and its immediate vicinity. The information presented was collected from the New York State Historic Preservation Office (NYSHPO), and the applicant's environmental report (Entergy 2007a).

2.2.9.1 Cultural Background

Prehistory

The basic prehistoric cultural sequence and chronology for New York State is presented in Table 2-19 below and the text that follows. This cultural sequence was generated primarily for western and southern New York, and its applicability to the unusual estuarine environments of the lower Hudson and southeastern New York is uncertain. Given the lack of excavated data specific to the lower Hudson River Valley, the NRC staff used this generalized sequence (Ritchie 1980).

Table 2-19. Cultural Sequence and Chronology

Cultural Period	Time Period
Paleo-Indian Period	9000–7000 B.C.
Archaic Period	7000–1000 B.C.
Woodland Period	1000 B.C.–A.D. 1524
European Contact	A.D. 1524–1608

Paleo-Indian Period

Archeological evidence suggests that Paleo-Indian people were hunter-gatherers who primarily hunted large mammals using projectiles tipped with distinctively flaked “fluted” stone points. These small, widely dispersed bands ranged over large geographic areas supplementing food taken from large mammal hunts by collecting edible wild plant foods, fishing, and hunting smaller game (Ritchie 1980).

Humans entered upstate New York and the Hudson River Valley for the first time around 10,000–9,000 B.C. Ritchie (1980) reports isolated finds of fluted points characteristic of the Clovis tradition in the Albany area. Data on Paleo-Indian fluted points indicate only one example each in Westchester, Rockland, and Orange Counties. Levine’s more extensive publication (1989) regarding Paleo-Indian fluted points from surface collections in the Upper Hudson River Valley is similarly vague regarding the nature of findspots and their environmental settings. Most appear to have been collected from agricultural plow zones and indicate a temporary occupation, such as a hunting camp.

Excavated sites are consistently small and indicative of extremely short-term utilization. Of particular interest to the lower Hudson is the Port Mobil site, located above the Arthur Kill on Staten Island. Though badly disturbed, the location of the site indicates a strong estuarine orientation, and the lithic materials recovered at the site derive from both eastern New York and eastern Pennsylvanian sources (Ritchie 1994).

Archaic Period

Generalized hunter-gatherers exploiting large game and a wide variety of fauna, including small mammals and birds, and fish, characterize the Archaic period. The Early and Middle Archaic Periods had long been interpreted as representing a low point in human occupation in the Northeast, but as with the Paleo-Indian period, surface collections have begun to fill in the gap (Levine 1989). Part of the explanation for the increasing density of human occupation of upper New York State may involve the gradual transition from relatively resource-poor coniferous forests to hardwood forests during the course of the period (Salwen 1975). Gradually rising sea levels would have shortened the descent to the Hudson River banks and flooded any number of Early Archaic sites.

Brennan noted that Archaic hunting and foraging was centered on two pools or bays, the Tappan Zee, stretching from just north of Yonkers to the Croton River, and Haverstraw Bay, from the Croton River to Bear Mountain. He disagreed, however, with the notion that any of the sites represented long-term, much less permanent, settlements and specialized subsistence. Instead, he suggested that Archaic exploitation of the lower Hudson was only seasonal, as part of a generalized subsistence strategy (Brennan 1977).

Plant and the Environment

Woodland Period

The Woodland Period in New York State saw the establishment of horticulture and the development of larger social units, including matriarchal and matrilineal clans, sedentary villages, and tribes. Pottery is gradually introduced, and a much wider variety of material culture comes into use. While minor climate fluctuations took place during this period, the overall environment was very similar to that of today.

Early Woodland sites are similar to those of the Late Archaic Period. They are typically small sites, with projectile points, scrapers, and bone tools providing evidence of hunting, fishing, and limited cultivation (Funk 1976). Pottery is found on an increasing number of sites, typically stamped and impressed cooking pots tempered with crushed shell. The wide variety of pottery types found at individual sites, however, points to low levels of interaction between groups. Other new features of the early Woodland Period are burials with elaborate grave goods, including flints and bone tools, shell and copper beads, and stone pendants (Ritchie 1980).

By the Middle and Late Woodland Periods, the size and complexity of sites increased tremendously. The key to later developments was the introduction of horticulture and the cultivation of maize (*Zea mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*). Processing of these crops was facilitated by the use of cooking pots and storage pits. Villages were occupied year-round by the end of the period and often comprised multiple longhouses positioned on defensible hills and fortified with walls or palisades.

European Contact, 1524–1608

The Contact Period in the lower Hudson Valley began in 1524, when the Spanish explorer Giovanni de Verrazzano reached New York Harbor in his ship, the *Dauphin*. After anchoring near Staten Island, he attempted to go ashore in a small boat but was forced to return to his ship because of a sudden storm. Verrazzano then departed quickly and continued up the East Coast. The Spanish continued to exploit the area between the Chesapeake and the Gulf of Maine, primarily as slavers, while French fishermen appear to have frequented the Grand Banks in the 16th century.

Historic Period

The Colonial Period, 1608–1776

The English explorer Henry Hudson undertook two unsuccessful Arctic explorations in search of the Northwest Passage to the Orient in 1608. With the support of the Dutch East Indies Company, Hudson's famous voyage in the *Half Moon* took place in 1609, whereupon he discovered instead the river that now bears his name. Almost immediately thereafter, Dutch traders in great numbers began flooding into the area, primarily in search of furs. In 1614, the New Netherlands Company was formed and given a charter by the Dutch to exploit the areas between the Connecticut, Mohawk, and Hudson Rivers. In 1614, the Dutch established Fort Nassau on the west bank of the Hudson River at what is now Albany.

The island known as Manhattan was, famously, purchased from the Manhattes in 1626, and other areas such as Staten Island, Hoboken, and Nyack were purchased in the succeeding decades (Francis 1997; Kraft 1991). Dutch, Walloon, Huguenot, and even small numbers of Jews began to arrive as refugees and settlers in New Amsterdam, but by 1630, the population was still only around 300. In 1664 an English fleet sailed into the harbor at New Amsterdam,

1 and after some negotiation, the Dutch capitulated. The English seized the entire colony of New
2 Amsterdam and renamed the area New York and New Jersey.

3 The Revolutionary War, 1776–1783

4 New York and, more specifically, Westchester County were the site of many significant events
5 during the American Revolution. The social and economic structure of the State was still
6 dominated by large landowners, and discontent had already emerged among tenant farmers
7 during the 1750s and 1760s. British troops landed on Staten Island in July 1776 and advanced
8 northward, pressing colonial forces under the command of George Washington to make a
9 strategic retreat north into Westchester County (Griffin 1946). With a large British force
10 advancing, the bulk of American forces in Westchester retreated across the Hudson to New
11 Jersey (Griffin 1946; Countryman 2001). Westchester remained on the front lines until the end
12 of the war. The American defense line stretched from Mamaroneck to Peekskill, with British
13 forces arrayed across southern Westchester County, creating a “neutral ground” in between,
14 across which violence raged. The British gradually captured the bulk of Westchester County by
15 1779 but were unable to press their advantage further (Griffin 1946; Countryman 2001).

16 The Americans slowly pushed the British back from the Hudson Highlands and then
17 Westchester County. In July 1779, General Anthony Wayne and his Corps of Light Infantry
18 conducted a successful assault against a British encampment at Stony Point. The modern
19 Stony Point Battlefield in Rockland County is across the Hudson River from the IP2 and IP3 site.

20 19th Century Development

21 The economy of Westchester County remained overwhelmingly agricultural during the first half
22 of the 19th century, driving a number of infrastructure improvements. The Croton Turnpike, for
23 example, was organized in 1807 to carry the enormous cattle traffic en route to New York City
24 from Westchester County. Though shipbuilding was a major industry on both the Hudson and
25 Long Island Sound sides of Westchester, regular sloop traffic to Manhattan did not begin until
26 the later 18th century. After 1807, the steamboat revolution, engineered by Robert Livingston
27 and Robert Fulton, opened a new era on the Hudson River.

28 The landscape of New York State and Westchester County was profoundly transformed by land
29 speculation, which opened virtually the entirety of the State for farming, and more gradually by
30 the spread of industry. Copper was mined near Sing-Sing and iron near Port Chester and
31 Irvington, and iron working was established in Peekskill. During the latter part of the
32 19th century, the area just north of the IP2 and IP3 site was surface-mined, and a small lime kiln
33 and blast furnace were operated within or adjacent to the footprint of the current facility
34 (Enercon, 2006). By the end of the 19th century, industrialization was widespread in
35 Westchester County.

36 20th Century Development

37 Land remained the dominant theme for the 20th century in Westchester County, but in a far
38 different sense than during the 19th. The preceding century had seen the landscape
39 transformed through the end of the manorial system and the spread of freehold farming, then by
40 industrialization and transportation networks, and finally by deliberate preservation as New York
41 City’s water source. Though the surrounding counties had always been secondary to New York
42 City in terms of population, productivity, and wealth, the 20th century gradually saw decisive
43 political and economic subordination.

2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site

Previously Recorded Resources

A Phase 1A Survey (literature review and sensitivity assessment) was conducted in 2006 by Entergy (Enercon, 2006). This survey was primarily a literature review and included only an informal walkover of a portion of the plant site. Areas of potential aboriginal and historical interest were noted; however, no sites were recorded as part of this effort. No systematic pedestrian or subsurface cultural resources surveys have been conducted at the IP2 and IP3 site.

NYSHPO houses the State's archeological site files and information on historic resources such as buildings and houses, including available information concerning the National or State Register eligibility status of these resources. The NRC cultural resources team visited NYSHPO and conducted a records search for archeological sites located within or near the IP2 and IP3 property. The results of this search are detailed below.

There are no previously recorded archeological sites within the IP2 & IP3 property. A search for sites within a 1-mi (1.6-km) radius of the plant also revealed no previously recorded sites. The nearest recorded site (A-119-02-0003) is located southwest of the plant, at Verplanck's Point. Site A-119-02-003 is the site of the Revolutionary War era Fort Lafayette. The New York State Historic Trust site inventory form indicates that there is no longer any visible, above ground evidence of the fort; however, the inventory form documents artifacts from the fort site (including cannonballs and uniform buttons) found in the collections of local residents in the mid-1970s. The nearest previously recorded prehistoric archaeological site is the "Peekskill Shell Heap" (NYSM 6910). This site is a shell and artifact midden deposit located northeast of the IP2 and IP3 site in the City of Peekskill.

A review of the NYSHPO files was conducted to identify aboveground historic resources within 5 mi (8 km) of the plant. In Westchester County, 29 resources are listed on the National Register of Historic Places (NRHP) within the 5-mi (8-km) radius. Additionally, there are 16 NRHP-listed resources in Rockland County, 19 in Orange County, and 22 in Putnam County within 5 mi (8 km). The nearest NRHP-listed historic resource to the IP2 and IP3 facilities is the Standard House in the City of Peekskill, approximately 2 mi (3.2 km) to the northeast. The Standard House is a three-story Italianate structure built in 1855 and originally used as a boarding house and tavern.

IP1 began operation in August 1962 and was shut down in October 1974 and placed in SAFSTOR with intent for decommissioning at a later date. The plant was one of three "demonstration plants" that began operation in the early 1960s and is representative of the earliest era of commercial reactors to operate in the United States. To date, no formal significance or eligibility evaluation has been conducted for IP1.

Results of Walkover Survey

The NRC staff performed an informal walkover survey of the IP2 and IP3 property during the environmental site audit, including portions of the power block area and portions of the former Lent's Cove Park (wooded area north of the power block area). During this walkover, it was observed that the power block area has been extensively disturbed and graded. The NRC staff walked a meandering path through the wooded area north of the plant and along a portion of the shoreline of Lent's Cove.

The NRC cultural resources team observed evidence of prehistoric use of this area in two locations along the walkover route. The NRC staff observed two pieces of chert debitage near a stream in the western portion of the wooded area, and a Woodland Period, Meadowood Phase, projectile point was observed near the shoreline along Lent's Cove. Historic Period use of this area was also observed in the form of an apparent stone house foundation and scattered historic era trash piles.

Evidence of mining (Enercon 2006) was confirmed in the western portion of the wooded area. Manmade holes of varying size and piles of spoil material were observed by the NRC staff along the route of the walkover in this portion of the property.

The NRC staff observed a concrete stairway and retaining wall (remnants of an early 20th century park) south of the main power block area. These appear to be the only remaining features of the former Indian Point Park, a popular recreation area from 1923 to 1956 (Enercon 2006).

Potential Archeological Resources

As the result of disturbances associated with site preparation and construction, the main generating station areas at IP2 and IP3 have little or no potential for archeological resources. There is potential for archeological resources to be present in the wooded area north of the main generating station areas, and the historic period mining features in this area represent a potentially significant resource. The portion of the property south and east of the power block area, which contains a variety of ancillary plant facilities, has been disturbed by construction activities over the course of the plant's history. It is possible, however, that portions of that area not disturbed by construction activities may contain intact subsurface archeological deposits. Additionally, the concrete stairway and retaining wall from the former Indian Point Park would require evaluation, should any construction activity be planned for that area of the facility.

2.2.10 Related Federal Project Activities and Consultations

During the preparation of the IP2 and IP3 ER, Entergy did not identify any known or reasonably foreseeable Federal projects or other activities that could contribute to the cumulative environmental impacts of license renewal at the site (Entergy 2006a).

The NRC staff further reviewed the possibility that activities of other Federal agencies might affect the renewal of the operating licenses for IP2 and IP3. The presence of any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of the draft SEIS.

The NRC staff identified several current Federal projects occurring near IP2 and IP3, which the staff will discuss in the following paragraphs. The NRC staff has determined that none of these Federal projects would result in impacts to the IP2 and IP3 license renewal review that would make it desirable for another Federal agency to become a cooperating agency in the preparation of this draft SEIS.

The NRC is required under Section 102(c) of NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. Federal agency comment correspondence is included in Appendix E.

Plant and the Environment

New York/New Jersey/Philadelphia Airspace Redesign

The Federal Aviation Administration (FAA) is proposing to redesign the airspace in the New York/New Jersey/Philadelphia (NY/NJ/PHL) Metropolitan Area. This redesign was conceived as a system for more efficiently directing Instrument Flight Rule aircraft to and from five major airports in the NY/NJ/PHL Metropolitan Area, including John F. Kennedy International Airport and LaGuardia Airport in New York, Newark Liberty International Airport and Teterboro Airport in New Jersey, and Philadelphia International Airport in Pennsylvania. All of these airports are south of the IP2 and IP3 facility with the closest being the Teterboro Airport which is about 30 mi away. The redesign project also included 16 satellite airports in the study area. Of these satellite airports, the White Plains/Westchester County Airport, located about 24 mi south-southeast of the IP2 and IP3 facility, and Stewart International Airport, located about 25 mi north, are the closest to the facility.

FAA, in cooperation with DOT, prepared an EIS to evaluate the environmental effects of the NY/NJ/PHL Metropolitan Area Airspace Redesign in accordance with NEPA (DOT/FAA 2007). The proposed action for this EIS is to redesign the airspace in the NY/NJ/PHL metropolitan area. This involves developing new routes and procedures to take advantage of improved aircraft performance and emerging air traffic control technologies. The final EIS identified that potential significant impacts exist in the categories Noise/Compatible Land Use and Socioeconomic Impacts/Environmental Justice (DOT/FAA 2007). The greatest potential impact of the proposed action and preferred alternative is changes in the noise levels in the airspace redesign area.

The EIS provides detailed descriptions of the proposed noise mitigation procedures identified for the preferred alternative mitigation package. The EIS studied regions of the Appalachian Trail which lie north of the IP2 and IP3 facility. The trail crosses the Hudson River about 4 mi north of the facility near Bear Mountain. In this area, the EIS mitigated preferred alternative for 2011 would result in an average of 512.4 daily air jet operations in the region (DOT/FAA 2007). The no action alternative for 2011 air traffic would result in an average of 268.1 daily air jet operations (DOT/FAA 2007). The mitigated preferred alternative would, therefore, result in a more than 90-percent increase in air traffic in the region immediately north and northwest of the facility. The formal Record of Decision (ROD) for the airspace redesign study which supports the FAA's mitigated preferred alternative was issued in September 2007 (FAA 2007).

Hudson River PCBs Site

The EPA Hudson River PCBs Site encompasses a nearly 200-mi stretch of the Hudson River in eastern New York State from Hudson Falls, New York, to the Battery in New York City and includes communities in 14 New York counties and 2 counties in New Jersey (EPA 2008c). The EPA ROD for the Hudson River PCBs Superfund Site addresses the risks to people and ecological receptors associated with PCBs in the in-place sediments of the Upper Hudson River. The February 2002 ROD calls for targeted environmental dredging and removal of approximately 2.65 million cubic yards of PCB-contaminated sediment from a 40-mi stretch of the Upper Hudson. In the ROD, EPA selected a plan that addresses the risks to people and the environment associated with PCBs in the sediments of the Upper Hudson River. The actions in the Upper Hudson will lower the risks to people, fish, and wildlife in the Lower Hudson (EPA 2008c).

1 On January 25, 2008, EPA completed the final step in the approval process for the design of
2 Phase 1 of the Hudson River PCBs Site dredging program (EPA 2008c). Phase 1
3 encompasses the construction of facilities necessary to process and transport sediments to be
4 dredged from the river, as well as the first year of the dredging program and the habitat
5 replacement and reconstruction program for those areas dredged during Phase 1. Phase 2 will
6 consist of dredging the first three sections of the Upper Hudson River (north of the Federal Dam
7 at Troy, New York) (EPA 2008d).

8 U.S. Army Corps of Engineers Hudson River Federal Navigation Project

9 The U.S. Army Corps of Engineers (USACE), New York District, prepared an EIS addressing
10 the effects of the Hudson River Federal Navigation Project in 1983. Environmental
11 assessments updating the EIS were prepared by the USACE New York District for various
12 maintenance dredging projects since the mid-1980s. USACE determined that the maintenance
13 dredging for the Hudson River Federal Navigation Project, with placement of dredged material
14 on the federally owned upland placement site on Houghtaling Island, has no significant adverse
15 environmental impacts on water quality, marine resources, fish, wildlife, recreation, aesthetics,
16 and flood protection (USACE 2006).

17 Coastal Zone Management Act

18 In the United States, coastal areas are managed through the Coastal Zone Management Act of
19 1972 (CZMA). The Act, administered by the NOAA Office of Ocean and Coastal Resource
20 Management, provides for management of the nation's coastal resources, including the Great
21 Lakes, and balances economic development with environmental conservation. The Federal
22 Consistency Regulations implemented by NOAA are contained in 15 CFR Part 930.

23 This law authorizes individual states to develop plans that incorporate the strategies and
24 policies they will employ to manage development and use of coastal land and water areas. Each
25 plan must be approved by NOAA. One of the components of an approved plan is "enforceable
26 polices," by which a state exerts control over coastal uses and resources.

27 The New York Coastal Management Program was approved by NOAA in 1982. The lead
28 agency is the Division of Coastal Resources within the Department of State. The lead agency
29 implements and supervises all the various Coastal Zone Management programs in the state.
30 New York's coastal zone includes coastal counties on Long Island as well as Westchester
31 County, the boroughs of New York City, counties along the Hudson River up the Federal Dam at
32 Troy, and counties along the Great Lakes (NOAA 2007b). Federal Consistency requires
33 "federal actions, occurring inside a state's coastal zone, that have a reasonable potential to
34 affect the coastal resources or uses of that state's coastal zone, to be consistent with that
35 state's enforceable coastal policies, to the maximum extent practicable."

36 IP2 and IP3 are located in Westchester County, within the State's Coastal Zone, specifically in
37 the Peekskill South region of the Hudson River (NYSDOS undated). The IP2 and IP3 site is
38 adjacent to a Significant Coastal Fish and Wildlife Habitat (Haverstraw Bay), and south of the
39 Hudson Highlands Scenic Area of Statewide Significance (NYSDOS undated). Based on IP2
40 and IP3's location within the State's Coastal Zone, license renewal of IP2 and IP3 will require a
41 State coastal consistency certification.

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Environmental issues associated with refurbishment activities are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾ The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this draft supplemental environmental impact statement (draft SEIS) unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

License renewal actions may include associated refurbishment actions that provide for safe and economic operation during the period of extended operation. These actions may have impacts on the environment that require evaluation, depending on the type of action and the plant-specific design.

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

3.1 Potential Refurbishment Activities

Entergy, in its environmental report, stated that its evaluation of structures and components required by Title 10, Section 54.21, "Contents of Application—Technical Information," of the *Code of Federal Regulations* (10 CFR 54.21), did not identify the need for refurbishment of structures or components for purposes of license renewal and that Entergy planned no such refurbishment activities (Entergy 2007). Entergy indicated that routine operational and maintenance activities would be performed during the license renewal period but that they were not refurbishment activities as described in the GEIS.

During the license renewal environmental scoping process, the staff of the U.S. Nuclear Regulatory Commission (NRC) received comments (Kaplowitz 2007; Shapiro 2007) indicating that Entergy had taken steps toward procuring replacement reactor vessel heads and control rod drive mechanisms (CRDMs) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The scoping comments indicated that an overseas firm plans to deliver replacement reactor vessel heads and CRDMs for IP2 and IP3 in October 2011 and October 2012, respectively. Based on this information, the staff requested, by letter to Entergy dated December 5, 2007, additional information regarding these potential refurbishment activities (NRC 2007).

Entergy's response, dated January 4, 2008, indicated that "no reactor vessel head replacements are required for purposes of aging management during the period of extended operation. Accordingly, no evaluation of the environmental impacts of reactor vessel head replacement as a refurbishment activity is required or presented in the Environmental Report." The response also stated that "the decision to proceed with procurement of long lead items [replacement vessel heads] is strictly economic" and therefore need not be addressed in Entergy's environmental report (Entergy 2008a).

During a telephone conference call on March 18, 2008 (NRC 2008a), the staff acknowledged that while there may be no requirement to replace the reactor vessel heads at IP2 and IP3 for license renewal, Section 2.6.1 of the GEIS discusses initiating actions for environmental impacts associated with license renewal. These actions include (1) refurbishment, repair, or replacement activities that "may be performed to ensure that this objective [aging management and maintaining functionality of certain SSCs] is achieved" and (2) activities that licensees may choose to undertake, including "various refurbishment and upgrade activities at their nuclear facilities to better maintain or improve reliability, performance, and economics of power plant operation during the extended period of operation." Since the GEIS considers refurbishment activities beyond those that are related to aging management during the period of extended operation, the NRC staff indicated that Entergy's response to the staff's request for additional information (RAI) did not effectively address the staff's need for information about the potential refurbishment activities.

During the conference call, Entergy staff indicated that, if license renewal were not being pursued for IP2 and IP3, Entergy would not have ordered the vessel head forgings. Entergy also indicated that the vessel head forgings that were procured for IP2 and IP3 may never be needed at IP2 and IP3.

Given that Entergy has taken steps toward obtaining the replacement reactor vessel heads and

CRDMs, and given that these replacement activities, should they occur, would be associated with license renewal (i.e., they would not be undertaken in the absence of license renewal), the NRC staff issued an additional RAI on April 14, 2008 (NRC 2008b), in which the staff requested information from Entergy regarding the process Entergy would use in deciding whether to replace the vessel heads and CRDMs, as well as indicating the potential environmental impacts of these replacement activities. Entergy submitted its response to NRC on May 14, 2008 (Entergy 2008b).

In its RAI response, Entergy reasserted that it did not believe vessel head and CRDM replacement constituted a refurbishment activity (Entergy 2008b). In addition, the response indicated that the current vessel heads are in good condition, though Entergy may eventually decide to replace them pending the results of future inspections.

Entergy's response also provided a likely hypothetical scenario for the replacement activities, should they occur. The scenario includes the following characteristics (Entergy 2008b):

- Approximately 250 additional workers would be required for the replacement of each reactor vessel head and CRDM. The replacement would take place during a 60-day refueling outage for each unit, when approximately 950 refueling outage workers are at the Indian Point site. An additional 50 workers would be required to construct the vessel head storage structure, though their work would be largely completed before the beginning of the refueling outage.
- The reactor vessel heads would be manufactured overseas, transported to a U.S. port, and shipped up the Hudson River via barge, with the CRDMs installed, to the existing IP barge slip.
- Once delivered to the IP2 and IP3 site, storage and preinstallation preparation would take place at onsite temporary structures. If possible, existing warehouses would also be used. The only permanent building constructed would be used to store the old reactor vessel heads and CRDMs; this building would likely be constructed near the onsite structure storing the old IP2 and IP3 steam generators and occupy less than 446 square meters (4800 square feet). All structures would be constructed on previously disturbed areas.
- Staff or contractors would cut a temporary opening in containment approximately 7.6 by 7.9 meters (26 feet by 25 feet) to allow for removal of the old heads and CRDMs and installation of the new ones. Containment concrete would be removed by hydro-demolition, while rebar and a portion of steel liner would be removed by other means.
- Before removing the old reactor vessel head from containment, Entergy would remove any loose contamination or affix it with a coating. The old head would then be transported to the onsite storage facility (for possible offsite permanent disposition). Meanwhile, the new head (with CRDMs) would be installed.
- Upon project completion, each unit's containment would be returned to its original configuration.

The NRC staff considered the GEIS guidance on refurbishment activities, the need to disclose

Environmental Impacts of Refurbishment

potential impacts of the proposed action, and Entergy's analysis of possible impacts of vessel head and CRDM replacements. The NRC staff also acknowledged that vessel head and CRDM replacements may not occur. Nevertheless, to ensure that, should these refurbishment activities occur, their environmental impacts will have been characterized and disclosed in accordance with the National Environmental Policy Act and NRC implementing regulations, the NRC staff determined that it would be appropriate to evaluate the potential impacts of these possible replacement activities using the GEIS framework for refurbishment.

3.1 Refurbishment Impacts

The IP2 and IP3 site was one of seven case study reactor locations the NRC staff used in determining potential environmental impacts from refurbishment activities while developing the GEIS. After reviewing construction-stage impacts at these seven plant sites and then scaling them down to better approximate the duration and intensity of impacts expected during plant refurbishment activities, the NRC staff determined that nine refurbishment-related issues would be Category 1 issues. The GEIS approach to refurbishment assumed longer duration outages, more workers, and a wider array of activities on site than would occur during the reactor vessel head and CRDM replacement project discussed here. The GEIS also noted, in Appendix B, that outages would grow shorter as licensees gained experience with major replacement activities. Additionally, the GEIS noted that some licensees may choose to perform only a few activities.

Even given larger workforces, more activities, and longer outages, the NRC staff determined in the GEIS that the impacts for these nine issues are SMALL.

Table 3-1 contains a list of Category 1 issues associated with refurbishment.

1

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4, 3.7.4.3, 3.7.4.4, 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

2 Provided below are the results of the NRC staff reviews and a brief statement of GEIS
3 conclusions, as codified in Table B-1 of 10 CFR Part 51, "Environmental Protection Regulations
4 for Domestic Licensing and Related Regulatory Functions," Subpart A, "National Environmental
5 Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of
6 Renewing the Operating License of a Nuclear Power Plant," for each of the Category 1
7 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not
8 identified any new and significant information during its review of the Entergy environmental
9 report (Entergy 2007), its site audit, the SEIS scoping process, and its evaluation of other
10 available information, including Entergy's May 14, 2008, RAI response (Entergy 2008b).

- 11 • Impacts of refurbishment on surface water quality. Based on information in the GEIS,
12 the Commission found the following:
13 Impacts are expected to be negligible during refurbishment because best
14 management practices are expected to be employed to control soil erosion and
15 spills.
- 16 • Impacts of refurbishment on surface water use. Based on information in the GEIS, the
17 Commission found the following:
18 Water use during refurbishment will not increase appreciably or will be reduced
19 during plant outage.

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- 1 • Impacts of refurbishment on aquatic biota. Based on information in the GEIS, the
2 Commission found the following:
3 During plant shutdown and refurbishment there will be negligible effects on
4 aquatic biota because of a reduction of entrainment and impingement of
5 organisms or a reduced release of chemicals.
- 6 • Impacts of refurbishment on ground water use and quality. Based on information in the
7 GEIS, the Commission found the following:
8 Extensive dewatering during the original construction on some sites will not be
9 repeated during refurbishment on any sites. Any plant wastes produced during
10 refurbishment will be handled in the same manner as in current operating
11 practices and are not expected to be a problem during the license renewal term.
- 12 • Impacts of refurbishment on onsite land use. Based on information in the GEIS, the
13 Commission found the following:
14 Projected onsite land use changes required during refurbishment and the
15 renewal period would be a small fraction of any nuclear power plant site and
16 would involve land that is controlled by the applicant.
- 17 • Radiation exposures to the public during refurbishment. Based on information in the
18 GEIS, the Commission found the following:
19 During refurbishment, the gaseous effluents would result in doses that are similar
20 to those from current operation. Applicable regulatory dose limits to the public
21 are not expected to be exceeded.
- 22 • Occupational radiation exposures during refurbishment. Based on information in the
23 GEIS, the Commission found the following:
24 Occupational doses from refurbishment are expected to be within the range of
25 annual average collective doses experienced for pressurized-water reactors and
26 boiling-water reactors. Occupational mortality risks from all causes including
27 radiation is in the mid-range for industrial settings.
- 28 • Public services: public safety, social services, and tourism and recreation. Based on
29 information in the GEIS, the Commission found the following:
30 Impacts to public safety, social services, and tourism and recreation are
31 expected to be of small significance at all sites.
- 32 • Aesthetic impacts (refurbishment). Based on information in the GEIS, the Commission
33 found the following:
34 No significant impacts are expected during refurbishment.

35 The NRC staff identified no new and significant information related to these issues during its
36 review of the Entergy ER, during the SEIS scoping process, in correspondence identified in
37 Section 3.1 of this chapter, or in Entergy's May 14, 2008, RAI response (Entergy 2008b).
38 Therefore, the NRC staff expects that there would be no impacts during the renewal term

beyond those discussed in the GEIS.

Environmental issues related to refurbishment considered in the GEIS for which these conclusions could not be reached for all plants, or for specific classes of plants, are Category 2 issues. These are listed in Table 3-2.

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
Terrestrial Resources		
Refurbishment impacts	3.6	E
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	3.9	E
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
Socioeconomics		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed ^(a)	Not addressed ^(a)
^(a) Environmental justice is not addressed in the GEIS because Executive Order 12898 issued on February 11, 1994, and implementation guidance were not available prior to completion of the GEIS. Table B-1 of Appendix B, Part A of 10 CFR Part 51 indicates that this issue will be addressed in site specific reviews. The NRC staff groups Environmental Justice with Category 2 issues because the NRC staff addresses it in site specific reviews along with Category 2 issues.		

The results of the review for each Category 2 refurbishment issue are provided in the following sections.

3.1.1 Terrestrial Ecology—Refurbishment Impacts

Refurbishment impacts on terrestrial ecology are a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that “Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific

Environmental Impacts of Refurbishment

proposal is presented with the license renewal application.”

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. Entergy indicated, however, that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3. Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units. Because Entergy plans to conduct all of these activities on previously disturbed land within a relatively short period of finite duration, the level of impact on terrestrial natural resources is expected to be SMALL.

Mitigation measures would include routine land and vegetation management practices, as well as using the most disturbed areas possible for new buildings and staging areas. The NRC staff did not identify any cost-benefit studies associated with these measures.

3.1.2 Threatened or Endangered Species—Refurbishment Impacts

Refurbishment impacts on threatened or endangered species are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

Generally, plant refurbishment and continued operation are not expected to adversely affect threatened and endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected.

The NRC staff identified three federally listed terrestrial species—bog turtle, *Clemmys muhlenbergii*; New England cottontail, *Sylvilagus transitionalis*; and Indiana bat, *Myotis sodalist*—and one aquatic species—shortnose sturgeon, *Acipenser brevirostrum*—potentially affected by the relicensing of Indian Point. As explained above under Section 3.1.1, Entergy plans to conduct all terrestrial refurbishment activities on previously disturbed land within a relatively short period of finite duration. Entergy does not plan to conduct these activities on undisturbed land, and no designated critical habitat occurs on the site (Entergy 2008b). As a result, the NRC staff finds that refurbishment activities are not likely to adversely affect the continued existence of listed terrestrial species or adversely modify designated critical habitats.

Based on analyses presented in Section 4.6.1, shortnose sturgeon eggs and larvae probably do not occur, or occur only rarely, in the vicinity of Indian Point. Juvenile and adult shortnose sturgeon do occur in the vicinity of Indian Point. For refurbishment, the replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). Entergy does not have plans to dredge to accommodate the barge at its dock and is not planning any other activities that would adversely affect aquatic species or habitats. Also, any onsite activities will have to follow existing regulations to control runoff from construction or industrial sites. Because no activities are planned that would

adversely affect the aquatic environment, refurbishment activities are not likely to adversely affect the continued existence of endangered shortnose sturgeon.

Essential fish habitat, as defined under the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, occurs in the vicinity of IP2 and IP3 for red hake (*Urophycis chuss*) larvae, winter flounder (*Pleuronectes americanus*) larvae, windowpane (*Scophthalmus aquosus*) juveniles and adults, and Atlantic butterfish (*Peprilus triacanthus*) juveniles and adults. Because Entergy plans no refurbishment activities that would adversely affect the aquatic environment, there should be no adverse individual or cumulative effects on essential fish habitat in the project area.

3.1.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

Air quality during refurbishment (nonattainment and maintenance areas) is a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage.

The May 14, 2008, RAI response from Entergy indicates that the replacement of reactor vessel heads and CRDMs for IP2 and IP3 will result in minor impacts to air quality. Citing the GEIS, Entergy states that the only potential sources of impacts to air quality would be (1) fugitive dust from site excavation and grading for construction of any new waste storage facilities and (2) emissions from motorized equipment and workers' vehicles.

Entergy indicates that the bulk of air quality impacts during the postulated refurbishment activity would result from exhaust emissions released by onsite motorized equipment and workers' vehicles (Entergy 2008b). These effects include temporary increases in atmospheric concentrations of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO₂), volatile organic compounds (VOC), ammonia, and particulate matter (PM).

A table summarizing the attainment status of the counties within the immediate area of IP2 and IP3 shows nonattainment of the National Ambient Air Quality Standards (NAAQS) for 8-hour ozone in Dutchess, Orange, Putnam, Rockland, and Westchester Counties. There is nonattainment of the NAAQS for PM_{2.5} in Orange, Rockland, and Westchester Counties. Westchester County is designated as a maintenance county for CO.

Based on a conservative assumption that 400 additional vehicles would travel to and from the site each day during a 65-day outage period (conservative because Entergy projects that only 300 additional workers over 60 days could accomplish the replacement activities), Entergy estimated that air emissions of VOCs, CO, and NO_x would increase by 0.95 tons (0.86 metric tons (MT)), 16.1 tons (14.6 MT), and 1.02 tons (0.925 MT), respectively (Entergy 2008b). The regulatory conformity thresholds for VOCs, CO, and NO_x are 50 tons (45 MT), 100 tons (90.7 MT), and 50 tons (45 MT), respectively, as indicated in 40 CFR Part 51.853(b). A comparison of Entergy's conservative estimates for vehicle emissions versus the associated regulatory conformity levels indicates that none of the thresholds would be exceeded. Based on

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1 this analysis, the NRC staff finds that air quality impacts during the postulated reactor vessel
2 head and CRDM replacement would be SMALL.

3 The NRC staff identified a variety of measures that could mitigate potential air quality impacts
4 resulting from the vessel head and CRDM replacements at IP2 and IP3. These include the use
5 of multiperson vans and carpooling policies to reduce the number of vehicles used to transport
6 workers to the site. The NRC staff did not identify any cost-benefit studies applicable to these
7 mitigation measures.

8 **3.1.4 Housing Impacts—Refurbishment**

9 Housing impacts during refurbishment are a Category 2 issue. Table B-1 of Appendix B to
10 10 CFR Part 51, Subpart A, notes the following:

11 Housing impacts are expected to be of small significance at plants located in a
12 medium or high population area and not in an area where growth control
13 measures that limit housing development are in effect. Moderate or large
14 housing impacts of the workforce associated with refurbishment may be
15 associated with plants located in sparsely populated areas or in areas with
16 growth control measures that limit housing development.

17 Entergy estimates that reactor vessel head and CRDM replacement would increase the number
18 of refueling outage workers at the Indian Point site for up to 60 days during two separate
19 refueling outages, one for each unit, 12 months apart. Approximately 250 workers would be
20 needed for each replacement in addition to the normal number of refueling outage workers. An
21 additional 50 workers would construct a storage structure for the old reactor vessel heads and
22 CRDMs. This work would be completed before the beginning of the refueling outage (Entergy
23 2008b).

24 The number of additional workers would cause a short-term increase in the demand for
25 temporary (rental) housing units in the region beyond what is normally experienced during a
26 refueling outage at the Indian Point site. Since IP2 and IP3 are located in a high-population
27 area (see Section 2.2.8.5) and the number of available housing units has either kept pace with
28 or exceeded changes in county populations (see Section 2.2.8.1), any changes in employment
29 would have no noticeable effect on the availability of housing in the socioeconomic region of
30 influence. Because of the short duration of the replacement activity for each unit's reactor
31 vessel head and CRDMs and the availability of housing in the region, employment-related
32 housing impacts would have no noticeable impact.

33 **3.1.5 Public Services: Public Utilities—Refurbishment**

34 Public utilities is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51,
35 Subpart A, notes that "[a]n increased problem with water shortages at some sites may lead to
36 impacts of moderate significance on public water supply availability."

37 Since there is no water shortage in the region and public water systems located in Dutchess,
38 Orange, and Putnam Counties have excess capacity (indicated in Table 2-9 in Chapter 2), any
39 changes in the Indian Point site and employee public water usage would have little noticeable
40 effect on public water supply availability in these counties. As discussed in Section 2.2.8.2, the

Indian Point site acquires potable water from the Village of Buchanan water supply system, and there are no restrictions on the supply of potable water from the village.

As discussed in Section 3.1.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). The additional number of refueling outage workers needed to replace the reactor vessel heads and CRDMs would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of the Indian Point site. Since the region has excess water supply capacity with no restrictions, these activities would create no impacts.

3.1.6 Public Services: Education—Refurbishment

Education is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that “[m]ost sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors.”

As discussed in Section 3.1.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers for up to 60 days at the Indian Point site (Entergy 2008b). Because of the short duration of the replacement activity for each unit’s reactor vessel head and CRDMs, workers would not be expected to bring families and school-age children with them; therefore, there would be no impact on educational services during this extended refueling outage.

3.1.7 Offsite Land Use—Refurbishment

Offsite land use is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that “Impacts may be of moderate significance at plants in low population areas.”

Since IP2 and IP3 are located in a high-population area, any changes in employment would have little noticeable effect on land use in the region. Because of the short duration of the replacement activity for each unit’s reactor vessel head and CRDMs, the additional number of refueling outage workers would not cause any permanent changes in population and tax-revenue-related land use in the immediate vicinity of IP2 and IP3.

3.1.8 Public Services: Transportation—Refurbishment

Transportation is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

The additional number of refueling outage workers and truck material deliveries needed to

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support the replacement of each reactor vessel head and CRDM would cause short-term level-of-service impacts on access roads in the immediate vicinity of the Indian Point site. According to Entergy, increased traffic volumes entering and leaving the Indian Point site during refueling outages, which occur at intervals of approximately 12 months for one unit or the other, have not degraded the level-of-service capacity on local roads, and the higher number of refueling outage workers during IP2 and IP3 steam generator replacement outages did not require any road improvements (Entergy 2008b). During routine periods of high traffic volume (i.e., morning and afternoon shift changes), Entergy has previously employed staggered shifts (starting and quitting times) during refueling outages to minimize level-of-service impacts on State Routes 9 and 9A (Entergy 2008b). Based on this information and because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs (up to 60 days), and given that the activity occurs at the same time as a normal refueling outage, the NRC staff finds that no transportation (level-of-service) impacts, beyond impacts from normal outages, would occur.

3.1.9 Historic and Archeological Resources—Refurbishment

Historic and archeological resources is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. However, Entergy indicated that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). Should Entergy replace the vessel heads and CRDMs, ground-disturbing activities would be reviewed in accordance with Entergy Nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed and that existing or potentially existing cultural resources are adequately protected (Enercon 2006). The procedures have been reviewed by the New York State Historic Preservation Office (NY SHPO). According to Entergy, the area of construction would be in an area that requires no prior consultation for historic, cultural, or archeological resources (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3.

Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units.

The impacts associated with this activity are not expected to adversely impact historic or archeological sites in the area of IP2 and IP3. Therefore, the potential impacts from this activity on National Register-eligible historic or archeological resources would be SMALL. However, should archeological resources be encountered during construction, work would cease until

Entergy environmental personnel would perform an evaluation and consider possible mitigation measures through consultation with the NY SHPO.

3.1.10 Environmental Justice—Refurbishment

Environmental justice is a plant-specific refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that “[t]he need for and the content of an analysis of environmental justice will be addressed in plant specific reviews.”

Since IP2 and IP3 are located in a high-population area, the small, short duration change in employment associated with the potential replacement activities would likely have no noticeable effect on minority and/or low-income populations in the region. Because of the short duration of the replacement activity for each unit’s reactor vessel head and CRDMs, and based on the analysis of impacts for the other resource areas discussed in Section 3.1, there would be no disproportionately high and adverse impacts to minority and low-income populations in the immediate vicinity of IP2 and IP3.

3.2 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment

Entergy, in its May 14, 2008, RAI response (Entergy 2008b), indicated that it had reviewed the findings included in Chapter 3 of the GEIS and identified no new and significant information that would invalidate the findings made in the GEIS. Further, the NRC staff has reviewed Entergy’s response, has evaluated the likely impacts of the vessel head and CRDM replacement, and has not identified any new and significant information associated with these activities.

3.3 Summary of Refurbishment Impacts

The NRC staff did not identify any information that is either new or significant related to any of the applicable Category 1 issues associated with replacement activities at IP2 and IP3 during the renewal term. The NRC staff concludes that the environmental impacts associated with those issues are bounded by the impacts described in the GEIS (NRC 1996). For each of the Category 1 issues addressed in this section, the GEIS concludes that impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For all Category 2 issues related to replacement activities at IP2 and IP3, the NRC staff concluded—after reviewing guidance in the GEIS and Entergy’s description of potential activities—that replacement activities would have SMALL or no impacts. The NRC staff’s conclusions for Category 2 impact levels considered the activities’ limited scope and duration compared to the refurbishment programs identified in the GEIS.

3.4 References

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

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- 1 10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, “Requirements for
2 Renewal of Operating Licenses for Nuclear Power Plants.”
- 3 Entergy Nuclear Operations, Inc. (Entergy). 2007. “Applicant’s Environment Report, Operating
4 21 License Renewal Stage.” (Appendix E of “IP2 and IP3, Units 2 and 3, License Renewal 22
5 Application”). April 23, 2007. Agencywide Documents Access and Management System
6 (ADAMS) Accession No. ML071210530.
- 7 Entergy Nuclear Operations, Inc. (Entergy). 2008a. “Indian Point, Units 2 and 3—Reply to
8 Request for Additional Information Regarding Environmental Review for License Renewal
9 Application.” January 4, 2008. ADAMS Accession No. ML080110372.
- 10 Entergy Nuclear Operations, Inc. (Entergy). 2008b. “Indian Point Units 2 & 3, Reply to Request
11 for Additional Information Regarding License Renewal Application—Refurbishment.” May 14,
12 2008. ADAMS Accession No. ML081440052.
- 13 Kaplowitz, Michael. 2007. Letter to Pao-Tsin Kuo, “Incompleteness and Inaccurate License
14 Renewal Application for Indian Point Energy Center, Units 2 and 3.” June 27, 2007. ADAMS
15 Accession No. ML071990093.
- 16 Shapiro, Milton B. and Susan H. Shapiro. 2007. Letter to Pao-Tsin Kuo, “Comments on Scope
17 of Environmental Impact Statement and Scoping Process Indian Point Energy Center Unit 2 and
18 Unit 3.” October 24, 2007. ADAMS Accession No. ML073100985.
- 19 U.S. Nuclear Regulatory Commission. 1996. “Generic Environmental Impact Statement for
20 License Renewal of Nuclear Plants.” NUREG-1437, Volumes 1 and 2. Office of Nuclear
21 Regulatory Research, Washington, DC.
- 22 U.S. Nuclear Regulatory Commission. 1999. “Generic Environmental Impact Statement for
23 License Renewal of Nuclear Plant.” NUREG-1437, Volume 1, Addendum 1. Office of Nuclear
24 Reactor Regulation, Washington, DC.
- 25 U.S. Nuclear Regulatory Commission. 2007. “Request for Additional Information Regarding
26 Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal
27 (TAC Nos. MD5411 and MD5412).” December 5, 2007. ADAMS Accession No. ML073330931.
- 28 U.S. Nuclear Regulatory Commission. 2008a. Summary of Telephone Conference Call
29 between NRC and Entergy Nuclear Operations, Inc., Pertaining to the Indian Point Units 2 & 3,
30 License Renewal Application—Environmental Request for Additional Information. April 9, 2008.
31 ADAMS Accession No. ML080920983.
- 32 U.S. Nuclear Regulatory Commission. 2008b. “Request for Additional Information Regarding
33 the Review of the License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2
34 & 3 (TAC Nos. MD5411 and MD5412).” April 14, 2008. ADAMS Accession No. ML080940408.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

Environmental issues associated with operation of a nuclear power plant during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾ The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3). In Section 4.1 of this draft supplemental environmental impact statement (SEIS), the U.S. Nuclear Regulatory Commission (NRC) staff addresses issues applicable to the IP2 and IP3 cooling systems. In Section 4.2, the NRC staff addresses issues related to transmission lines and onsite land use. In Section 4.3, the NRC staff addresses the radiological impacts of normal operations, and in Section 4.4, the NRC staff addresses issues related to the socioeconomic impacts of normal operations during the renewal term. In Section 4.5, the NRC staff addresses issues related to ground water use and quality, while the NRC staff addresses the impacts of renewal term operations on threatened and endangered species in Section 4.6. The NRC staff addresses potential new information in Section 4.7 and addresses cumulative impacts in Section 4.8. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to IP2 and IP3 because they are related to plant design features or site characteristics not found at IP2 and IP3 are

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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listed in Appendix F to this draft SEIS.

4.1 Cooling System

Generic (Category 1) issues in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that are applicable to IP2 and IP3 cooling system operation during the renewal term are listed in Table 4-1. Entergy Nuclear Indian Point 2 and Entergy Nuclear Indian Point 3, LLC (Entergy) stated in its environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses related to cooling system operation. The NRC staff has not identified any new and significant information related to cooling system operation during its independent review of the Entergy ER, the site visit, the scoping process, or the evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the Category 1 issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, for each of these issues follows.

Table 4-1. Generic (Category 1) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	4.2.1.2.3
Eutrophication	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
Water-use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Premature emergence of aquatic insects	4.2.2.1.7
Gas supersaturation (gas bubble disease)	4.2.2.1.8

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Low dissolved oxygen in the discharge	4.2.2.1.9
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10
Stimulation of nuisance organisms	4.2.2.1.11

HUMAN HEALTH

Noise	4.3.7

1 The NRC staff reviewed information provided from the Entergy ER, the NRC staff's site visit, the
2 scoping process, the New York State Pollutant Discharge Elimination System (SPDES) permits
3 for IP2 and IP3 that expired in 1992 and the subsequent draft permit, ongoing Hudson River
4 monitoring programs and their results, and other available information. The NRC staff has not
5 identified any new and significant information for Category 1 issues applicable to the operation
6 of the IP2 and IP3 cooling system during the period of extended operation.

7 Therefore, the NRC staff concludes that there would be no impacts for these issues during the
8 renewal term beyond those discussed in the GEIS. The following bullets identify the Category 1
9 issues applicable to the operation of the IP2 and IP3 cooling system during the period of
10 extended operation and the Commission's findings as indicated in the GEIS:

- 11 • Altered current patterns at intake and discharge structures. Based on information in the
12 GEIS, the Commission found the following:

13 Altered current patterns have not been found to be a problem at operating
14 nuclear power plants and are not expected to be a problem during the license
15 renewal term.

- 16 • Temperature effects on sediment transport capacity. Based on information in the GEIS,
17 the Commission found the following:

18 These effects have not been found to be a problem at operating nuclear power
19 plants and are not expected to be a problem during the license renewal term.

- 20 • Scouring caused by discharged cooling water. Based on information in the GEIS, the
21 Commission found the following:

22 Scouring has not been found to be a problem at most operating nuclear power
23 plants and has caused only localized effects at a few plants. It is not expected to
24 be a problem during the license renewal term.

- 25 • Eutrophication. Based on information in the GEIS, the Commission found the following:

26 Eutrophication has not been found to be a problem at operating nuclear power
27 plants and is not expected to be a problem during the license renewal term.

- 28 • Discharge of chlorine or other biocides. Based on information in the GEIS, the
29 Commission found the following:

30 Effects are not a concern among regulatory and resource agencies, and are not

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expected to be a problem during the license renewal term.

- Discharge of sanitary wastes and minor chemical spills. Based on information in the GEIS, the Commission found the following:

Effects are readily controlled through the NPDES permit² and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found the following:

These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

- Water-use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission found the following:

These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.

- Accumulation of contaminants in sediments or biota. Based on information in the GEIS, the Commission found the following:

Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

- Entrainment of phytoplankton and zooplankton. Based on information in the GEIS, the Commission found the following:

Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

- Cold shock. Based on information in the GEIS, the Commission found the following:

Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.

² NPDES stands for National Pollutant Discharge Elimination System; in the case of IP2 and IP3, it is issued by the New York State Department of Environmental Conservation (NYSDEC) and the NRC staff refers to it as an SPDES throughout this draft SEIS.

- 1 • Thermal plume barrier to migrating fish. Based on information in the GEIS, the
2 Commission found the following:
3 Thermal plumes have not been found to be a problem at operating nuclear power
4 plants and are not expected to be a problem during the license renewal term.
- 5 • Distribution of aquatic organisms. Based on information in the GEIS, the Commission
6 found the following:
7 Thermal discharge may have localized effects but is not expected to affect the
8 larger geographical distribution of aquatic organisms.
- 9 • Premature emergence of aquatic insects. Based on information in the GEIS, the
10 Commission found the following:
11 Premature emergence has been found to be a localized effect at some operating
12 nuclear power plants but has not been a problem and is not expected to be a
13 problem during the license renewal term.
- 14 • Gas supersaturation (gas bubble disease). Based on information in the GEIS, the
15 Commission found the following:
16 Gas supersaturation was a concern at a small number of operating nuclear
17 power plants with once-through cooling systems but has been satisfactorily
18 mitigated. It has not been found to be a problem at operating nuclear power
19 plants with cooling towers or cooling ponds and is not expected to be a problem
20 during the license renewal term.
- 21 • Low dissolved oxygen in the discharge. Based on information in the GEIS, the
22 Commission found the following:
23 Low dissolved oxygen has been a concern at one nuclear power plant with a
24 once-through cooling system but has been effectively mitigated. It has not been
25 found to be a problem at operating nuclear power plants with cooling towers or
26 cooling ponds and is not expected to be a problem during the license renewal
27 term.
- 28 • Losses from predation, parasitism, and disease among organisms exposed to sublethal
29 stresses. Based on information in the GEIS, the Commission found the following:
30 These types of losses have not been found to be a problem at operating nuclear
31 power plants and are not expected to be a problem during the license renewal
32 term.
- 33 • Stimulation of nuisance organisms. Based on information in the GEIS, the Commission
34 found the following:
35 Stimulation of nuisance organisms has been satisfactorily mitigated at the single
36 nuclear power plant with a once-through cooling system where previously it was
37 a problem. It has not been found to be a problem at operating nuclear power

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plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

- Noise. Based on information in the GEIS, the Commission found the following:

Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.

The NRC staff identified no new and significant information related to these issues during its independent review (including information provided from the Entergy ER, the NRC staff's site audit, the scoping process, the SPDES permits for IP2 and IP3 that expired in 1992 and the subsequent draft permit, ongoing Hudson River monitoring programs and their results, and other available information). Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The Category 2 issues (issues that the NRC staff must address in a site-specific review based on the framework established in the GEIS) related to cooling system operation during the renewal term that are applicable to IP2 and IP3 are discussed in the sections that follow and are listed in Table 4-2.

Table 4-2. Site-Specific (Category 2) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(a)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early lifestages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4

For power plants with once-through cooling systems, the NRC considers the impingement and entrainment of fish and shellfish and thermal impacts from nuclear power plant cooling systems to be site-specific (Category 2) issues for license renewal. The NRC staff reviewed the applicant's ER (Entergy 2007a), visited the plant site, and reviewed the applicant's draft SPDES permit, fact sheets describing it, and the NYSDEC permit renewal process (NYSDEC 2003b). The NRC staff also reviewed relevant scientific publications, technical articles, and compilations associated with the study area, as well as documents and technical reports from NYSDEC, the National Marine Fisheries Service (NMFS), and other sources.

The SPDES permit for the Indian Point site, which addressed discharge from the currently operating IP2 and IP3, as well as the shutdown IP1 unit, expired in 1992 but has been administratively extended by NYSDEC. The NYSDEC proposed new SPDES permit for the site, currently in draft form, is in adjudication.

Section 316(b) of the Clean Water Act of 1997 (CWA) (Title 33, Section 1326, of the United States Code (33 USC 1326)) requires that the location, design, construction, and capacity of

cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In the fact sheet for the site's draft SPDES permit, NYSDEC states that it has determined that the site-specific best technology available to minimize the adverse environmental impacts of the IP Units 1, 2, and 3 cooling water intake structures is closed-cycle cooling (NYSDEC 2003b). Under the terms of the proposed SPDES permit, NYSDEC (2003b) states that it will evaluate proposals from Entergy to institute alternative methods to avoid adverse environmental impacts. Given NYSDEC's statements in the proposed SPDES permit, the NRC staff decided to consider the environmental impacts that may occur if Entergy institutes closed-cycle cooling at IP2 and IP3—as well as the environmental impacts of a possible alternative method of reducing impacts to aquatic life—in Chapter 8 of this SEIS. In the following sections, the NRC staff addresses impacts from the current cooling system.

Applicant Assessment

In the draft environmental impact statement (DEIS) for the SPDES permits for IP2 and IP3, Roseton, and the Bowline Point generating stations (CHGEC et al. 1999), as well as in the IP2 and IP3 ER (Entergy 2007a), the plant owner or owners (IP2 and IP3 had separate owners in 1999) acknowledged that some impinged fish survive and others die. Mortality can occur immediately or at a later time. The DEIS examined impingement effects by evaluating conditional mortality rates (CMR) and trends (through 1997) associated with population abundance for eight selected taxa representing 90 percent of those fish species collected from screens at IP2 and IP3. These included striped bass, white perch, Atlantic tomcod, American shad, bay anchovy, alewife, blueback herring, and spottail shiner. Estimates of CMR, defined as the fractional reduction in the river population abundance of the vulnerable age group caused by a single source of mortality (in this case impingement) were assumed to be the same as or lower than that which occurred in the years before installation of modified Ristroph screens and fish return systems at IP2 and IP3 in 1991. For species exhibiting low impingement mortality (e.g., striped bass, white perch, and Atlantic tomcod), future impingement effects were expected to be substantially lower than they were before installation and use of modified Ristroph screens and fish return systems.

The Hudson River electric-generating utilities (CHGEC et al. 1999) estimated the maximum expected total impingement CMR for white perch and other taxa to quantify impact to the species. In the ER, Entergy (2007a) stated that the results of in-river population studies performed from 1974 to 1997 did not show any negative trend in overall aquatic river species populations attributable to plant operations. The ER also stated that ongoing population studies continued to support these conclusions. Thus, the applicant asserted that impingement impacts were SMALL and did not warrant further mitigation measures. In support of this assessment, the applicant provided two reviews (Barnthouse et al. 2002, 2008) in addition to the DEIS (CHGEC et al. 1999).

Regarding entrainment, the applicant concluded that population studies performed from 1974 through 1997 have not shown any negative trend in overall aquatic populations attributable to plant operations and that current mitigation measures will ensure that entrainment impacts remain SMALL during the license renewal term. Therefore, the applicant asserted (Entergy 2007a) that continued operation of once-through cooling at the site “does not have any demonstrable negative effect on representative Hudson River fish populations nor does it warrant further mitigation measures.” Barnthouse et al. (2008) used an ecological risk assessment approach to evaluate the potential for adverse impacts to the representative

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important species (RIS) of the Hudson River from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 cooling water intake system, fishing pressure, the presence of zebra mussels, predation by striped bass, and water temperature. The authors concluded that operation of the IP2 and IP3 cooling met the NRC criteria for a SMALL impact level.

NYSDEC Assessment

Under the CWA, the U.S. Environmental Protection Agency (EPA) has delegated authority for the NPDES permit and Water Quality Certification programs in the State of New York to NYSDEC. The regulatory role of NYSDEC in the operation of the IP2 and IP3 cooling system includes protecting aquatic resources from impacts associated with impingement, entrainment, and thermal and chemical discharges through issuance of State (SPDES) permits and other means. The last SPDES permit for IP2 and IP3 expired in 1992, but its terms have been continued under provisions of the New York State Administrative Procedure Act. Regarding Section 316(b) of the CWA and New York Code, Rules and Regulations, Section 704.5 (6 NYCRR Section 704.5), NYSDEC (2003b) has determined that the site-specific best technology available to minimize the adverse environmental impact of the IP1, IP2, and IP3 cooling water intake structures is closed-cycle cooling.

In 2003, NYSDEC developed a final environmental impact statement (FEIS) (NYSDEC 2003a) in response to the DEIS submitted by the operators of IP2 and IP3, Roseton, and Bowline Point (CHGEC et al. 1999). In the FEIS, NYSDEC noted that “while the DEIS was acceptable as an initial evaluation and assessment, it was not sufficient to stand as the final document, and additional information as to alternatives and evaluation of impacts must be considered.” In responding to public comments on the DEIS (CHGEC et al. 1999), NYSDEC noted that, in contrast to the utilities’ assertions that the Hudson River fish community is healthy and robust, changes in “total species richness and diversity suggest that the Hudson estuary ecosystem is far from equilibrium.” NYSDEC points out that the approach used by the utilities assumes “selected cropping” of individual fish species while “the impacts associated with power plants are more comparable to habitat degradation; the entire natural community is impacted” because entrainment, impingement, and warming of the water simultaneously affect the entire aquatic community of organisms. Emphasizing a more ecological approach, NYSDEC detailed the importance of food webs, trophic and other interspecies relationships, and ecosystem functioning.

NYSDEC (2003a) also stated that, while the changes to the IP2 and IP3 cooling system, including the use of dual-speed and variable-flow pumps and the installation of modified Ristroph traveling screens, “represent some level of improvement compared to operations with no mitigation or protection, there are still significant unmitigated mortalities from entrainment and impingement at all three of the Hudson River Settlement Agreement (HRSA) facilities.” NYSDEC (2003a) concluded that the millions of fish killed by impingement, entrainment, and thermal effects at the HRSA power plants represent a significant source of mortality and stress on the Hudson River’s fish community and must be taken into account when assessing the observed fish population declines. To help mitigate such losses, the NYSDEC (2003b) fact sheet for the SPDES permit states that “This permit does not require the construction of cooling towers unless: (1) the applicant seeks to renew its NRC operating licenses, (2) the NRC approves extension of the licenses, and determines that the installation and operation of closed-cycle cooling is feasible and safe, and (3) all other necessary Federal approvals are obtained.”

Furthermore, NYSDEC states that if the NRC grants extensions of the operating licenses, Indian Point would have to submit for NYSDEC approval a revised construction schedule for closed-cycle cooling.

NYSDEC, in Section 1, "Biological Effects," of Attachment B to the 2003 SPDES fact sheet (NYSDEC 2003b), states that operation of IP2 and IP3 results in the mortality of more than a billion fish of various lifestages per year and that losses are distributed primarily among seven species, including bay anchovy, striped bass, white perch, blueback herring, Atlantic tomcod, alewife, and American shad. Of these, NYSDEC indicates that the populations of Atlantic tomcod, American shad, and white perch are known to be declining in the Hudson River and considers current losses to be substantial.

Studies have also been conducted to detect trends of fish populations in the Hudson River. Both the applicant and NYSDEC have used the results of these studies to assess the potential for adverse effects associated with the operation of the IP2 and IP3 cooling system. The results of these assessments are described below. Some nongovernmental organizations (NGOs) and citizens have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the Hudson River are in decline and that the entrainment and impingement of all lifestages of fish and shellfish at IP2 and IP3 is contributing to the decline of these important aquatic resources.

NRC Assessment

Because the proposed SPDES permit (which includes NYSDEC's 316(b) determination regarding the cooling water intake structure) is still in draft stage and subject to ongoing adjudication, the NRC staff conducted an independent impact analysis for the purpose of addressing the Category 2 issues identified in Table 4-2 of this draft SEIS. The operation of the IP2 and IP3 cooling system can directly affect the aquatic communities of the Hudson River through impingement, entrainment, and thermal releases. Evaluating the potential for adverse impacts of the cooling system to the aquatic resources of the Hudson River estuary presents a significant challenge for three primary reasons:

- (1) The potential stressor of interest (the IP2 and IP3 cooling system) occupies a fixed position on the Hudson River, while many of the RIS that the NRC staff have chosen for evaluation have the freedom to move up- and down-river during different stages in their growth and development, during different seasons of the year, and, in some cases, at different times of day.
- (2) The Hudson River estuary is a dynamic, open-ended system containing a complex food web that extends from the freshwater portion of the river downstream of the Troy Dam to the Atlantic Ocean. Detectable changes in RIS populations may be influenced by natural stressors or may be the result of stressors associated with human activities, which include the operation of IP2 and IP3.
- (3) Because the Hudson River estuary represents a complex system with hundreds of aquatic species, the NRC staff chose to focus its analysis of impact on a subset of RIS historically used to monitor the lower Hudson River (as indicated in Section 2.2.5.4 of this SEIS). By focusing on a subset of species that are representative of many of the species that exist in the lower Hudson River fish community, the NRC staff can more-easily analyze impacts to the Hudson River community, and the NRC staff can make use of a large body of sampling data compiled over many years. The NRC staff

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acknowledges that the simplification inherent in relying on RIS may introduce some additional uncertainty, but the NRC staff finds that the utility of the RIS approach (due to the availability of large, long-term data sets; applicability to species with similar characteristics; and comparability to other Hudson River studies) in evaluating communitywide effects outweighs the uncertainties associated with using it.

Because impingement and entrainment are fundamentally linked, the NRC staff determined that the effects of each should be assessed using an integrated approach, described in Section 4.1.3 of this draft SEIS. The NRC staff assessed thermal impacts separately in Section 4.1.4. Because the analysis of the environmental impacts associated with the IP2 and IP3 cooling system is complex, the NRC staff provides summary results, analyses, and conclusions in this chapter, and provides a complete discussion of the environmental impact assessment in Appendix H, with supporting statistical analyses in Appendix I to this draft SEIS.

4.1.1 Impingement of Fish and Shellfish

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to a slower death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. In this section, the NRC staff provides a summary assessment of impingement impacts based on NRC staff analyses of available data. More detail appears in Appendix H.

Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their contractors between 1975 and 1990 using a variety of techniques. (A complete description of the impingement monitoring studies conducted at IP2 and IP3 appears in Appendix H to this draft SEIS.) The NRC staff assessment for the effects of cooling water system operation concentrated on 18 RIS identified in Section 2.2.5.4, which include the 17 species identified in the Hudson River utilities' DEIS (CHGEC et al. 1999) for assessing power plant effects plus the Atlantic menhaden (*Brevoortia tyrannus*), a member of the herring family whose young are common inhabitants of the lower Hudson River. All but one RIS are fish; the exception is the blue crab (*Callinectes sapidus*). The estimated number of impinged RIS made up greater than 90 percent of all impinged taxa for all but 1 year at IP2 (Figure 4-1); at IP3, the estimated number of RIS impinged was greater than 85 percent for all but 1 year (Figure 4-2). To assess impingement impacts, the NRC staff analyzed weekly estimated impingement numbers at IP2 and IP3 from January 1975 to November 1980 and seasonally estimated impingement numbers from January 1981 to December 1990. (The former plant owners and their contractors based estimated numbers on sampling data.) The combined numbers of young of the year (YOY), yearling, and older fish were used for analysis since these data were available for all years of sampling.

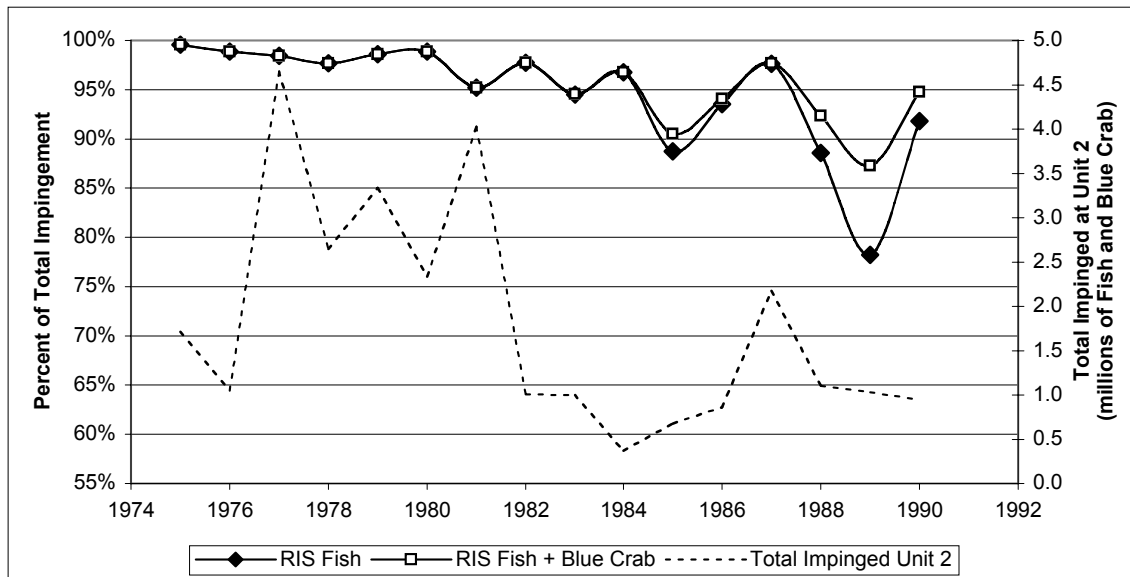


Figure 4-1. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP2 (data from Entergy 2007b)

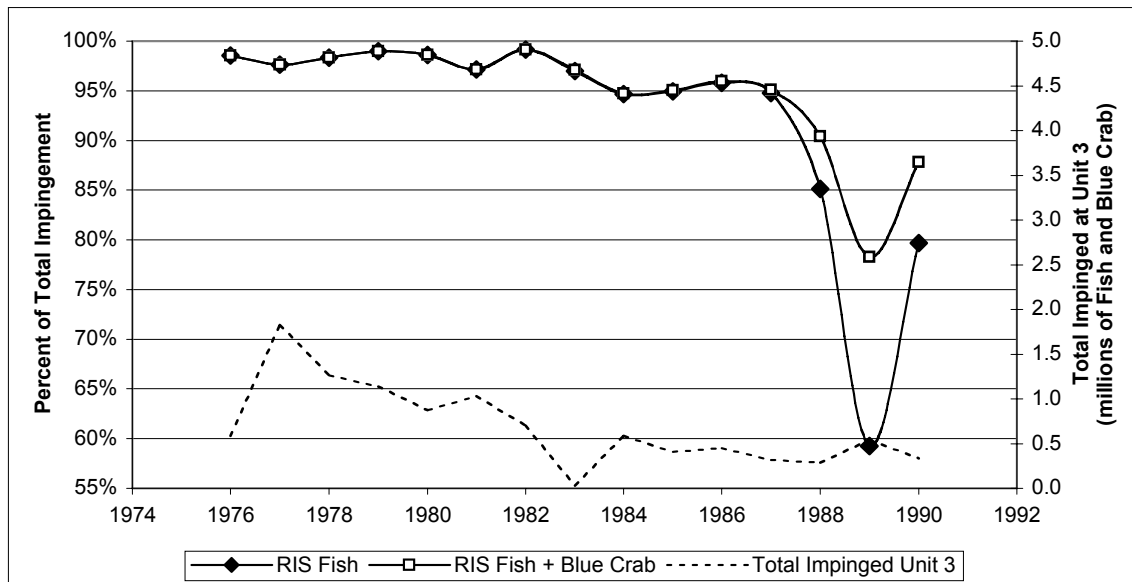


Figure 4-2. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP3 (data from Entergy 2007b)

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Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab impinged tended to decrease between 1977 and 1982, then generally leveled off between 1982 and 1990 (as show in Figures 4-1 and 4-2). If the IP2 and IP3 cooling systems are considered a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in days of operation and volume of water circulated at IP2 and IP3 from 1975 to 1990), then the decrease in the percent of RIS impinged and total impingement would suggest that RIS and all other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively constant lower level between 1984 and 1990. This decline will be explored further in Section 4.1.3 of this draft SEIS.

In addition to evaluating trends in impingement losses, the NRC staff also reviewed the results of studies designed to evaluate impingement mortality. Before installation of modified Ristroph screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species (see Appendix H for additional detail). The final design of the screens (Version 2), as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the existing (original) system in place at IP2 and IP3. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad (Table 4-3). The plant owners did not monitor impingement rates or validate impingement mortality estimates after the new Ristroph screens were installed at IP2 and IP3 in 1991.

Table 4-3. Assumed Cumulative Mortality and Injury of Selected Fish Species after Impingement on Ristroph Screens

Species	Percent Dead and Injured
Alewife	62
American Shad	35
Atlantic Tomcod	17
Bay Anchovy	23
Blueback Herring	26
Hogchoker	13
Striped Bass	9
Weakfish	12
White Catfish	40
White Perch	14

Source: Fletcher 1990

Based on Fletcher's assessment, the NRC staff concludes that the IP2 and IP3 cooling system continues to impinge RIS of the lower Hudson River and that impingement mortality for several species exceeds 25 percent. Monitoring data (Entergy 2007b, reviewed by NRC staff) also suggest that impingement is greater at IP2 than at IP3 and that impingement has generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph screens and fish

return systems to increase the survival rates of impinged organisms, the actual improvements in fish survival after installation of these systems at IP2 and IP3 have not been established (impingement monitoring last occurred in 1990). In Section 4.1.3 of this draft SEIS, the NRC staff includes impingement results in a weight-of-evidence (WOE) analysis to evaluate the overall impacts of the IP2 and IP3 cooling system on lower Hudson River RIS.

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals and primarily affects organisms with limited swimming ability that can pass through the screen mesh, which is typically 0.25 to 0.5 inch (in.) (6.35 to 12.7 millimeters (mm)), used on the intake systems. Organisms typically entrained include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish and invertebrates.

Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system (see Appendix H for a more-detailed discussion). Despite increasingly refined study techniques, entrainment survival estimates were compromised by poor ichthyoplankton survival in control samples, and entrainment survival for many species is still unresolved. The variability of entrainment data informed the NRC staff's decision to employ a WOE approach.

To assess the effects of entrainment on the aquatic resources of the lower Hudson River, the NRC staff evaluated weekly average densities of entrained taxa for a given lifestage for IP2 and IP3 that were provided by the applicant. The NRC staff then multiplied the sum of the mean densities of all lifestages by the volume of circulated water to estimate the mean number entrained per taxa and season.

The NRC staff found that a total of 66 taxa were identified during entrainment monitoring in data supplied by Entergy (2007b). There were no blue crabs, shortnose or Atlantic sturgeon, or gizzard shad identified in the 1981–1987 entrainment data. Because of the difficulty in identification of early lifestages, RIS included those taxa that were identified only to family or genus (e.g., herring family, anchovy family, *Alosa* spp., and *Morone* spp.). The percent RIS fish entrained and the total entrainment are presented in Figure 4-3. Except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were recorded,

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RIS represented at least 90 percent of all entrainment. The total number of identified fish entrained has decreased at a rate of 1.6 billion fish per year since 1984. This result is consistent with the decrease observed in the number of fish impinged (Figures 4-1 and 4-2).

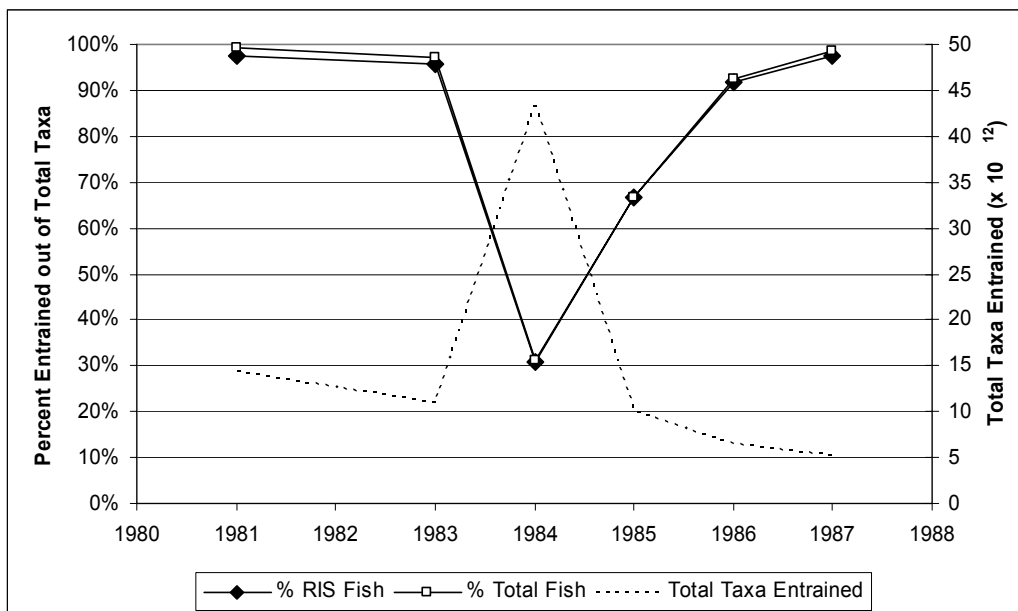


Figure 4-3. Percentage of entrainment comprised of RIS fish and total fish in relation to the total estimated entrainment at IP2 and IP3 combined (data from Entergy 2007b)

4.1.3 Combined Effects of Impingement and Entrainment

The NRC staff employed a modified WOE approach to evaluate whether the impingement and entrainment that occurs during the operation of the IP2 and IP3 cooling system has the potential to adversely affect RIS in the lower Hudson River. The term “weight of evidence” has many meanings, but it is defined by the NRC staff in this draft SEIS as an organized process for evaluating information or data from multiple sources to determine whether there is evidence to suggest that an existing or future environmental action has the potential to result in an adverse impact. The NRC staff employs a WOE approach adapted from the process described in Menzie et al. (1996). The overall approach is represented in Figure 4-4 and presented in detail in Appendix H to this draft SEIS; specific steps in the process are defined below.

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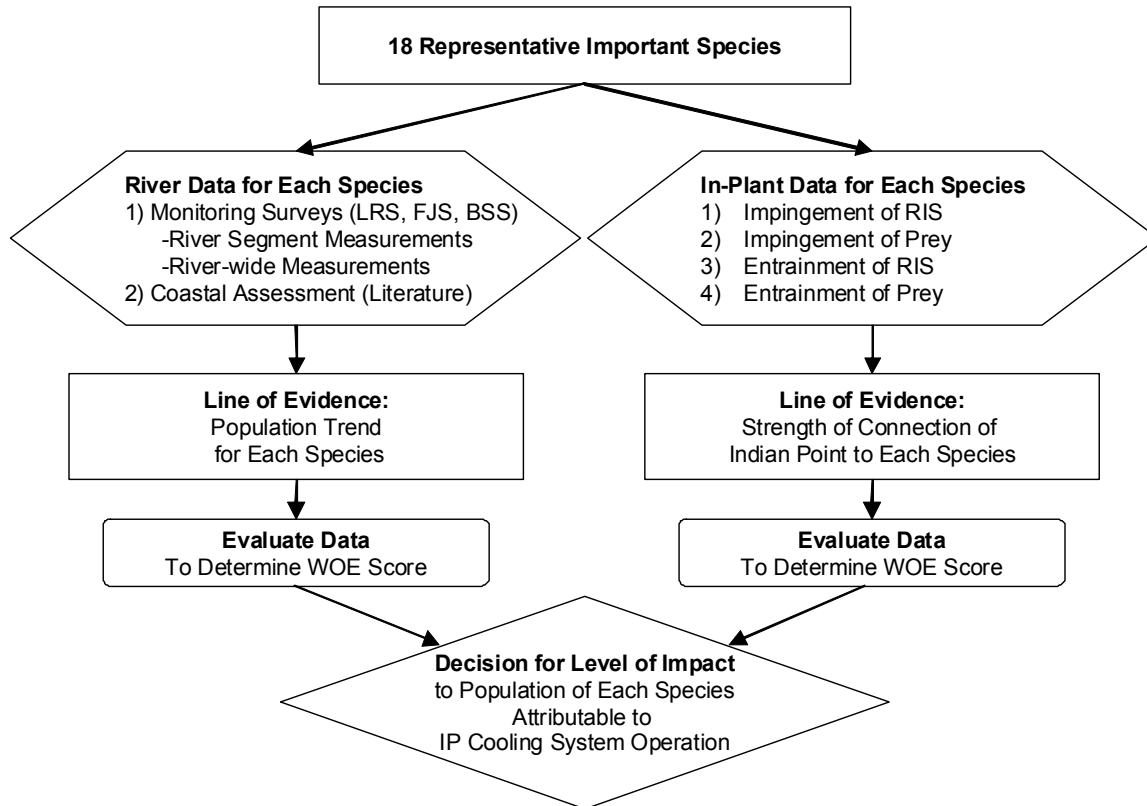


Figure 4-4. General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation

Step 1: Identify the Environmental Component or Value To Be Protected

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4. These species represent a variety of feeding strategies and food web classifications and are ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to young-of-the-year and yearling fish and their food sources. The long-term sampling programs of the Hudson River, on which this analysis is based, focused on these early lifestages. Although eggs and larval forms are important components to the food web, the natural mortality to these lifestages is high. In contrast, fish surviving to the YOY stage and older are more likely to add to the adult breeding population and are at greater risk from the cooling system operation. Any factor that decreases (or increases) the survival of those fish during juvenile and yearling stages can affect the sustainability of the population.

Step 2: Identify Lines of Evidence and Quantifiable Measurements

The goal of this step is to identify data sets and information that can be used to assess the potential for adverse environmental effects and evaluate whether the IP2 and IP3 cooling system is contributing to the effect. The NRC staff developed two primary lines of evidence (LOE) to evaluate impacts. The first LOE included measurements of RIS population trends in the lower Hudson River and coastal areas to assess whether populations were increasing, decreasing, or stable; the second LOE addressed how much influence the operation of the IP2

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and IP3 cooling systems had on the RIS populations in the lower Hudson River (i.e., the strength of connection between IP2 and IP3 and the aquatic environment). The NRC staff used impingement and entrainment monitoring data obtained from the IP2 and IP3 facility; data from the lower Hudson River collected during the Long River Survey (LRS), Fall Juvenile/Fall Shoals Survey (FJS/FSS), and Beach Seine Survey (BSS), as described in Table 2-3 in the main text; and coastal fishery trend data, when available. A summary of measurements associated with each LOE is presented in Appendix H to this draft SEIS.

Step 3: Quantify the Use and Utility of Each Measurement

The following attributes of each measurement within each LOE were assigned an ordinal score corresponding to a ranking of its use and utility of low, medium, or high:

- Strength of Association: The extent to which the measurement is representative of, correlated with, or applicable to the RIS.
- Stressor-specificity: The extent to which the measurement is associated with a specific stressor or the extent to which the data used in the assessment relate to the stressor of interest.
- Site-specificity: The extent to which data used in the assessment relate to the site of interest.
- Sensitivity of the Measurement: The ability of the measurement to detect a response.
- Spatial Representativeness: The degree of compatibility between the study area and the location of measurements, known stressors, and biological receptors.
- Temporal Representativeness: The degree of compatibility between the measurement and the time period during which effects are expected to occur.
- Correlation of Stressor to Response: The degree of correlation between the levels of exposure to a stressor and levels of response observed in the measurement.

The NRC staff then calculated overall use and utility scores for each measurement within each LOE as the average of the individual attribute numbers. Scores for each LOE are available in Appendix H, Section H.3.

Step 4: Develop Quantifiable Decision Rules for Interpreting the Results of Each Measurement

Decision rules are used to assign a level of potential impact based on an analysis of the data. In support of the first LOE, the NRC staff developed decision rules that described a small, moderate, and large potential for adverse impact. Because the development and use of these rules is complex, a general definition of a small, moderate, and large potential for adverse impact is presented below. A detailed discussion of how the decision rules were developed and used in the environmental assessment is presented in Appendices H and I to this draft SEIS.

- A small potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population had remained stable over time and that the observed population levels were generally within the range of expected natural variability.

- A moderate potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population was declining over time, OR that many of the observed population levels were outside the range of expected natural variability.
- A large potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that the population was declining over time, AND that many of the observed population levels were outside the range of expected natural variability.

These decision rules were applied to each RIS species if sufficient data were available to support a determination. If sufficient data were not available, the NRC staff called the level of impact "unknown."

In support of the second LOE, which evaluated the strength of connection between the operation of the IP2 and IP3 cooling system and the RIS in the lower Hudson River, the NRC staff developed decision rules to assess whether the proportion of RIS present in impingement and entrainment samples obtained from IP2 and IP3 were similar to the proportions observed from the environmental sampling conducted in the lower Hudson River (e.g., the LRS, FJS/FSS, and BSS studies). The general definitions for each rule are presented below; a detailed discussion of decision rule development and use to assess strength of connection is presented in Appendices H and I to this draft SEIS.

- A low strength of connection was present if the proportional representation of a given RIS in the cooling system (entrainment and impingement samples) was less than the proportional representation obtained from the fishery studies, suggesting the RIS is underrepresented in the cooling system samples compared to the fishery studies.
- A medium strength of connection was present if the proportional representation of a given RIS in the cooling system samples was equal to the proportional representation observed in the fishery studies, suggesting the cooling system sample is equally representing the Hudson River population near IP2 and IP3.
- A high strength of connection was present if the proportional representation of a given RIS in the cooling system entrainment samples was greater than the proportional representation observed in the fishery studies, suggesting the cooling system sample is overrepresenting the Hudson River population near IP2 and IP3.

These decision rules were applied to each RIS species if sufficient data were available to support the determination. As described above, numerical scores were assigned to each impact level to facilitate integration.

Step 5: Integrate the Results and Assess Impact

The process used to integrate the two LOE and associated measurements brought together the assessment of population impacts and strength of connection derived from the use of the decision rules and the overall use and utility of each measurement with regards to decisionmaking. A detailed description of the process and statistical analysis employed is presented in Appendices H and I to this draft SEIS. The final determination of impact is

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consistent with the NRC guidelines for SMALL, MODERATE, and LARGE potential for adverse impacts as defined below:

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably—but not to destabilize—any important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

What follows is the NRC staff assessment of the two LOE (population trends and strength of connection) and a determination of impact associated with impingement and entrainment at IP2 and IP3 using the above definitions.

4.1.3.1 Assessment of Population Trends—The First Line of Evidence

As described above, data from the LRS, FSS, and BSS studies of the lower Hudson River were used to assess population trends. Data from 1974 to 2005 were obtained from the applicant in electronic format. The NRC staff used an abundance index calculated by the applicant and calculated catch-per-unit-effort values where available. The NRC staff also evaluated coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish using commercial and recreational harvest statistics provided by the Atlantic States Marine Fisheries Commission (ASMFC).

To evaluate the population trend LOE, the NRC staff assessed population trends in river segment 4 (the region of the lower Hudson River encompassing IP2 and IP3), population trends in the lower Hudson River from the Troy Dam to the Battery, and the coastal trends reported by ASMFC. For each measurement, a WOE score was calculated, and a final WOE score was obtained. The results from this analysis appear in Appendix H to this draft SEIS and predict a moderate to large potential for adverse impacts for 13 of the 18 RIS. For two of these (Atlantic menhaden and Atlantic sturgeon) the moderate to large potential impact determination was based on only one LOE (coastal trends). The NRC staff predicts a small potential for adverse population-level impacts for blue crab based on only one LOE (coastal trends). The NRC staff could not reach an impact conclusion for gizzard shad because it was not a target species for the LRS, FSS, or BSS surveys. Likewise, NRC staff was unable to reach a determination of impact for the shortnose sturgeon because of a lack of available data for the YOY lifestage, the primary focus of the WOE assessment. Based on a lack of information for these species, the population trend LOE impact level could range from small to large. Population trends for year 1 and older Atlantic and shortnose sturgeon are presented in Section 4.6.1 of this draft SEIS based on electronic data provided by the applicant.

4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence

To determine whether the operation of the IP2 and IP3 cooling system had the potential to influence RIS populations near the facility or within the lower Hudson River, the NRC staff conducted strength of connection analyses. A summary of this analysis can be found in Appendix H, and detailed information on the analysis is presented in Appendix I to this draft SEIS.

The strength of connection analysis assumes the IP2 and IP3 cooling system can affect aquatic resources directly through impingement or entrainment, or indirectly by impinging and entraining potential food (prey). By comparing the rank order of RIS caught in the river to the order observed in impingement and entrainment samples, it is possible to evaluate how efficient the IP2 and IP3 cooling system is at removing RIS from the river (e.g., how strongly it is connected to the RIS of interest). The results of this analysis are presented in Table 4-4 and show that a HIGH strength of connection was observed for only two species (bluefish and striped bass). For those species, the IP2 and IP3 cooling system was removing either the species or its prey at levels that were proportionally higher than what was observed in the river studies. This suggests that there is strong evidence that the operation of the cooling system is affecting these species. For the remaining RIS, the strength of connection ranged from low (minimal evidence of connection) to medium (some evidence of connection). The strength of connection was unknown for five species (Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab) because of a lack of available data. For these species, actual strength of connection could be low, medium, or high, but the lack of data makes a specific determination impossible.

4.1.3.3 Impingement and Entrainment Impact Summary

The NRC staff presents the final integration of population-level and strength-of-connection LOE in Table 4-4. This table shows the final conclusions for both LOE (i.e., population trends and strength of connection). An adverse impact from IP2 and IP3 means that the data show both a measurable response in the RIS population and clear evidence that the RIS is influenced by the operation of the IP2 and IP3 cooling system. Thus, when the strength of connection is low, it is not possible to arrive at an impact level greater than SMALL because there is little evidence that a relationship between the cooling system and RIS exists. This logic also requires that for an RIS with a HIGH strength of connection to the IP2 and IP3 cooling system operation but little evidence of population decline, the final determination must also be SMALL.

Based on the final WOE assessment (available in Appendix H, Section H.3.3), a SMALL potential for adverse impact was predicted for two species (striped bass and weakfish) because there was no evidence of a population decline even though the strength of connection was MEDIUM or HIGH. A SMALL to MODERATE impact was predicted for seven species (alewife, bay anchovy, American shad, blueback herring, spottail shiner, Atlantic tomcod, and white catfish). A MODERATE impact was predicted for rainbow smelt, and a MODERATE to LARGE impact level was predicted for the hogchoker and white perch. A LARGE potential for adverse impact was predicted for only one species, the bluefish, based on observed population declines and an apparent HIGH strength of connection to the IP2 and IP3 cooling system. An impact determination could not be made for Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab because of a lack of data for YOY lifestages, and therefore specific impacts are unknown and could range from SMALL to LARGE. The NRC staff addresses mitigation measures for these impacts in Section 4.1.5 of this draft SEIS.

The NRC staff assigns an overall impact level of SMALL to LARGE for impingement and entrainment to encompass the range of impacts for individual species. The RIS identified in this section are meant to represent the overall aquatic resource, express uncertainty from unquantifiable impact levels for some individual RIS, and reflect the complexity of the Hudson River ecosystem by encompassing a broad range of attributes, such as biological importance, commercial or recreation value, trophic position, commonness or rarity, interaction with other

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species, vulnerability to cooling system operation, and fidelity or transience in the local community. This range of impacts, then, expresses the impact to the overall aquatic community.

Table 4-4. Impingement and Entrainment Impact Summary for Hudson River RIS

Species	Population Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling System on Aquatic Resources
Alewife	Large	Low to Medium	Small to Moderate
Bay Anchovy	Moderate	Low to Medium	Small to Moderate
American Shad	Large	Low to Medium	Small to Moderate
Bluefish	Large	High	Large
Hogchoker	Large	Medium to High	Moderate to Large
Atlantic Menhaden	Moderate to Large	Unknown ^(a)	Unknown ^(b)
Blueback Herring	Large	Low to Medium	Small to Moderate
Rainbow Smelt	Large	Medium	Moderate
Shortnose Sturgeon	Unknown	Unknown ^(a)	Unknown ^(b)
Spottail Shiner	Large	Low to Medium	Small to Moderate
Atlantic Sturgeon	Large	Unknown ^(a)	Unknown ^(b)
Striped Bass	Small	High	Small
Atlantic Tomcod	Large	Low to Medium	Small to Moderate
White Catfish	Large	Low to Medium	Small to Moderate
White Perch	Large	Medium to High	Moderate to Large
Weakfish	Small	Medium to High	Small
Gizzard Shad	Unknown	Unknown ^(a)	Unknown ^(b)
Blue Crab	Small	Unknown ^(a)	Unknown ^(b)

^(a)Strength of connection could not be established using WOE, therefore strength of connection could range from LOW to HIGH.

^(b)Conclusion of impact could not be established using WOE, therefore impacts could range from SMALL to LARGE.

4.1.3.4 Discussion of Uncertainty

As part of reporting ecological risks, the EPA (1998) has recommended that practitioners review and summarize the major areas of uncertainty in their analyses. In this section, the NRC staff discusses the known uncertainties inherent with using the WOE approach.

As with any quantitative evaluation, the rigor of the analysis is dependent on the quality and source of data. The NRC staff acknowledges that the lack of studies and data on impingement and entrainment at IP2 and IP3 since 1990 and 1987, respectively, yields potential uncertainties for the staff's disposition of impingement and entrainment impacts using the WOE approach. The range and age of the data used is expected to introduce some inherent uncertainties (i.e., the current impacts, as described in Table 4-4, are inferred from impingement and entrainment data collected between 1975 and 1990). The NRC staff also notes that data collection for impingement and entrainment at Indian Point ended around the same time that the plant installed the modified Ristroph screens and fish return systems. Although it is expected that this

1 system would likely have a positive effect on impingement mortality, there have been no
2 additional data since 1990 to validate any impingement mortality estimates. More recent
3 impingement and entrainment data, that reflect the effects of these plant modifications, could
4 potentially affect the results of the Staff's WOE analysis; without such data, however, the NRC
5 staff did not quantitatively incorporate this effect into the WOE approach. Nevertheless, as
6 previously noted, the final design of the screens appeared to reduce impingement mortality for
7 some species based on a pilot study compared to the original system in place at Indian Point
8 (Fletcher 1990). The NRC staff did not include the results of this pilot study during or following
9 the application of the WOE approach. As such, the NRC staff recognizes, in Appendix H, that
10 the WOE results may potentially yield overestimates.

11 As previously noted, using the same data available to the staff with a different analytical
12 approach, and affording consideration to the plant modifications which have been made, the
13 applicant assessed impacts from impingement and entrainment as SMALL in its ER. The
14 NYSDEC, however, while acknowledging that the Ristroph screens provide some
15 improvements, expressed a continuing concern with respect to mortalities from impingement
16 and entrainment. For these impacts, the NRC staff has independently chosen the use of the
17 WOE approach to make its determination as quantitatively as possible, using available data.

18 The Massachusetts Weight-of-Evidence Workgroup (Menzie et al. 1996) discussed the value
19 and use of both quantitative and qualitative approaches in development of the weight-of-
20 evidence methodology. As recommended by the Workgroup (Menzie et al. 1996), NRC staff
21 has used professional judgment to select and refine methods before analyzing data and
22 documented all steps (see Appendices H and I) to allow interested readers to gain an
23 understanding of the assumptions and limitations associated with this assessment. The NRC
24 staff has also employed a similar methodology (Menzie et al. 1996), using other data, for
25 assessing the effects of power plant operation on fish populations in its GEIS Supplement 22,
26 regarding Millstone Power Station, Units 2 and 3 (NRC 2005).

27 In summary, the NRC staff's findings for impact from impingement and entrainment, as
28 described in Table 4-4, are subject to the potential uncertainties described above to varying
29 degrees. They also represent the NRC staff's best estimates based on the WOE derived from
30 the available data.

31 **4.1.3.5 Overall Impingement and Entrainment Impact**

32 Based on the results of the NRC staff WOE analysis for RIS and the uncertainties discussed in
33 the previous section, the NRC staff concludes that the overall impact to aquatic resources from
34 impingement and entrainment ranges from SMALL to LARGE, depending on species affected.

35 **4.1.4 Heat Shock**

36 As discussed in Chapter 2, thermal discharges associated with the operation of the once-
37 through cooling water system for IP2 and IP3 are regulated by NYSDEC. Temperature
38 limitations are established and imposed on a case-by-case basis for each facility subject to
39 6 NYCRR 704.

40 Specific conditions associated with the extent and magnitude of thermal plumes are addressed
41 in 6 NYCRR 704 as follows:

- 42 (5) Estuaries or portions of estuaries.

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(i) The water temperature at the surface of an estuary shall not be raised to more than 90 degrees Fahrenheit at any point.

(ii) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than four Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin or a maximum of 83 degrees Fahrenheit, whichever is less.

(iii) From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than 83 degrees Fahrenheit an increase in temperature not to exceed 1.5 Fahrenheit degrees at any point of the estuarine passageway as delineated above, may be permitted.

(iv) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than four Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

Thermal discharges associated with the operation of IP2 and IP3 are regulated under SPDES permit NY-0004472. This permit imposes effluent limitations, monitoring requirements, and other conditions to ensure that all discharges are in compliance with Title 8 of Article 17 of the Environmental Conservation Law (ECL) of New York State, 6 NYCRR 704, and the CWA. Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified in NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110 degrees F (43 degrees C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2 degrees F (34 degrees C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2 degrees F (34 degrees C) on more than 15 days during that period in any year.

4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota

The discharge of heated water into the Hudson River can cause lethal or sublethal effects on resident fish, influence food web characteristics and structure, and create barriers to migratory fish moving from marine to freshwater environments. The potential for harm associated with the discharge of heated water into streams, rivers, bays, and estuaries became known during the early 1960s as new power facilities were being considered or constructed, and resulted in the definition of waste heat as a pollutant in the Federal Water Pollution Control Act of 1965. Waste heat discharges can directly kill sensitive aquatic organisms if the duration and extent of the organism's exposure exceeds its upper thermal tolerance limit. Indirect effects associated with exposure to nonlethal temperatures can result in disruptions or changes to spawning behavior, accelerated or diminished growth rates of early life stages (both positive and negative), or changes in growth or survival in response to changes to food web dynamics or predator/prey interactions (CHGEC et al. 1999). Indirect effects can also occur if the presence of a thermal plume restricts or blocks a species' migratory pattern during a critical life stage, or results in

1 avoidance behavior that affects species' viability or increases the likelihood of predation.

2 Adverse thermal effects can also occur when thermal discharges are interrupted, resulting in
3 cold shock. To evaluate the nature and extent of thermal discharges, it is necessary to have an
4 understanding of the characteristics of the thermal plume when it enters the receiving water, the
5 lethal and sublethal tolerance limits for key aquatic species and lifestages of interest, and the
6 possible exposure scenarios (nature and extent). Thus, regulatory agencies tasked with
7 developing thermal discharge criteria that are protective of aquatic resources (in this case,
8 NYSDEC) generally set limits on the extent, magnitude, and duration of the thermal plume to
9 ensure it addresses potential lethal and sublethal effects associated with the temperature of
10 heated water discharged into the environment, and its characteristics when it enters receiving
11 waters.

12 **4.1.4.2 Historical Context**

13 Thermal impacts associated with the operation of IP2 and IP3, Roseton, and the Bowline Point
14 electrical generating stations have been a concern of NYSDEC, the NRC's predecessor
15 organization (the U.S. Atomic Energy Commission (USAEC)), and the NRC. In the 1972 final
16 environmental statement (FES) for the IP2 operating license (USAEC 1972), the USAEC
17 concluded that, although operation of IP2 would meet New York thermal standards for river
18 surface water temperature, there was evidence to suggest that the IP2 discharge could exceed
19 New York State standards for surface area and cross-sectional area enclosed within the
20 4 degrees Fahrenheit (F) isotherm. USAEC, in response, issued an operating license for IP2
21 with the following conditions related to potential thermal impacts:

- 22 • operation of the once-through system would be permitted until January 1, 1978, and
23 thereafter a closed-cycle system would be required;
- 24 • the applicant would perform an economic and environmental impact analysis of an
25 alternative closed-cycle system, and provide the evaluation to the USAEC by July 1,
26 1973; and
- 27 • after approval by the USAEC, the required closed-cycle cooling system would be
28 designed, built, and placed in operation no later than January 1, 1978.

29 The operating license also required the applicant to monitor dissolved oxygen in the discharge
30 water and thermal plume, and monitor the size, shape, and locations of isotherms in the thermal
31 plume (USAEC 1972). In the FES developed for the IP3 operating license, the NRC staff
32 assessed the impact of thermal discharges from once-through cooling for all units (IP1, IP2, and
33 IP3) and again concluded that, under certain conditions, the thermal discharges from the three
34 units would exceed New York State thermal criteria (NRC 1975). The NRC issued an operating
35 license to IP3 with conditions similar to those of IP2, but reflecting the decisions of the Atomic
36 Safety and Licensing Board in 1974 that required closed-cycle cooling by May 1, 1979.

37 In 1976, the former owners of IP2 and IP3 submitted an environmental report to the NRC that
38 evaluated various alternative closed-cycle cooling systems from an economic and
39 environmental standpoint. In 1978, the former owners submitted a 316(a) determination to
40 NYSDEC asserting that the facility complied with thermal standards established by New York
41 State (6 NYCRR 704). In 1980, litigation associated with the operation of electric generation
42 stations along the Hudson River resulted in the HRSA. In place of the cooling tower

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1 requirement, HRSA required a variety of mitigation measures including seasonal outages and
2 the installation of dual-speed or variable-speed pumps at IP2 and IP3. The existence of HRSA
3 also superseded the 1978 316(a) study. In support of the Fourth Amended Consent Order to
4 HRSA (NYSDEC 1997), the owners of IP2 and IP3 developed flow efficiency curves for each
5 unit that related flow to inlet temperature. For both units, flows of 500,000 gallons per minute
6 (gpm) (1900 cubic meters per minute (m^3/min)) were generally attainable during the winter
7 months (December–March when water inlet temperatures were less than 50 degrees F
8 (10 degrees Celsius (C)), with flow rates of 700,000 gpm (2650 m^3/min) required during the
9 summer months when inlet temperatures exceeded 70 degrees F (21 degrees C) (NYSDEC
10 1997, Figures B-1 and B-2). The Fourth HRSA Consent Order also developed a system of “flow
11 variation points” as a means of evaluating changes in plant operations at IP2 and IP3, Bowline
12 Point, and Roseton that offset exceedences of recommended flows with reductions at other
13 times.

14 4.1.4.3 Thermal Studies and Conclusions

15 A detailed discussion of the thermal studies conducted at IP2 and IP3 to supplement the initial
16 316(a) work performed in the late 1970s is presented in CHGEC et al. (1999). The studies
17 included thermal modeling of near-field effects using the Cornell University Mixing Zone Model
18 (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology
19 (MIT) dynamic network model (also called the far-field thermal model). For the purpose of
20 modeling, near field was defined as the region in the immediate vicinity of each station
21 discharge where cooling water occupies a clearly distinguishable, three-dimensional
22 temperature regime in the river that is not yet fully mixed; far field was defined as the region
23 farthest from the discharges where the plumes are no longer distinguishable from the river, but
24 the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to
25 simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed
26 sufficient by the utilities and their contractor and was designed and configured to account for
27 time-variable hydraulic and meteorological conditions and heat sources of artificial origins.
28 Model output included a prediction of temperature distribution for the Hudson River from the
29 Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the
30 permit applicants applied CORMIX modeling to develop a three-dimensional plume
31 configuration of near-field thermal conditions that could be compared to applicable water quality
32 criteria (CHGEC et al. 1999).

33 Former owners of IP2 and IP3 conducted thermal plume studies employing both models for time
34 scenarios that encompassed the period of June–September (CHGEC et al. 1999). These
35 months were chosen because river temperatures were expected to be at their maximum levels.
36 The former owners used environmental data from 1981 to calibrate and verify the far-field MIT
37 model and to evaluate temperature distributions in the Hudson River under a variety of power
38 plant operating conditions. They chose the summer months of 1981 because data for all
39 thermal discharges were available, and because statistical analysis of the 1981 summer
40 conditions indicated that this year represented a relatively low-flow, high-temperature summer
41 that would represent a conservative (worst-case) scenario for examining thermal effects
42 associated with power plant thermal discharges. Modeling was performed under the following
43 two power plant operating scenarios to determine if New York State thermal criteria would be
44 exceeded:

(1) Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.

(2) Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4 degrees F (2 degrees C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999).

For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86 degrees F (1.18 to 1.59 degrees C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4 degrees F (2 degrees C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24 degrees F (1.80 degrees C) during June ebb tides to 4.63 degrees F (2.57 degrees C) during flood tides in August. Temperature increases exceeded 4 degrees F (2 degrees C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4 degrees F (2 degrees C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events. These results suggest that the 4 degrees F (2 degrees C) lateral extent and cross-sectional criteria may sometimes be exceeded at IP2 and IP3. Exceedences generally occurred under scenarios that the applicants indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding,

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CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

4.1.4.4 Assessments of Thermal Impacts

In this section, the NRC staff provides a summary of the various assessments of impacts associated with thermal discharges from the IP2 and IP3 cooling system. The applicant's assessment is based primarily on statements made in the ER (Entergy 2007a). The conclusions of NYSDEC concerning the thermal impacts of the IP2 and IP3 cooling system are presented in the final impact statement associated with the SPDES permits for Roseton Units 2 and 3, Bowline Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a). The NRC staff also notes that NGOs and members of the public have expressed concern that the applicant's assessment of the effect of thermal discharges is incomplete, and that there is evidence to suggest that the existing thermal discharges do not consistently meet applicable criteria as defined in 6 NYCRR 704.2(b)(5).

Applicant's Assessment

The IP2 and IP3 ER (Entergy 2007a) discusses the potential environmental impacts of thermal discharges from IP2 and IP3. The conclusions provided in the ER acknowledge that the current owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is complying with the terms of this permit. The conclusions of the ER also describe the current mitigation required under the terms of the Fourth HRSA Consent Order that include flow reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate temporal and spatial trends. The applicant concludes that "continued operation in the manner required by the current SPDES permit and the associated agreement to continue implementation of the fourth Consent Degree ensures that thermal impacts will satisfy the requirements of CWA 316(a) and will thus remain SMALL during the license renewal term. Therefore, no further mitigation measures are warranted" (Entergy 2007a).

NYSDEC Assessment

In the FEIS associated with the SPDES permits for Roseton Units 1 and 2, Bowline Point Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a), NYSDEC concludes that "Thermal modeling indicates that the thermal discharge from IP2 and IP3 causes water temperatures to rise more than allowed, which is four degrees (F.) over the temperature that existed before the addition of heat, or a maximum of 83 °F, whichever is less, in the estuary cross sections specified in 6 NYCRR § 704.2(b)(5)."

According to NYSDEC (2003b), the last SPDES permit for the Indian Point facility expired in 1992, but its terms have been continued under provisions of the NY State Administrative Procedure Act. The fact sheet published by NYSDEC (2003b) in November 2003 describes the environmental and facility operational issues and permit conditions of the draft SPDES permit that NYSDEC has proposed to issue for IP2 and IP3. In Section IV, "Overview of the Permit" (Section B, "Thermal Discharges"), NYSDEC indicates that the permittee must satisfy the provisions of Section 316(a) of the CWA and related requirements in 6 NYCRR Section 704.2 "which provide that the thermal discharges from IP2 and IP3 to the Hudson River should meet regulatory temperature criteria for estuaries, and must meet the NYS standard of ensuring the propagation and survival of a balanced, indigenous population of shellfish, fish, and other

1 aquatic species.”

2 To meet this goal, NYSDEC requires, within the first 2 years of the SPDES permit term, that
3 Entergy conduct a triaxial (three-dimensional) thermal study to document whether the thermal
4 discharges associated with the operation of IP2 and IP3 comply with New York State water
5 quality criteria. In the event the discharges do not comply, the permittee is allowed to apply for
6 a modification of one or more criteria as provided by 6 NYCRR Section 704.4, but must
7 demonstrate to the satisfaction of NYSDEC “that one or more of the criteria are unnecessarily
8 restrictive and that the modification would not inhibit the existence and propagation of a
9 balanced indigenous population of shellfish, fish, and wildlife in the Hudson River” (NYSDEC
10 2003a). In the ongoing proceeding before NYSDEC, Entergy has indicated that it would
11 propose an alternative study. This matter is still under review before NYSDEC, and may not be
12 resolved before NRC issues a final SEIS (Entergy 2006).

13 **4.1.4.5 NRC Staff Assessment of Thermal Impacts**

14 In the absence of the thermal study proposed by NYSDEC (or an alternative proposed by
15 Entergy and accepted by NYSDEC), existing information must be used to determine the
16 appropriate thermal impact level to sensitive lifestages of important aquatic species. Since
17 NYSDEC modeling in the FEIS (NYSDEC 2003a) indicates that discharges from IP2 and IP3
18 could raise water temperatures to a level greater than that permitted by water quality criteria that
19 are a component of existing NYSDEC permits, the staff must conclude that adverse impacts are
20 possible. The NRC staff, after a review of available information on aquatic life in the Hudson
21 River Estuary, did not find evidence of adverse effects on aquatic life that are clearly noticeable
22 and sufficient to destabilize important attributes of an aquatic resource (the criteria for a LARGE
23 finding). In the absence of specific studies, and in the absence of effects sufficient to make a
24 determination of a LARGE impacts, the NRC staff concludes that thermal impacts from IP2 and
25 IP# could thus range from SMALL to MODERATE depending on the extent and magnitude of
26 the thermal plume, the sensitivity of various aquatic species and lifestages likely to encounter
27 the thermal plume, and the probability of an encounter occurring that could result in lethal or
28 sublethal effects. Additional thermal studies—as proposed by NYSDEC and Entergy—will
29 generate data that could further refine or modify this impact level. For the purposes of this draft
30 SEIS, the NRC staff concludes that impacts could range from SMALL to MODERATE.

31 **4.1.5 Potential Mitigation Options**

32 Potential mitigation options related to the operation of the IP2 and IP3 once-through cooling
33 system are discussed in Chapter VII of the DEIS (CHGEC et al. 1999). Impacts associated with
34 impingement were assumed by the Hudson River utilities to be adequately mitigated because
35 previous IP2 and IP3 owners installed dual- and variable-speed pumps at IP2 and IP3,
36 respectively, in 1994, and also installed modified Ristroph screens at both units in the early
37 1990s (CHGEC et al. 1999). The summary conclusion of the DEIS in 1999 was that the Hudson
38 River utilities considered the system to be the best technology available to mitigate impingement
39 losses (CHGEC et al. 1999). NYSDEC, however, has determined that closed-cycle cooling is
40 the best technology available to protect aquatic resources (NYSDEC 2003b).

41 CHGEC et al. (1999) also discusses the mitigation of entrainment losses at IP2 and IP3 by
42 ensuring that minimum flows are used for reactor cooling through the use of dual- or variable-
43 speed pumps. In the ER (Entergy 2007a), the applicant concludes that, because impingement

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and entrainment are not having any demonstrable negative effects on Hudson River RIS, further mitigation measures are not warranted. NYSDEC's FEIS (2003a) indicated that "a range of available technologies exist to minimize aquatic resource mortality from the cooling water intake structures" at the Hudson River power plants, including IP2 and IP3. While NYSDEC indicated that IP2 and IP3 pump systems and modified Ristroph screens help mitigation impingement mortality, it also indicated that "significant unmitigated mortalities from entrainment and impingement" remain at all of the Hudson River power plants (NYSDEC 2003a).

The NRC staff, in the results of its analysis provided in Sections 4.1.3 and 4.1.4 of this draft SEIS, has found that impingement and entrainment from the operation of IP2 and IP3 are likely to have an adverse effect on aquatic ecosystems in the lower Hudson River during the period of extended operation. The available evidence suggests that the operation of the cooling systems directly affects RIS by impingement and entrainment, and indirectly affects these resources through the impingement and entrainment of their prey. The thermal discharges may also be influencing RIS, but the extent of this influence cannot be determined without further studies, such as those proposed in the draft SPDES permit for IP2 and IP3.

To assess potential mitigation options, the NRC staff reviewed the comments and responses provided in NYSDEC (2003a) and information provided by EPA in support of its Phase II 316(b) program (EPA 2008a). Based on this review, additional mitigation options that may be available for the existing cooling system include the following:

- additional flow reductions or planned outages
- use of wedgewire or fine-mesh screens
- use of barrier systems at the intake locations
- use of behavioral deterrent systems
- closed-cycle cooling using cooling towers (e.g., hybrid wet/dry mechanical draft towers)
- restoration

What follows is an overview of the effects of employing the above mitigation options to the existing system currently in operation at IP2 and IP3. Because NYSDEC indicated closed-cycle cooling is the best technology available for IP2 and IP3 (NYSDEC 2003b), the NRC staff will review a cooling tower alternative in Chapter 8, as well as an alternative that includes restoration with other mitigation measures intended to offset the effects of the existing once-through cooling system. Because the NRC staff will address them in greater depth in Chapter 8, closed-cycle cooling and restoration will not be addressed further in this chapter.

Costs and benefits of these measures have been addressed in the 1999 DEIS and evaluated by NYSDEC in the FEIS. Of these alternative options, NYSDEC received comments indicating that the cost figures for closed-cycle cooling in the DEIS were inflated by the Hudson River utilities. After reviewing cost data with consultants, however, NYSDEC indicated that costs were generally reasonable (noting that site-specific factors and changes in the cost of replacement power may affect cost estimates) (NYSDEC 2003a).

The measures the NRC staff addresses below and in Chapter 8, as well as any other measures to reduce entrainment and impingement at Indian Point, fall under the regulatory authority of NYSDEC and the powers delegated to it by the EPA under the CWA. While the NRC has no

1 role in regulating or enforcing water quality standards, the NRC staff has included these
2 mitigation measures in the interest of fulfilling the NRC's obligations under the National
3 Environmental Policy Act (NEPA) (42 USC 4321, et. seq) and 10 CFR Part 51.

4 Additional Flow Reductions or Shutdowns

5 As discussed in Section 4.1.1.1 of this draft SEIS, under the conditions of HRSA and the
6 subsequent consent orders, the operators of IP2 and IP3 developed programs to employ flow-
7 reduction measures and scheduled outages to reduce impingement and entrainment impacts.
8 Because flow rates were dependent on water temperature, greater flows were required during
9 the months of May through October when river water temperatures were above 15 degrees C.
10 It may be possible to further reduce flows or increase the length or frequency of scheduled
11 outages, though these options will cause the plant operator to lose revenue from operating IP2
12 and IP3. In the 1999 DEIS, CHGEC et al. estimated that outages could cost between
13 \$14 million and \$73 million per year.

14 Wedgewire or Fine-Mesh Screens

15 In some cases, the use of wedgewire or fine-mesh screens has shown potential for decreasing
16 entrainment at once-through powerplants. Wedgewire screens typically have a screen size of
17 0.5 to 10 mm and are designed to reduce entrainment by physical exclusion and exploiting
18 hydrodynamic patterns (EPA 2008). Fine-mesh screens generally employ a mesh size of
19 0.5 mm or less, and reduce entrainment by gently trapping organisms and reintroducing them
20 back into the environment via plant-specific collection and transfer systems. Factors influencing
21 the use of this technology include the screen size, the location and configuration of the system
22 relative to the intake, the intake flow rates, the presence and magnitude of a "sweeping" current
23 that can limit impingement or move organisms past the screen into safe water, and the size of
24 the organism present near the intake. In its evaluation of wedgewire and fine-mesh screens,
25 EPA (2008a) indicated that these technologies showed promise for reducing entrainment, but
26 expressed concerns about the maintenance required to prevent clogging and the potential for
27 this technology to reduce entrainment but increase impingement. EPA (2008a) considered the
28 use of wedgewire screen technology to be more suitable for use in closed-cycle makeup water
29 systems where lower flow rates exist and fewer screens are required.

30 Because the portion of the Hudson River near IP2 and IP3 is subject to tidal influence, there are
31 periods of time when a sweeping current is not present. During this time, impingement against
32 wedgewire or fine-mesh screen systems would be exacerbated. Although the use of these
33 technologies at IP2 and IP3 is possible, numerous technical challenges would exist, including
34 how to configure and clean the screens, how to evaluate capture and removal success, and
35 how to assess the environmental effects and tradeoffs that would occur when one type of
36 impact (entrainment) is reduced while another impact (impingement) may increase. CHGEC
37 estimated that wedgewire screens could cost \$44 million to \$55 million per year in lost electricity
38 production, and indicated that fine-mesh screens would not be feasible.

39 Barrier Systems

40 Gunderboom® and Marine Life Exclusion System™ (MLES™) technologies provide additional
41 exclusion of entrainable-sized organism from cooling systems. Nets or screens are deployed
42 during peak periods of entrainment to reduce overall entrainment. Gunderboom technology has
43 been evaluated at the Lovett fossil fuel generating station since 1994. The system deployed in
44 2000 consisted of a two-ply fabric 500 feet (ft) (150 meters (m)) long, with a surface area of

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8000 square feet (ft²) (743 square meters (m²)), and equipped with 500-micrometer (0.020 in.) perforations. The system extended to a depth of 20–30 ft (6.1–9.1 m) and was held in place with anchors. An automated airburst system with strain gages and head differential monitors was used to release compressed air at depth to clean the screens. The preliminary results from the 2000 deployment documented by Raffenberg et al. (2008) suggested that the system resulted in an 80-percent reduction in ichthyoplankton entering the facility, and that periodic elevated densities of ichthyoplankton inside the barrier were linked to breaches of the system. Impingement investigations suggested that eggs did not adhere to fabric, and mortality was below 2 percent in laboratory studies. Based on observational data, larvae did not orient toward the flow, and did not impinge on the fabric with a through-fabric velocity of 5 gallons per minute per square foot or 0.20 meters per minute (Raffenberg et al. 2008).

The use of barrier systems may be feasible at IP2 and IP3 as a mitigation action, but further study may be needed to determine the long-term impacts of these systems. CHGEC et al. (1999) indicated that barrier nets or fine-mesh barrier nets would not be feasible at Indian Point, and did not assign a cost. EPA (2008), however, has indicated that barrier systems like Gunderboom show significant promise for minimizing entrainment, but still considers the technology “experimental in nature.” Some advantages of the systems are that they can be deployed, retrieved, and replaced seasonally as needed. They are suitable for use in all types of water bodies and appear to reduce entrainment and impingement losses. The disadvantages are related to the limited number of long-term studies available to assess the performance of the technology, the durability of the systems in high-energy areas, the level of maintenance and monitoring required, the effects of biofouling on system performance, and the large volume of water that IP2 and IP3 withdraw. Additionally, it may be necessary to determine whether potential safety issues associated with the deployment of the systems at a nuclear generating station can be addressed.

Behavioral Deterrent Systems

Behavioral deterrent systems such as noncontact sound barriers or the use of light sources to reduce impingement have been evaluated at a variety of power generating stations in marine, estuarine, and freshwater environments (EPA 2008a). At present, a sonic deterrent system is being used at the Danskammer Point fossil energy plant on the Hudson River, and a similar system has been evaluated at Roseton. The advantage to these systems is that they can be configured and deployed at a variety of locations at costs that are not prohibitively high for simple system configurations. The disadvantages of the systems are that pneumatic air guns, hammers, and fishpulser systems are not considered reliable, the cost of sophisticated acoustic sound-generating systems can be high, and the use of high-technology equipment requires maintenance at the site (EPA 2008a). EPA (2008a) further states that, although many studies have been conducted to evaluate the feasibility of sound and light to reduce impingement and entrainment, the results “have either been inconclusive or shown no tangible reduction in impingement or entrainment” (EPA 2008a). There is, however, evidence that the use of acoustic sound barriers at a site in Pickering, Ontario, did appear to reduce the impingement and entrainment of alewife, but no benefits were realized for rainbow smelt or gizzard shad. At the Roseton facility, the use of sound barriers provided little or no deterrence for any species (EPA 2008a). In its review, the EPA concluded that it may be possible to employ acoustic or light barrier systems in conjunction with other technologies to reduce impingement or entrainment, but further studies are likely necessary to evaluate the feasibility of various

technology combinations. The 1999 DEIS from CHGEC et al. indicated an unknown cost associated with implementing behavioral deterrence systems.

4.2 Transmission Lines

The two transmission lines and right-of-ways (ROWs) built to connect IP2 and IP3 with the transmission system that existed before their construction are described in Section 2.1.7 and mapped on Figure 2-3 of this draft SEIS. The lines are each about 2000 ft (610 m) in length, and have ROW widths of approximately 150 ft (46 m). The transmission lines are located within the site except for a terminal, 100-ft (30.5-m) segment of each that crosses the facility boundary and Broadway (a public road) to connect to the Buchanan substation (Entergy 2007a).

Of the total of 4000 ft (1220 m) of transmission line, about 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. The remaining 500 ft (150 m) of ROW is vegetated. In these segments, the growth of trees is prevented and a cover of mainly grasses and forbs is maintained.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the IP2 and IP3 transmission lines are listed in Table 4-5 of this draft SEIS. The applicant stated in its ER that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses (Entergy 2007a). The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, the NRC staff's site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-5. Category 1 Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Floodplains and wetland on power line right-of-way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line right-of-way	4.5.3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
1 A brief description of the GEIS conclusions, as codified in Table B-1, for each of these issues 2 follows:	
3 • <u>Power line right-of-way management (cutting and herbicide application)</u>. Based on 4 information in the GEIS, the Commission found the following:	
5 The impacts of right-of-way maintenance on wildlife are expected to be of small 6 significance at all sites.	
7 • <u>Bird collisions with power lines</u>. Based on information in the GEIS, the Commission 8 found the following:	
9 Impacts are expected to be of small significance at all sites.	
10 • Impacts of electromagnetic fields (EMFs) on flora and fauna (plants, agricultural crops, 11 honeybees, wildlife, livestock). Based on information in the GEIS, the Commission 12 found the following:	
13 No significant impacts of electromagnetic fields on terrestrial flora and fauna 14 have been identified. Such effects are not expected to be a problem during the 15 license renewal term.	
16 • <u>Floodplains and wetlands on power line right-of-way</u>. Based on information in the GEIS, 17 the Commission found the following:	
18 Periodic vegetation control is necessary in forested wetlands underneath power 19 lines and can be achieved with minimal damage to the wetland. No significant 20 impact is expected at any nuclear power plant during the license renewal term.	
21 • <u>Air quality effects of transmission lines</u>. Based on the information in the GEIS, the 22 Commission found the following:	
23 Production of ozone and oxides of nitrogen is insignificant and does not 24 contribute measurably to ambient levels of these gases.	
25 • <u>Onsite land use</u>. Based on the information in the GEIS, the Commission found the 26 following:	
27 Projected on-site land use changes required during...the renewal period would 28 be a small fraction of any nuclear power plant site and would involve land that is 29 controlled by the applicant.	
30 • <u>Power line right-of-way</u>. Based on information in the GEIS, the Commission found the 31 following:	
32 Ongoing use of power line rights-of-way would continue with no change in 33 restrictions. The effects of these restrictions are of small significance.	

The NRC staff identified no new and significant information associated with these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The NRC staff has identified one Category 2 issue and one uncategorized issue related to transmission lines. These issues are listed in Table 4-6 and are discussed in Sections 4.2.1 and 4.2.2 of this draft SEIS.

Table 4-6. Category 2 and Uncategorized Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
HUMAN HEALTH			
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

Based on the GEIS, the Commission determined that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been found to be a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this draft SEIS.

In the GEIS, the NRC staff found that, without a review of the conformance of each nuclear plant transmission line to National Electrical Safety Code (NESC) (IEEE 1997) criteria, it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

As described in Section 2.1.7 of this draft SEIS, two 345-kilovolt (kV) transmission lines were built to distribute power from IP2 and IP3 to the electric grid. Also, two 138-kV lines that use the same transmission towers supply offsite (standby) power to IP2 and IP3. These lines are contained within the IP2 and IP3 site, except for where they cross Broadway (a public road) to connect to the Buchanan substation. Electric lines having voltages exceeding 98 kV of alternating current to ground must comply with the NESC provision on minimum vertical clearance, adopted in 1977, that limits the steady-state current from electrostatic effects to 5 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment under the line were

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1 short circuited to ground. The New York Public Service Commission (NYPSC) requires a more
2 restrictive induced current limit of 4.5 mA (Entergy 2007a).

3 Entergy indicates that at the time it acquired IP2 from the Consolidated Edison Company of
4 New York, the transmission lines connecting IP2 and IP3 to the Buchanan substation were in
5 compliance with the applicable NESC provisions for preventing electric shock from induced
6 current. The lines were also in compliance with the NYPSC 4.5-mA criterion, as calculated
7 using the methods described in the Electric Power Research Institute (EPRI) document
8 "Transmission Line Reference Book" (Con Edison 2007). There have been no configuration or
9 operation changes made to these lines since transfer of their ownership to Entergy (Entergy
10 2007a). Entergy indicates that it has maintenance procedures to ensure that the transmission
11 lines continue to conform to ground clearance standards (Entergy 2008).

12 Entergy commissioned a study of the two 345-kV lines that connect IP2 and IP3 to the electric
13 transmission system to demonstrate to the NRC staff that they meet the NESC and NYPSC
14 requirements (Enercon 2008). The two 138-kV lines, which are at similar ground-crossing
15 heights to the 345-kV lines, are also addressed by the study. The analysis was performed using
16 the EPRI TL Workstation calculation software to determine the highest ground-level electric field
17 strengths at the ROWs where they cross Broadway. Enercon employed procedures and
18 calculations from the EPRI "Transmission Line Reference Book, 200kV and Above (Third
19 Edition)", which Enercon indicates is the industry-accepted reference for transmission line
20 design and field effects. Enercon notes that The EPRI parameters for a 55-ft- (17-m)-long
21 tractor trailer were used, with the length increased to 65 ft (20 m) to represent the maximum
22 allowed under New York size restrictions. The analysis revealed a maximum calculated
23 induced current for the 345-kV lines of 1.3 mA, below the NYPSC 4.5-mA limit (Enercon 2008).

24 In the GEIS, the NRC staff found that electrical shock is of SMALL significance for transmission
25 lines that are operated in adherence with the NESC criteria for limiting hazards. Based on a
26 review of the available information, including that provided in the ER (Entergy 2007a), the NRC
27 staff's environmental site audit, the scoping process, the NRC staff's evaluation of Entergy's
28 2008 study (Enercon 2008), and existing NESC requirements, the NRC staff concludes that the
29 transmission lines associated with IP2 and IP3 meet NESC criteria for limiting hazards, and thus
30 the potential impact from electric shock during the renewal term is SMALL.

31 The NRC staff identified measures that could further mitigate potential acute EMF impacts
32 resulting from continued operation of the IP2 and IP3 transmission lines, including installing
33 road signs at road crossings and increasing transmission line clearances. These mitigation
34 measures could reduce human health impacts by minimizing public exposures to electric shock
35 hazards. The staff did not identify any cost benefit studies applicable to the mitigation measures
36 mentioned above.

4.2.2 Electromagnetic Fields—Chronic Effects

38 In the GEIS, the chronic effects of 60-hertz EMFs from power lines were not designated as
39 Category 1 or 2, and a designation will not be made until scientific consensus is reached on the
40 health implications of these fields.

41 The potential for chronic effects from these fields continues to be studied and is not known at
42 this time. The National Institute of Environmental Health Sciences (NIEHS) directs related

research through the U.S. Department of Energy (DOE). The 1999 report of the NIEHS and DOE Working Group (NIEHS 1999) contains the following conclusion:

The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC to reach a conclusion with respect to the chronic effects of EMFs as detailed below (from 10 CFR Part 51, Subpart A, Appendix B, Table B-1):

If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The NRC staff considers the GEIS finding of “uncertain” still appropriate and continues to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to IP2 and IP3 in regard to radiological impacts are listed in Table 4-7. Entergy stated in its ER that it was aware of one new issue associated with the renewal of the IP2 and IP3 operating licenses—potential ground water contamination and a new radioactive liquid effluent release pathway as a result of leakage from the plant. The NRC staff has discussed this issue and the various studies relating to it in Section 2.2.7 of this draft SEIS, and addresses the significance of this issue in Section 4.5. The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER, during its independent review of Entergy’s ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information.

As discussed in Sections 2.2.7 and 4.5 of this SEIS, the NRC staff concludes that the new issue is not significant, and thus does not challenge the finding in the GEIS. According to the GEIS, the impacts to human health are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-7. Category 1 Issues Applicable to Radiological Impacts of Normal Operations during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER concerning potential ground water contamination and a new radioactive effluent release pathway for leakage from the plant, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information. The NRC evaluated the detailed information provided by the applicant, State agencies, and NRC inspections on the new issue and concluded that the new issue is not significant and that the impacts are SMALL. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

The NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20, "Standards for Protection against Radiation," and are not considered to have a significant impact on plant workers, the public, or the environment. Furthermore, the NRC staff acknowledges that the commitments made by Entergy—and identified in Section 2.2.7 of this SEIS—for long-term monitoring and remediation will help to minimize the potential impacts from contaminated ground water and help maintain radiological impacts within NRC radiation safety standards.

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found the following:

Radiation doses to the public will continue at current levels associated with normal operations.

- Occupational exposures to public (license renewal term). Based on information in the GEIS, the Commission found the following:

Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

The NRC staff identified no information that was both new and significant on these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

4.4 Socioeconomic Impacts of Plant Operations during the License Renewal Term

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to socioeconomic impacts during the renewal term are listed in Table 4-8 of this draft SEIS. As stated in the GEIS, the impacts associated with these Category 1 issues were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issues Applicable to Socioeconomics during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

The NRC staff reviewed and evaluated the IP2 and IP3 ER, scoping comments, and other available information. The NRC staff also visited IP2 and IP3 in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was identified during this review and evaluation. Therefore, the NRC staff concludes that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

The results of the review and brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues are provided below:

- Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found the following:
Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
- Public services: education (license renewal term). Based on information in the GEIS, the Commission found the following:
Only impacts of small significance are expected.
- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found the following:
No significant impacts are expected during the license renewal term.

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- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found the following:

No significant impacts are expected during the license renewal term.

The NRC staff identified no new and significant information regarding these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

Table 4-9 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and an environmental justice impact analysis, which was not addressed in the GEIS.

Table 4-9. Category 2 Issues Applicable to Socioeconomics and Environmental Justice during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR	SEIS Section
		51.53(c)(3)(ii) Subparagraph	
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services: transportation	4.7.3.2	J	4.4.4
Historic and archeological resources	4.7.7	K	4.4.5
Environmental justice	Not addressed ^(a)	Not addressed ^(a)	4.4.6

^(a)Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in plant-specific reviews.

4.4.1 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors, sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1 of the GEIS). A matrix is used to rank the population category as low, medium, or high (see Figure C.1 of the GEIS).

In Chapter 2 of this draft SEIS, the NRC staff describes the local population around IP2 and IP3. As NRC staff indicated in Section 2.2.8.5, the 2000 U.S. Census noted that approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per square mi (332 persons per square km). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mi within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per square mi (825 persons per square km). Applying the GEIS proximity measures, the IP2 and IP3 site is classified as proximity Category 4 (greater than or equal to 190 persons per square mi within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of

sparseness Category 4 and proximity Category 4 result in the conclusion that Indian Point is located in a high population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of small significance in high-density population areas where growth-control measures are not in effect. Since Indian Point is located in a high population area and Dutchess, Orange, Putnam, and Westchester Counties are not subject to growth-control measures that would limit housing development, any changes in IP2 and IP3 employment would have little noticeable effect on housing availability in these counties. Because Entergy has indicated in its ER that there would be no hiring of additional workers to support license renewal, nonoutage employment levels at IP2 and IP3 would remain relatively constant with no additional demand for permanent housing during the license renewal term (Entergy 2007a). In addition, the number of available housing units has kept pace with or exceeded the low growth in the area population. Based on this information, the NRC staff concludes that there would be no impact on permanent housing during the license renewal term beyond what is currently being experienced.

However, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms (CRDMs) at some time in the future before or during the license renewal term, and the decision to proceed with this replacement activity would be made based on future inspection results (Entergy 2008b). Entergy estimates that this replacement activity at IP2 and IP3 would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would increase the demand for temporary (rental) housing in the immediate vicinity of IP2 and IP3. Even though it is not certain whether Entergy will replace the reactor vessel heads and CRDMs, the NRC staff has reviewed the potential environmental impacts of this replacement activity. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.2 Public Services—Public Utility Impacts

The GEIS indicates that impacts on public utilities are SMALL if the existing infrastructure could accommodate plant-related demand without a noticeable effect on the level of service. The GEIS indicates that MODERATE impacts arise when the demand for service or use of the infrastructure is sizeable and would noticeably decrease the level of service or require additional resources to maintain the level of service. The GEIS indicates that LARGE impacts would result when new programs, upgraded or new facilities, or substantial additional staff are required because of plant-related demand.

In the absence of new and significant information to the contrary, the only impacts on public utilities that the NRC staff found in the GEIS could be significant during license renewal are impacts on public water supplies. The NRC staff's analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. In the GEIS, the NRC staff found that impacts from license renewal on public water supplies could range from SMALL to MODERATE, with the site-specific impact depending on factors that exist at each plant site.

As previously discussed (in Section 2.2.8.2) of this draft SEIS, potable water and process water is supplied to IP2 and IP3 by the Village of Buchanan water supply system (VBNY 2006). IP2

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and IP3 use approximately 2.3 million ft³ (65,000 m³) or 17.4 million gallons of potable water per month, and there is no indicated restriction on the amount of potable water that IP2 and IP3 can use. Further, Entergy (NRC 2007a) does not project an increase in plant demand.

Because Entergy staff has indicated that there would be no hiring of additional workers during the license renewal period (Entergy 2007a), overall employment levels at IP2 and IP3 would remain relatively unchanged with no additional demand for public water and sewer services. Public water systems in the region would remain adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no impact to public water and sewer services during the license renewal term beyond what is currently being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of refueling outage workers needed for this replacement activity would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.3 Offsite Land Use—License Renewal Period

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that “significant changes in land use may be associated with population and tax revenue changes resulting from license renewal.”

Section 4.7.4 of the GEIS defines the magnitude of land use changes as a result of plant operation during the license renewal term as follows:

SMALL—Little new development and minimal changes to an area’s land use pattern.

MODERATE—Considerable new development and some changes to the land use pattern.

LARGE—Large-scale new development and major changes in the land use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant’s payments relative to the community’s total revenues, (2) the nature of the community’s existing land use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant’s tax payments are projected to be small relative to the community’s total revenue, tax-driven land use changes during the plant’s license renewal term would be SMALL, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction’s revenue, the significance level would be SMALL. If the plant’s tax payments are projected to be medium to large relative to the community’s total revenue, new tax-driven land use changes would be MODERATE. If the plant’s tax payments are projected to be a dominant source of the

community's total revenue, new tax-driven land use changes would be LARGE. This would be especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development.

4.4.3.1 Population-Related Impacts

Since Entergy has indicated that it has no plans to add nonoutage employees during the license renewal period, there would be no noticeable population change to drive changes in land use conditions in the vicinity of IP2 and IP3 that is attributable to the plant. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Because of the short amount of time needed for this replacement activity, the NRC staff finds that additional number of refueling outage workers would not cause any permanent population-related land use changes in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.3.2 Tax-Revenue-Related Impacts

As discussed in Chapter 2 of this draft SEIS, Entergy pays annual real estate taxes to the Town of Cortlandt, Hendrick Hudson Central School District, and the Village of Buchanan (see Table 2-18 in Chapter 2 for more detail). As reported in Chapter 2, tax payments to the Town of Cortlandt represented between 11 and 16 percent of the town's total annual tax revenues for the 3-year period from 2003 through 2005, and payments to the Hendrick Hudson Central School District represented approximately 30 to 38 percent of the school district's total revenues over the same time period. Entergy's tax payments to the Village of Buchanan make up a high percentage of the village's tax collection. For the period 2003 through 2005, tax payments to the Village of Buchanan represented 39 to 43 percent of the village's total revenues.

The NRC staff notes that since Entergy started making payments to local jurisdictions, population levels and land use conditions in the Town of Cortlandt, Village of Buchanan, and Westchester County have not changed significantly, which might indicate that these tax revenues have had little or no effect on land use activities within the county.

Entergy has indicated that it plans no license-renewal-related construction activities to support the continued operation of IP2 and IP3 during the license renewal period. Accordingly, the NRC staff expects that there would be no increase in the assessed value of IP2 and IP3 and that the annual payment-in-lieu-of-taxes and property taxes paid to the Town of Cortlandt, the Hendrick Hudson Central School District, and the Village of Buchanan would remain relatively unchanged throughout the license renewal period. Based on this information, there would be no tax-revenue-related land use impacts during the license renewal term beyond those currently being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). This replacement activity would not likely increase the assessed value of IP2 and IP3, and property tax payments would remain unchanged. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.4 Public Services: Transportation Impacts during Operations

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Since Entergy has no plans to add nonoutage employees during the license renewal period, there would be no noticeable change in traffic volume and levels of service on roadways in the vicinity of IP2 and IP3. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of outage workers and truck material deliveries needed to support this replacement activity could cause short-term transportation impacts on access roads in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.5 Historic and Archeological Resources

The National Historic Preservation Act (NHPA), as amended, requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The criteria for eligibility are listed in 36 CFR 60.4, "Criteria for Evaluation," and include (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodies distinctive characteristics of type, period, or construction, and (4) yielded or is likely to yield important information (ACHP 2008). The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties." The issuance of a renewed operating license for a nuclear power plant is a Federal action that could possibly affect either known or currently undiscovered historic properties located on or near the plant site and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking.

4.4.5.1 Site-Specific Cultural Resources Information

A review of the New York State Historic Preservation Office (NYSHPO) files shows that there are no previously recorded archeological or above-ground historic architectural resources identified on the IP2 and IP3 property. As noted in Section 2.2.9.1 of this draft SEIS, a

1 Phase 1A survey (literature review and background research) of the plant property was
2 conducted in 2006; however, no systematic pedestrian or subsurface archeological surveys
3 have been conducted at the IP2 and IP3 site. Background research revealed a total of 76
4 resources listed on the National Register of Historic Places within a 5-mile radius of IP2 and
5 IP3; however, none are located within the boundaries of the property.

6 There is potential for archeological resources to be present on some portions of the IP2 and IP3
7 property. As noted in Section 2.2.9.2 of this draft SEIS, because of disturbances associated
8 with site preparation and construction, the power block area at IP2 and IP3 has little or no
9 potential for archeological resources. There is potential for archeological resources to be
10 present in the wooded area northeast of the power block area. A portion of the property south
11 and east of the power block area, which contains a variety of ancillary plant facilities, has been
12 disturbed by construction activities over the course of the plant's history. It is possible, however,
13 that portions of that area not disturbed by construction activities may contain intact subsurface
14 archeological deposits. In addition, the IP1 reactor was one of three "demonstration plants" that
15 began operation in the early 1960s. It is representative of the earliest era of commercial
16 reactors to operate in the United States. To date, no formal significance or eligibility evaluation
17 has been conducted for IP1; however, the plant could become eligible for inclusion on the
18 National Register of Historic Places. As mandated by Section 106 of the NHPA, an evaluation
19 would be conducted if it was determined that a project could affect IP1.

20 4.4.5.2 Conclusions

21 Entergy has proposed no specific new facilities, service roads, or transmission lines for the IP2
22 and IP3 site *associated with continued operation and* refurbishment. However, Entergy
23 indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs during the
24 license renewal period. This activity would involve ground-disturbing activities associated with
25 the construction of a storage building for the existing reactor vessel heads and CRDMs.
26 Ground-disturbing activities would be reviewed in accordance with Entergy nuclear fleet
27 procedures, which are designed to ensure that investigations and consultations are conducted
28 as needed, and that existing or potentially existing cultural resources are adequately protected
29 by Entergy such that the applicant can meet State and Federal expectations (Enercon 2007).

30 Therefore, the potential for impacts from continued operation of IP2 and IP3 on historic or
31 archeological resources eligible for the National Register is SMALL. However, as noted in the
32 NRC staff walkover survey discussed in Chapter 2 of this draft SEIS, there is the potential for
33 prehistoric and historic archeological resources to be present on the northeastern portion of the
34 site. Even though this area was previously disturbed by surface mining in the 19th century, the
35 potential for intact prehistoric/historic and archeological resources remains. In addition, Section
36 106 of NHPA requires that lands not previously surveyed in the vicinity of IP2 and IP3 would
37 require investigation by a professional archeologist in consultation with the NYSHPO before any
38 ground-disturbing activities. To mitigate any potential adverse impacts to historic and
39 archeological resources from continued plant operations in these areas, field surveys
40 (archeological investigations) and consultation under the NHPA should be conducted before any
41 ground-disturbing activities. Entergy procedures should be followed to mitigate any potential
42 adverse impacts to historic and archeological resources.

4.4.6 Environmental Justice

Under Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations" (Volume 59, page 7629 of the *Federal Register* (59 FR 7629)), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued its "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" (69 FR 52040), which states, "The Commission is committed to the general goals set forth in E.O. 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in its publication entitled, "Environmental Justice: Guidance under the National Environmental Policy Act" (1997):

- **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA Act) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).
- **Disproportionately High and Adverse Environmental Effects.** A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of IP2 and IP3 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

- (1) **Minority individuals.** Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

- (2) **Minority populations.** Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- (3) **Low-income populations.** Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

Minority Population in 2000

According to 2000 census data, 48.7 percent of the population (approximately 16,805,000 individuals) residing within a 50-mi (80-km) radius of IP2 and IP3 identified themselves as minority individuals. The largest minority group was Black or African American (3,480,000 persons or 20.7 percent), followed by Hispanic or Latino of any race (3,439,000 or about 20.5 percent) (USCB 2003—LandView 6). About 36 percent of the Westchester County population were minorities, with Hispanic or Latino the largest minority group (15.6 percent) followed by Black or African American (13.6 percent) (USCB 2008).

Census block groups with minority populations exceeding 50 percent were considered minority block groups. Based on 2000 census data, Figure 4-5 of this draft SEIS shows minority block groups within a 50-mi (80-km) radius of IP2 and IP3 in which more than 50 percent of the block group population is minority.

Low-Income Population in 2000

According to 2000 census data, approximately 484,000 families (approximately 11.7 percent) residing within a 50-mi (80-km) radius of the IP2 and IP3 were identified as living below the Federal poverty threshold in 1999 (USCB 2003—LandView 6). The 1999 Federal poverty threshold was \$17,029 for a family of four.

According to census data, the median household income for New York in 2004 was \$45,343, while 14.5 percent of the State's population was determined to be living below the Federal poverty threshold. Westchester County had a much higher median household income (\$63,924) and a lower percentage (8.9 percent) of individuals living below the poverty level when compared to the State. Dutchess, Orange, and Putnam Counties also had much higher median household incomes in 2004 (\$56,971, \$54,771, and \$75,514, respectively) and lower percentages (7.7 percent, 10.2 percent, and 4.5 percent, respectively) of individuals living below the poverty level when compared to the State (USCB 2008).

Census block groups were considered low-income block groups if the percentage of the population living below the Federal poverty threshold exceeded the State percentage of 14.5 percent. Based on 2000 census data, Figure 4-6 of this draft SEIS shows low-income block groups within a 50-mi (80-km) radius of IP2 and IP3.

Analysis of Impacts

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as minority and low-income populations residing within a 50-mi radius of the IP2 and IP3. Based on the analysis of environmental health and safety impacts presented in this draft SEIS for other resource areas (contained in Chapters 2 and 4 of this SEIS), there would be no disproportionately high and adverse impacts to minority and low-

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- 1 income populations from continued operation of IP2 and IP3 during the license renewal period.

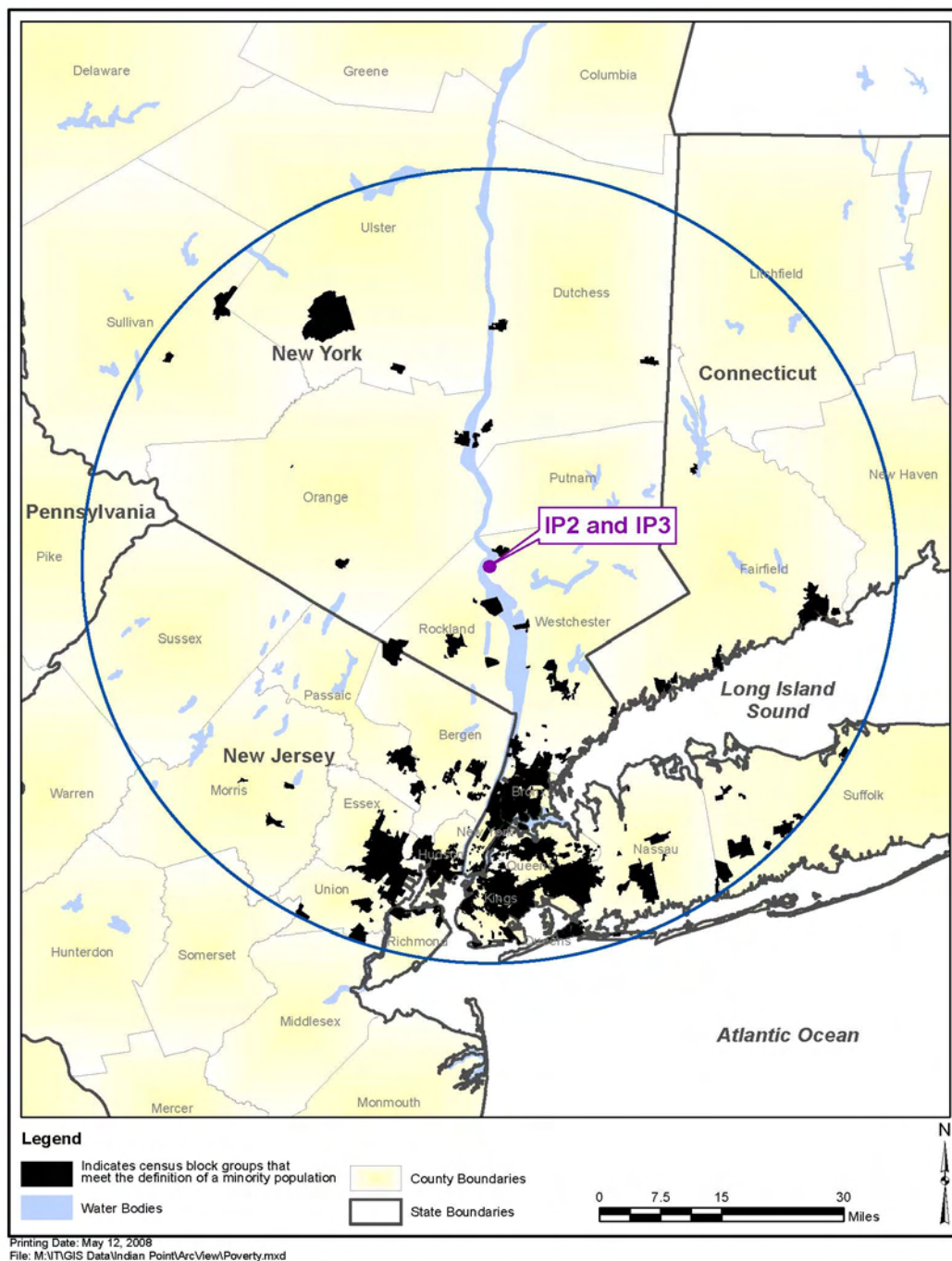


Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

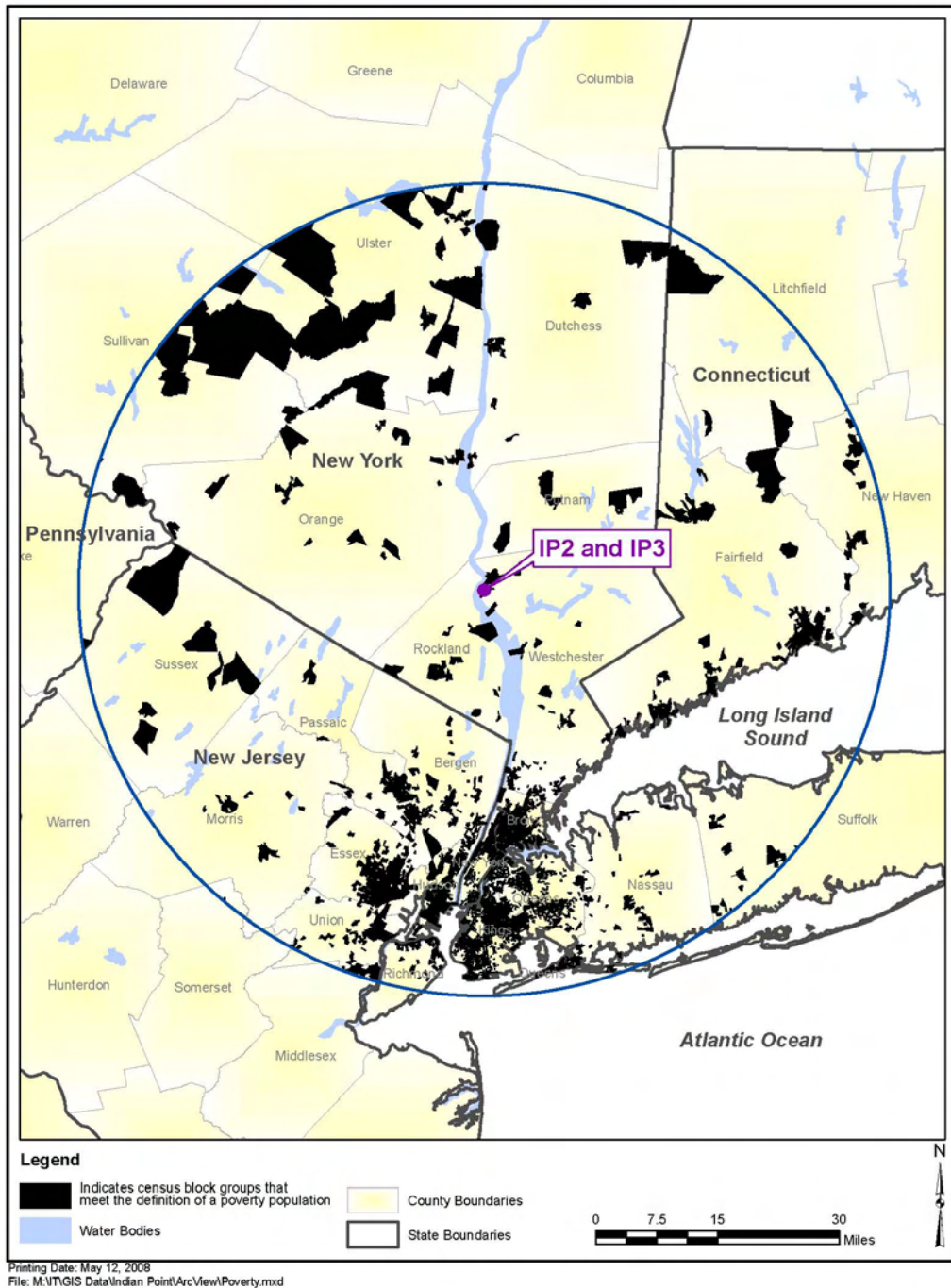


Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

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As discussed in Section 4.4.1, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Entergy estimates that this would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). This replacement activity would have little noticeable effect on minority and/or low-income populations in the region. These impacts are discussed in Chapter 3 of this draft SEIS.

The NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this draft SEIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the IP2 and IP3 site were considered.

Entergy has a comprehensive Radiological Environmental Monitoring Program (REMP) at IP2 and IP3 to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways in the vicinity of IP2 and IP3. The aquatic pathways include fish, Hudson River water, ground water, aquatic vegetation, sediment, and shoreline soil. The terrestrial pathways include airborne particulates, broad leaf vegetation, and direct radiation. During 2006, Entergy or its contractors performed 1342 analyses on collected samples of environmental media as part of the required REMP which showed no significant or measurable radiological impact from IP2 and IP3 operations (ENN 2007).

The NRC staff presents a summary of results from the IP2 and IP3 REMP program in Section 2.2.7 of this draft SEIS. The results of the 2006 REMP (the most recent available) demonstrate that the routine operation at the IP2 and IP3 site has had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of IP2 and IP3 did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents. The REMP continues to demonstrate that the dose to a member of the public from the operation of IP2 and IP3 remains significantly below the Federally required dose limits specified in 10 CFR Part 20 and 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

The NRC staff's review of recent REMP monitoring results shows that concentrations of contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding IP2 and IP3 have been quite low (at or near the threshold of detection) and seldom

above background levels. Consequently, the NRC staff concludes that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.5 Ground Water Use and Quality

No Category 1 or Category 2 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, are potentially applicable to IP2 and IP3 ground water use and quality during the renewal term. The applicant stated in its ER that IP2 and IP3 do not use any ground water, though onsite monitoring wells exist for the purpose of monitoring ground water conditions.

In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this draft SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

4.6 Threatened or Endangered Species

Potential impacts to threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-10.

Table 4-10. Category 2 Issues Applicable to Threatened or Endangered Species during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	Draft SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or Endangered Species	4.1	E	4.6

This issue requires consultation under Section 7 of the Endangered Species Act of 1973 (ESA 1973) with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear facility during the license renewal term. The presence of threatened or endangered species in the vicinity of the IP2 and IP3 site is discussed in Sections 2.2.5.5 and 2.2.6.2 of this draft SEIS. In 2007, the NRC staff contacted NMFS and the U.S. Fish and Wildlife Service (FWS) to request information on the occurrence of threatened or endangered species in the vicinity of the site and the potential for impacts on those species from license renewal. NMFS identified in its response two Federally protected sturgeon species under its jurisdiction as having the potential to be affected by the proposed action (NMFS 2007a). FWS provided a link to the Web site of its New York Field Office, where lists of species occurrences were available by county (FWS

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2007). Three terrestrial species with a Federal listing status were identified as potentially occurring at or near the site—the Indiana bat (*Myotis sodalis*), bog turtle (*Clemmys muhlenbergii*), and New England cottontail (*Sylvilagus transitionalis*).

Because the NRC recognizes that there is the potential that the continued operation of IP2 and IP3 could adversely affect the Federally listed species shortnose sturgeon (*Acipenser brevirostrum*), the NRC staff has prepared a biological assessment (BA) for NMFS that documents its review. The BA is provided in Appendix E to this draft SEIS. During informal consultation regarding the potential for effects on terrestrial threatened or endangered species, FWS determined that a BA was not needed because there was no likelihood of adverse effects on potentially occurring species under its jurisdiction (NRC 2008).

4.6.1 Aquatic Threatened or Endangered Species

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA 1973), the NRC staff requested in a letter dated August 16, 2007 (NRC 2007a), that NMFS provide information on Federally listed endangered or threatened species, as well as proposed candidate species. In its response on October 4, 2007 (NMFS 2007b), NMFS expressed concern that the continued operation of IP2 and IP3 could have an adverse impact on the shortnose sturgeon, an endangered species that occurs in the Hudson River. NMFS also noted that the Atlantic sturgeon (*A. oxyrinchus*) also occurs in the river and is currently a candidate for listing as threatened or endangered. The NRC staff also reviewed the list of threatened and endangered fish species available at the NYSDEC Web site (NYSDEC 2008a) and determined that the only listed species occurring in the Hudson River near the IP2 and IP3 facility was the shortnose sturgeon. Based on this information, the NRC staff determined that an analysis of impacts was required only for the shortnose sturgeon. The NRC staff has, however, included an assessment of impact for the Atlantic sturgeon in this section, given its current status as a candidate for listing.

As described in Section 2.2.5.5 of this draft SEIS, the shortnose sturgeon is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater and move to salt water periodically, independent of spawning periods (Collette and Klein-MacPhee 2002). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998).

Shortnose sturgeon are found in the lower Hudson River and are dispersed throughout the river-estuary from late spring to early fall, congregating to winter near Sturgeon Point (RKM 139; RM 86). The population of shortnose sturgeon in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Woodland and Secor (2007) estimate a fourfold increase in sturgeon abundance over the past 3 decades, but report that the population growth slowed in the late 1990s as evidenced by the nearly constant recruitment pattern at depressed levels relative to the classes in 1986–1992. Although the Hudson River appears to support the largest population of shortnose sturgeon in the region, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continue.

As described in Section 2.2.5.5 of this draft SEIS, the Atlantic sturgeon is an anadromous species with a range extending from St. Johns River, Florida, to Labrador, Canada. This species is long lived, matures slowly, and can reach 60 years of age (ASMFC 2007; Gilbert 1989). In 1996, the State of New York placed a moratorium on harvesting Atlantic sturgeon when it became apparent that the Hudson River stock was overfished. Unfortunately, the American shad gill net fishery continues to take subadult sturgeon as bycatch (e.g., the unintentional collection of some species during the harvest or others). The Status Review Team for Atlantic Sturgeon concluded in 2007 that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years because of the threat of commercial bycatch. However, the New York Bight distinct population segment, which includes the Hudson River subpopulation, was determined to have a greater than 50-percent chance of becoming endangered in the foreseeable future. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and the abundance appears to be stable or even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) suggests that a substantial population of juvenile Atlantic sturgeon is present in Haverstraw Bay, and that this area should be the focus of future monitoring studies to obtain the greatest statistical power for assessing population trends.

To determine the potential adverse impacts of the IP2 and IP3 cooling system on these species, the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges for all RIS, including both sturgeon species, in Sections 4.1.1, 4.1.2, and 4.1.3 of this draft SEIS. Based on an evaluation of entrainment data provided by the applicant, there is no evidence that the eggs or larvae of either species are commonly entrained at IP2 or IP3. The potential impacts of thermal discharges on shortnose and Atlantic sturgeon cannot be determined at this time because additional studies are required to quantify the extent and magnitude of the thermal plume, as discussed in Section 4.1.4 of this draft SEIS.

Impingement data provided by the applicant (Entergy 2007b) suggest that both species of sturgeon have been impinged at IP2 and IP3, with impingement of Atlantic sturgeon accounting for the largest losses (Table 4-11). Impingement data for the endangered shortnose sturgeon show that from 1975 to 1990, 317 fish were impinged at IP2 and 407 fish were impinged at IP3. Impingement of this species was greatest in 1984 and 1988, and no impinged fish were observed at either unit in 1981, 1982, 1983, 1985, and 1986 (Table 4-11). Impingement of Atlantic sturgeon was much greater than that observed for shortnose sturgeon, with 2667 fish impinged at IP2 and 1268 fish impinged at IP3 between 1975 and 1988. The only year when impingement of Atlantic sturgeon at both units was not observed (Table 4-11) was 1988. Because recent data are not available, it is not possible to determine whether the current impingement losses are similar to the past observations.

Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3, 1975–1990 (data from Entergy 2007b)

Study Year	IP2		IP2 Total	IP3		IP3 Total	Grand Total
	Shortnose Sturgeon	Atlantic Sturgeon		Shortnose Sturgeon	Atlantic Sturgeon		
1975	3	302	305	- ^a	-	-	305
1976	2	17	19	-	14	14	33
1977	11	105	116	2	252	254	370
1978	5	38	43	5	31	36	79
1979	4	75	79	3	61	64	143
1980	-	24	24	2	17	18	42
1981	-	221	221	-	73	73	294
1982	-	217	217	-	127	127	344
1983	-	149	149	-	-	-	149
1984	176	363	539	154	179	333	872
1985	-	460	460	-	300	300	760
1986	-	696	696	-	126	126	822
1987	116	-	116	55	88	143	259
1988	-	-	-	186	-	186	186
1989	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-
Grand Total	317	2667	2984	407	1268	1674	4658

^(a) - = not indicated in sample

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Because of the uncertainty of the current impingement losses of both species of sturgeon and because insufficient data exist to use the WOE approach used earlier in Chapter 4 to address impacts to RIS, operation of IP2 and IP3 has the potential to adversely affect the Atlantic and shortnose sturgeons during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site, including associated transmission line ROWs, on aquatic species that are Federally listed as threatened or endangered could be SMALL to LARGE. However, if monitoring were to be reinstated at IP2 and IP3, the range of impact levels from continued operation could possibly be refined.

The NRC staff has included a biological assessment of the impacts of license renewal on the shortnose sturgeon in Appendix E to this draft SEIS for NMFS to review. Should NMFS determine that there is a potential that the continued operation of IP2 and IP3 will adversely impact the shortnose sturgeon, NMFS will issue a biological opinion. Included in the biological opinion would be any reasonable and prudent measures that the applicant could undertake, as well as the terms and conditions for the applicant to comply with the formal Section 7 consultation. Possible mitigation measures could range from monitoring to determine the number of shortnose sturgeon impinged at IP2 and IP3 to changes in the cooling water intake

1 system, as described in Section 4.1.5 of this draft SEIS. Additionally, as described in Chapter 8,
2 the installation of cooling towers could reduce impingement, entrainment, and thermal impacts
3 for all aquatic resources, including those that are Federally listed.

4 **4.6.2 Terrestrial Threatened or Endangered Species**

5 There are two Federally listed terrestrial species that have the potential to occur at or near the
6 IP2 and IP3 site and its associated transmission line ROWs, the endangered Indiana bat
7 (*M. sodalis*) and the threatened bog turtle (*C. muhlenbergii*). A candidate species, the New
8 England cottontail (*S. transitionalis*), also may occur in the vicinity. The characteristics, habitat
9 requirements, and likelihood of occurrence of each of these species are discussed in
10 Section 2.2.6.2 of this draft SEIS.

11 Although Westchester County is within the potential range of the Indiana bat in New York, winter
12 hibernacula and summer maternity colonies and bachelor colonies are not known to be present
13 in the county or the vicinity of the site (NYNHP 2008a). The NRC staff notes that it is possible
14 that the 70-acre (ac) (28-hectare (ha)) forest at the north end of the site could provide summer
15 habitat for the Indiana bat because of the presence of suitable foraging habitat and possible
16 roosting trees in the forest and the presence of large hibernacula within migration distance of
17 the site. The ER indicated that no expansion of existing facilities or disturbance of forest or
18 other land on the site would occur during the renewal period. Thus, even if Indiana bats
19 currently utilize habitat on the site, it is not likely that they would be adversely affected by
20 ongoing operations and maintenance activities during the renewal period.

21 In Section 2.2.6.2, the NRC staff noted that the IP2 and IP3 site area does not have suitable
22 habitat for the bog turtle, and that bog turtles have not been observed in the region of
23 Westchester County near the IP2 and IP3 site (NYSDEC 2008b). The NRC staff acknowledged
24 that wetlands nearest the site had not, however, been evaluated for the presence of the bog
25 turtle. Given the available information, the NRC staff concludes that the bog turtle is not likely to
26 occur on or in the immediate vicinity of the site. The known locations of the New England
27 cottontail in Westchester County are in the central and northeastern areas of the county
28 (NYNHP 2008b), not in the northwestern area where the site is located. The forests on the site
29 consist mainly of mature hardwoods and do not contain early successional habitats, such as
30 thickets, that are required by the New England cottontail, so the NRC staff does not expect the
31 species to occur on or in the immediate vicinity of the site.

32 The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site,
33 other reports, and information from FWS. Operation of IP2 and IP3 is not expected to adversely
34 affect any threatened or endangered terrestrial species during the license renewal term.
35 Therefore, the NRC staff concludes that the impacts of an additional 20 years of operation and
36 maintenance of the site, including associated transmission line ROWs, on terrestrial species
37 that are Federally listed as threatened or endangered would be SMALL. Because no listed
38 species are known to be present in the area of the IP2 and IP3 site, there are no recommended
39 mitigation measures, unless the applicant becomes aware of the presence of a listed species, in
40 which case appropriate protective action should be taken, and the NRC and FWS should be
41 notified. Informal consultation with FWS indicated that formal consultation and a BA are not
42 required for terrestrial threatened or endangered species.

4.7 Evaluation of New and Potentially Significant Information on Impacts of Operations during the Renewal Term

The NRC staff has conducted its own independent review of environmental issues through staff research, consultation with State and Federal agencies, and comments delivered to the NRC by the public during the environmental scoping period to identify potentially new and significant information about environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation of IP2 and IP3 during the renewal term. Processes for identification and evaluation of new information are described in Section 1.2.2 of this draft SEIS.

As discussed in Section 2.2.7 of this draft SEIS and synopsis in Section 4.5 of this chapter, Entergy identified leakage from onsite spent fuel pools as potentially new information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this draft SEIS. Based on the NRC staff's review of Entergy's ground water analyses, the NRC ground water inspection report, and Entergy's subsequent statements (all discussed in Section 2.2.7 of this draft SEIS), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while constituting new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff did not identify any other information that was both new and significant. As such, the NRC staff adopts the GEIS findings for Category I issues applicable to Indian Point, as described in the previous sections of this chapter.

4.8 Cumulative Impacts

The NRC staff considered potential cumulative impacts on the environment resulting from past, present, and reasonably foreseeable future actions. The geographical area over which past, present, and future actions are assessed is dependent on the affected resource.

The impacts of the proposed action, license renewal, as described in previous sections of Chapter 4 of this draft SEIS, are combined with other past, present, and reasonably foreseeable future actions in the potentially affected area regardless of which agency (Federal or non-Federal) or entity is undertaking the actions. The combined impacts are defined as "cumulative" in 40 CFR 1508.7, "Cumulative Impact," and include individually minor but collectively significant actions taking place over a period of time (CEQ 1997). It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL direct or indirect impact could be important if it contributes to or accelerates the overall resource decline.

The NRC staff has identified the principal past, present, and reasonably foreseeable future actions potentially impacting the environment affected by IP2 and IP3. The potential cumulative impacts of these actions are discussed below.

4.8.1 Cumulative Impacts on Aquatic Resources

The purpose of this section is to address past, present, and future actions that have created or could result in cumulative adverse impacts to the aquatic resources of the lower Hudson River. In Section 2.2.5.2 of this SEIS, the NRC staff discussed a wide variety of historical events that have affected the Hudson River and its resources. The NRC staff notes that these historical events are contributors to the cumulative effects on the Hudson River. In addition to the past events in Section 2.2.5.2, the NRC staff has identified a variety of current and likely future stressors that may also contribute to cumulative impacts. These stressors, included in the follow list, is consistent with those identified by the Pew Oceans Commission (2003).

- the continued operation of the IP2 and IP3 once-through cooling system (addressed in Section 4.1 of this Chapter)
- continued withdrawal of water to support fossil fuel electrical generation or water for human use
- the presence of invasive or nuisance species
- fishing pressure
- habitat loss
- changes to water and sediment quality
- climate change

Each of these potential stressors may influence the structure and function of freshwater, estuarine, and marine food webs and result in observable changes to the aquatic resources in the lower Hudson River estuary. Examples of measurable changes to aquatic resources could include the following:

- reductions or increases in RIS populations or changes in their distribution
- changes in predator-prey relationships or noticeable alterations to food webs, including the permanent loss of species
- changes in contaminant body-burdens in fish and shellfish that result in the imposition or lifting of consumption advisories
- introduction of exotic or nuisance species and increases or decreases in populations of existing invasive species

What follows is a brief discussion of how the stressors listed above might have cumulative impacts on aquatic resources of the lower Hudson River estuary. An expanded discussion of cumulative impacts is presented in Appendix H to this draft SEIS. Because in most cases it is not possible to quantitatively determine the impact of each stressor, or a collection of stressors, on the aquatic resources of the lower Hudson River, the following is a general discussion of cumulative impacts.

Environmental Impacts of Operation

Continued Operation of the IP2 and IP3 Once-Through Cooling System

Based on the assessment presented in Sections 4.1.3 and 4.1.4 of this draft SEIS, the NRC staff concludes that the operation of IP2 and IP3 has the potential to adversely affect a variety of RIS species that currently exist in the Hudson River between Troy Dam and the Battery. Based on the staff's analysis of entrainment and impingement impacts, effects to RIS range from SMALL to LARGE, depending on the species affected. It is also possible that the operation of IP2 and IP3 could be affecting the endangered shortnose sturgeon. If the IP2 and IP3 once-through cooling system continues to operate as it has for the past 3 decades, the NRC staff finds that it will continue to contribute to cumulative effects.

Continued Water Withdrawals

As described in Section 2.2.5 of this draft SEIS, water is withdrawn from the Hudson River to support fossil fuel electrical generation and to provide a source of drinking water. Although some fossil fuel electrical generating stations that use natural gas or oil operate only intermittently, coal-fired electrical generation stations that employ once-through cooling systems are expected to continue to operate in the future. Likewise, water withdrawals in the freshwater portions of the Hudson River will continue to occur and increase in the future. Because the NRC staff concludes that water withdrawals from the Hudson River to support human needs will continue and will likely increase during the relicensing term, this stressor will continue to contribute to the cumulative effects in the river.

Invasive and Nuisance Species

As discussed in Section 2.2.5 of this draft SEIS, the presence of invasive or nuisance species in the Hudson River estuary has been documented for over 200 years. While the presence of new or exotic species can benefit some existing species, introductions of new species often have a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Since 1992, zebra mussels have been a dominant species in the freshwater tidal portion of the Hudson River and constitute more than half of heterotrophic biomass. Strayer (2007) estimated that the current population is capable of filtering a volume of water equal to all of the water in the estuary every 1 to 4 days during the summer.

Some evidence suggests that the presence of zebra mussels can affect the species composition and abundance of some Hudson River RIS. Strayer et al. (2004) hypothesized that the abundance or growth rates of American shad, blueback herring, alewife, gizzard shad, white perch, and striped bass would decline following the zebra mussel invasion or that their distributions within the river would shift downriver away from the zone of greatest zebra mussel impacts. The authors found that significant decreases in early lifestages of the estimated riverwide abundance of several species of fish coincided with the zebra mussel invasion, including American shad and white perch. Barnthouse et al. (2008) also concluded that zebra mussels may have contributed to declines in white perch, but rejected the hypothesis that zebra mussels were affecting American shad. Independent analyses by the staff suggested that the presence of zebra mussels resulted in a MODERATE to LARGE potential for adverse impacts to the American shad, blueback herring, spottail shiner, and white perch (see Appendices H and I to this draft SEIS). The presence of invasive or nuisance species in the lower Hudson River will continue to be a concern, as it is in other locations throughout the world, and the presence of these species will continue to represent an important source of cumulative impacts to the

1 river.

2 Fishing Pressure

3 Many RIS are commercially or recreationally important, and are thus subject to effects from
4 fishing pressure. In many cases, the commercial or recreational catches of RIS are regulated
5 by Federal or State agencies or entities, but losses of some RIS continue to occur as the result
6 of bycatch. The extent and magnitude of fishing pressure and its relationship to overall
7 cumulative impacts to the aquatic resources of the lower Hudson River is difficult to determine
8 because of the large geographic scale and the natural variation that exists in the system.
9 Recent work by Barnthouse et al. (2008) has suggested that fishing pressure is contributing to
10 the decline of some RIS in the lower Hudson River, but this could not be confirmed by the staff.
11 The staff does acknowledge that fishing pressure (or the lack of it due to catch restrictions) has
12 the potential to influence the freshwater, estuarine, and marine food webs present in the lower
13 Hudson River and may contribute to cumulative impacts in the future.

14 Habitat Loss

15 As described in Section 2.2.5 of this draft SEIS, alterations to terrestrial, wetland, nearshore,
16 and aquatic habitats have occurred in the Hudson River estuary since colonial times. During
17 the colonization of the region, upland habitat alterations profoundly influenced watershed
18 dynamics. The creation of dams and the filling or isolation of wetlands to support industrial
19 activities have dramatically changed patterns of nutrients and sediment loading to the estuary.
20 In addition, historic dredging activities altered aquatic environments and affected river flow
21 patterns, and future activities, as described in Section 2.2.10 of this draft SEIS, may continue to
22 influence the river. Finally, development along the shores of the Hudson has resulted in the
23 loss or isolation of nearshore habitat, and the armoring of the shoreline in the lower portions of
24 the river from Yonkers to the Battery has effectively eliminated nearshore habitat. The NRC
25 staff recognizes that Federal, State, and local agencies, as well as many NGOs, are interested
26 in restoring habitat lost during past development and notes that the identification of four
27 locations along the lower Hudson River estuary for inclusion in the National Estuarine Research
28 Reserve System in 1982 represents a important step in protecting and restoring important
29 habitats.

30 Because habitat loss remains a concern, the NRC staff concludes that this stressor will continue
31 to be an important contributor to cumulative impacts to the lower Hudson River.

32 Water and Sediment Quality

33 In general, there is evidence to conclude that the overall quality of water and sediment in the
34 lower Hudson River is improving. Cleanup of polychlorinated biphenyls in stretches of the river
35 above the Troy Dam continues, and upgrades to wastewater treatment facilities during the past
36 20 years have reduced the amount of untreated sewage discharged into the river and
37 contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical
38 contaminants continue to persist in the tissues of fish and invertebrates inhabiting the lower
39 Hudson River, and the presence of nonpoint discharges of chemicals and constituents
40 continues to be a concern of local, State, and Federal regulatory agencies and NGOs. The
41 NRC staff concludes that the quality of water and sediment in the lower Hudson River will
42 continue to be a concern and a potential contributor to cumulative impacts.

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Climate Change

The potential cumulative effects of climate change on the Hudson River watershed, whether from natural cycles or related to anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance identified by Kennedy (1990) that could affect estuarine systems included sea level rise, temperature increase, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects to nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes to marsh communities, and influences to wetland areas adjacent to nearshore systems. Water temperature increases could affect spawning patterns or success, or influence the distribution of key RIS when cold-water species move northward while warm-water species become established in new habitats. Changes to river salinity and the presence of the salt front could influence the spawning and distribution of RIS and the range of exotic or nuisance species. Fundamental changes in precipitation could profoundly influence water circulation and change the nature of sediment and nutrient inputs to the system. This could result in changes to primary production and influence the estuarine food web on many levels. Kennedy (1990) also concluded that some fisheries and aquaculture enterprises might benefit from climate change, while others would suffer extensive economic losses.

The extent and magnitude of climate change impacts to the aquatic resources of the lower Hudson River are an important component of the cumulative assessment analyses and could be substantial.

Final Assessment of Cumulative Impacts on Aquatic Resources

Based on the NRC staff review, it is clear that Hudson River RIS are affected (some to a lesser degree than others) by multiple stressors. The NRC staff's analysis (Appendix H) demonstrated that the food web and abundance of RIS were noticeably altered, and many RIS appeared to be directly influenced by the operation of the IP2 and IP3 cooling system (e.g., HIGH strength of connection). The impacts of some of the stressors may be addressed by management actions (e.g., IP2 and IP3 cooling system operation, fishing pressure, and water quality) and some cannot (e.g., long-term impacts associated with climate change). Although the impacts associated with increased human populations and associated development of the Hudson River basin, climate change, redistribution of resources, and the presence of invasive species and disease cannot be quantitatively calculated, the cumulative impacts on aquatic resources have had destabilizing effects on Hudson River living resources, including threatened and endangered species (i.e., the net effect of all stressors destabilized some populations) and are considered by the NRC staff to be LARGE.

4.8.2 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in cumulative adverse impacts on terrestrial resources, including wildlife populations, vegetation communities of uplands and riparian zones, wetlands, and land use. For purposes of this analysis, the geographic area considered consists of the IP2 and IP3 site, which encompasses its associated transmission line ROWs, and the surrounding region of the lower Hudson Valley.

The changes in land use associated with historical settlement and development of this region are described in Section 2.2.5.2 of this draft SEIS. During precolonial and colonial settlement

1 by European immigrants, large areas of the forest that had almost completely covered the
2 region were cleared for agriculture, and by 1880, 68 percent of the Hudson River watershed had
3 become farmland. Also in the 19th century, major changes in land use occurred in the region in
4 conjunction with the industrial revolution as human populations grew and houses, roads,
5 railroads, bridges, and industrial facilities were constructed. These historical trends of
6 increasing development and decreasing terrestrial habitat in the region continued through the
7 20th century to the present, resulting in large reductions in native forests and other habitats for
8 terrestrial wildlife, increases in precipitation runoff due to impervious surfaces, and pollution
9 (Swaney et al. 2006).

10 Before the historical clearing of land at the IP2 and IP3 site, the terrestrial communities of the
11 area consisted mainly of upland and riparian forests (NRC 1975). The site was originally
12 purchased in 1683 by a Dutch settler, who established a homestead there. By the latter 19th
13 century, the north end of Indian Point was being surface mined for iron, and a lime kiln and blast
14 furnace were located at the shoreline. By 1900 a brickyard existed on the site, and farming still
15 occurred there. In 1920 an amusement park was built on the site. The park closed in 1956, and
16 construction of the first commercial nuclear reactor in the United States then began at the site
17 (Enercon 2007). Thus, the site had been largely cleared of forest and developed for various
18 uses for well over a century before its development for power generation began in the second
19 half of the 20th century. Power plant development resulted in over half of the site (134 ac
20 (54.2 ha)) being covered by facilities and pavement, with forest having regenerated at the north
21 end of the site where mining occurred historically. Remaining native forest habitat in central and
22 southern portions of the site has been fragmented by roads, ROWs, parking areas, and other
23 development, a phenomenon that has commonly occurred in the region.

24 Developed areas with impervious surfaces have increased precipitation runoff and reduced
25 infiltration into the soil, thus reducing ground water recharge, altering streamflow, and increasing
26 soil erosion. Maintenance of vegetation in ROWs and other developed areas, such as by
27 mowing and spraying of herbicides, has altered the ecological communities in these areas by
28 preventing natural succession. It also likely has resulted in increases in invasive species, such
29 as Japanese knotweed (*Fallopia japonica*), which typically are more aggressive than native
30 species in colonizing disturbed areas; increases in species that prefer edge habitat; and
31 decreases in species that prefer interior forest habitat. Such effects from development within
32 the IP2 and IP3 site contribute to cumulative impacts from similar effects on native ecological
33 communities from other development in the region.

34 Land use data provide an indication of the impacts on terrestrial resources that have resulted
35 from historical and ongoing development. Current land uses in the region are discussed by
36 county in Section 2.2.8.3 of this draft SEIS. In Westchester County, based on 1992 data, forest
37 was the predominant type of land cover (53 percent), followed by residential (30 percent),
38 agricultural and recreational (7 percent), and commercial/industrial/transportation uses
39 (3 percent) (Energy 2007a). In four nearby counties in the lower Hudson Valley (Rockland,
40 Orange, Putnam, and Dutchess), forest also was the predominant type of land cover, followed
41 by residential or agricultural, and commercial/industrial/transportation land uses ranged from
42 about 1 to 4 percent (Energy 2007a). Thus, commercial, industrial, and transportation facilities,
43 including the IP2 and IP3 site, have had a relatively small impact on the loss of native terrestrial
44 forest habitats in the region compared to residential and agricultural development. The
45 commercial, industrial, and transportation facilities that have impacted terrestrial resources in

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the region in addition to the IP2 and IP3 site include six power generation facilities on the Hudson River between RM 37 and 67 (RKM 60 to 97), highways, railways along both sides of the river, and manufacturing plants.

Although development of the site has contributed to cumulative impacts on terrestrial resources from historical and ongoing development in the region, portions of the site have been protected from development. The 70-ac (28-ha) forest community at the north end of the site has been and, under the proposed action, would continue to be preserved, providing a beneficial effect by reducing the potential for cumulative impacts from further loss of forests in the region. In conjunction with this onsite forest tract, public lands in the region also preserve forest habitat and have a beneficial cumulative impact on terrestrial resources. These lands include three State parks in Westchester County and a total of 22 others in Rockland, Orange, Putnam, and Dutchess Counties (Entergy 2007a), as well as forested lands of the New York State National Guard's Camp Smith and the U.S. Military Academy at West Point.

Ultimately, development of the IP2 and IP3 site for power generation contributed incrementally to a substantial, cumulative reduction in terrestrial resources resulting from other development activities in the region that have occurred since precolonial times. However, as discussed in Section 4.4.3 of this draft SEIS, there would be no population-related land use impacts attributable to IP2 and IP3 during the license renewal term beyond those already being experienced, and there would be no noticeable change in land use conditions in the vicinity of IP2 and IP3.

The NRC staff concludes that the impact of past, present, and reasonably foreseeable future actions in the region on terrestrial resources is considered LARGE relative to predevelopment conditions, and that much of this impact had occurred before the construction and operation of IP2 and IP3.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the IP2 and IP3 site was included. The radiological environmental monitoring program conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive materials from all sources; therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994 radiological environmental monitoring data from the area around IP2 and IP3 reported by New York State; the data showed no adverse environmental impact. For the new issue identified by Entergy concerning the tritium leak into the Hudson River, the NRC staff also reviewed the information reported by Entergy, the NYSDEC and NYSDOH, and by the NRC. No adverse impacts were identified (Entergy 2007b, NYSDEC and NYSDOH 2008, NRC 2006b, NRC 2007b).

Radiation monitoring results for the 5-year period from 2002 to 2006 were reviewed as part of the cumulative impacts assessment. In Sections 2.2.7 and 4.3 of this draft SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from

1 operation of IP2 and IP3 during the renewal term are SMALL. The NRC and the State of New
2 York would regulate any future actions in the vicinity of the IP2 and IP3 site that could contribute
3 to cumulative radiological impacts (Entergy 2003, 2004, 2005, 2006, 2007b).

4 Entergy has constructed an independent spent fuel storage installation (ISFSI) on the IP2 and
5 IP3 site in 2008 for the storage of its spent fuel. The installation and monitoring of this facility is
6 governed by NRC requirements in 10 CFR Part 72, "Licensing Requirements for the
7 Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-
8 Related Greater Than Class C Waste." Radiation from this facility as well as from the operation
9 of IP2 and IP3 must not exceed the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190,
10 and 10 CFR Part 72 (Entergy 2007a).

11 In addition, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and
12 CRDMs during the period of extended operation. Such an action is not expected to change the
13 applicant's ability to maintain radiological doses to members of the public well within regulatory
14 limits because the amount of radioactive liquid, gaseous, and solid waste is not expected to
15 increase significantly (see Sections 2.1.4 and 2.2.7 of this draft SEIS for the detailed
16 discussion).

17 For these reasons, the NRC staff concludes that cumulative radiological impacts are SMALL, as
18 are the contribution to radiological impacts from continued operation of IP2 and IP3 and their
19 associated ISFSI. The NRC and the State of New York will continue to regulate operation of
20 IP2 and IP3 for radiological impacts.

21 **4.8.4 Cumulative Socioeconomic Impacts**

22 As discussed in Section 4.4 of this draft SEIS, continued operation of IP2 and IP3 during the
23 license renewal term would have no impact on socioeconomic conditions in the region beyond
24 those already being experienced. Since Entergy has indicated that it plans to hire no additional
25 nonoutage workers during the license renewal term, overall expenditures and employment
26 levels at IP2 and IP3 would be expected to remain relatively constant with no additional demand
27 for permanent housing, public utilities, and public services. In addition, since employment levels
28 and the value of IP2 and IP3 would not change, there would be no population and tax-revenue-
29 related land use impacts. Also, there would be no disproportionately high and adverse health
30 and environmental impacts on minority and low-income populations in the region.

31 Entergy has indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs,
32 and the decision to proceed with this replacement activity would be made based on future
33 component inspection results (Entergy 2008b). Nevertheless, Entergy estimates that this
34 replacement activity would require an increase in the number of refueling outage workers for up
35 to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy
36 2008b). These additional workers would create short-term increases in the demand for
37 temporary (rental) housing, increased use of public water and sewer services, and
38 transportation impacts on access roads in the immediate vicinity of IP2 and IP3. Since it is not
39 certain if Entergy will replace the IP2 and IP3 reactor vessel heads and CRDMs, and given the
40 short amount of time needed for this replacement activity, the cumulative effects of these
41 replacement activities on socioeconomic conditions in the vicinity of IP2 and IP3 would not likely
42 be noticeable. Also, there would be no long-term cumulative socioeconomic impacts after the
43 reactor vessel heads and CRDMs are replaced.

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In general, the region surrounding IP2 and IP3 has experienced growing population, increasing economic activity and tax revenue, and changes in demographics over time. These effects in the region have been LARGE, though the contribution of IP2 and IP3 to these effects have been SMALL, except, in some cases, locally. Additionally, development in the region has had a significant effect on historical and archaeological resources, which could be LARGE, as the region is home to significant historic and prehistoric resources (as noted in 4.4.5, however, continued operation of the plant would only have SMALL effects on historic and archaeological resources).

4.8.5 Cumulative Impacts on Ground Water Use and Quality

In 2005 tritium was located beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these abnormal leaks to the ground water is discussed in Section 2.2.7 of this draft SEIS, and referenced in Sections 4.5 and 4.7.

The topography of the site and the foundation drains around the structures result in a flow regime that transports ground water towards the Hudson River. As a result, the contaminated ground water will be transported to the Hudson River and not off site in a direction that it might be captured by an offsite ground water user. The results of monitoring programs support this conclusion.

Because the water travels off site and into the Hudson River, there are no users for onsite ground water. Any effects from the plant, previous development, or future development on site will likely remain limited to effects on ground water transiting the site to the Hudson River, and thus, are likely to be limited.

On the basis of the topography of the site, the characteristics of the subsurface media, location of the plant relative to the Hudson River, recent ground water monitoring observations, and the fact that there are no users for the site's ground water, the NRC staff concludes that the cumulative impact on the site's ground water use and quality are SMALL.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from the operation of IP2 and IP3 and resulting from other past, present, and reasonably foreseeable future actions in the vicinity. The NRC staff's determination is that the cumulative impacts to the environment surrounding IP2 and IP3 from past and present human activities (beyond impacts from IP2 and IP3) have generally been LARGE and could continue to be LARGE in some issue areas. Future development is likely to continue to affect these resources.

4.9 Summary of Impacts of Operations during the Renewal Term

The NRC staff did not identify any information that is both new and significant related to any of the applicable Category 1 issues associated with the operation of IP2 and IP3 during the renewal term, including information related to ground water contamination at Indian Point. Consequently, the NRC staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS

concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Thirteen of the site-specific environmental issues identified in the GEIS related to operational impacts, and postulated accidents during the renewal term are discussed in detail in this draft SEIS. These include 11 Category 2 issues and two uncategorized issues (environmental justice and the chronic effects of EMFs). The NRC staff did not evaluate the chronic effects of EMFs because research is continuing in the area and no scientific consensus on human health impacts exists. The NRC staff will evaluate severe accident mitigation alternatives in Chapter 5.

For 6 of the remaining 10 Category 2 issues and environmental justice, the NRC staff concluded that the potential impacts of continued plant operation during the license renewal period on these issues are of SMALL significance in the context of the standards set forth in the GEIS. For four of these issues, the NRC staff concluded that the impacts of continued operation would have a significant effect. On the issue of heat shock on the aquatic ecology, the NRC staff concludes that effects are of SMALL to MODERATE significance, given uncertainty about actual thermal effects of the plant. The NRC staff evaluated the combined effects of entrainment and impingement on aquatic life and found the impacts to range from SMALL to LARGE, depending on the species. Finally, the NRC staff found that impacts to threatened and endangered species could range from SMALL to LARGE but that existing data make it difficult for staff to assign a single impact level. Further sampling for threatened and endangered species at IP2 and IP3 could reduce this uncertainty.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

Environmental issues associated with postulated accidents are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾ The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

5.1.1 Design-Basis Accidents

In order to receive U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, as well as a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) and 10 CFR Part 100, "Reactor Site Criteria."

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license. The results of these evaluations are found in licensing documentation such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, the final environmental statement (FES), and Section 5.1 of this draft supplemental environmental impact statement (SEIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these DBAs are evaluated for the hypothetical maximally exposed individual. Changes in the plant's surroundings, including local population, will not affect the evaluation for the maximally exposed individual. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the period of extended operation. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The early resolution of the DBAs makes them a part of the current licensing basis (CLB) of the plant; the CLB of the plant, which is maintained by the licensee under its current license, will continue to be maintained under a renewed license in accordance with 10 CFR 54.33, "Continuation of CLB and Conditions of Renewed License." Therefore, under the provisions of 10 CFR 54.30, "Matters Not Subject to a Renewal Review," the CLB is not subject to review under license renewal. This issue, applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), is listed in Table 5-1.

Table 5-1. Category 1 Issues Applicable to Postulated Accidents during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
POSTULATED ACCIDENTS	

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Design-basis accidents	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found the following:

The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to DBAs beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, regardless of offsite consequences. In the GEIS, the NRC staff assessed the impacts of severe accidents using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, traditionally have not been discussed in quantitative terms in FESs and were not specifically considered for IP2 and IP3 in the GEIS. However, in the GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal documents a discretionary analysis of acts of sabotage in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concluded that the risk from sabotage and beyond-design-basis earthquakes at existing nuclear power plants is small and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (see Volume 1 of the GEIS, page 5-18).

Based on information in the GEIS, the Commission found the following:

The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to IP2 and IP3, is listed in Table 5-2.

Table 5-2. Category 2 Issues Applicable to Postulated Accidents during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
POSTULATED ACCIDENTS			
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the IP2 and IP3 ER (Entergy 2007a), the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for IP2 and IP3. The results of its review are discussed in Section 5.2 of this draft SEIS.

5.2 Severe Accident Mitigation Alternatives

As required by 10 CFR 51.53(c)(3)(ii)(L), license renewal applicants must consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS), or related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for IP2 and IP3; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for IP2 and IP3, conducted by Entergy, and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Information Systems Laboratories, Inc. The NRC staff's review is available in full in Appendix G to this draft SEIS; the SAMA evaluation is available in full in Entergy's ER.

The SAMA evaluation for IP2 and IP3 was conducted using a four-step approach. In the first step, Entergy quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic safety assessment (PSA) and other risk models.

In the second step, Entergy examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Entergy initially identified 231 and 237 potential SAMAs for IP2 and IP3, respectively. For each unit, Entergy performed an initial screening in which it eliminated SAMAs that are not applicable to IP2 and IP3 because of design differences, have already been implemented at IP2 and IP3, or are similar in nature and could be combined with another SAMA candidate. This screening reduced the list of potential SAMAs to 68 for IP2 and

62 for IP3.

In the third step, Entergy estimated the benefits and the costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997). The cost of implementing the proposed SAMAs also was estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost benefit). Entergy concluded in its ER that several of the SAMAs evaluated for each unit are potentially cost beneficial (Entergy 2007b). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Entergy 2008a). The NRC staff identifies potentially cost-beneficial SAMAs in Section 5.2.5.

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for IP2 and IP3 as part of the ER (Entergy 2007b). This assessment was based on the most recent IP2 and IP3 PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the IP2 and IP3 individual plant examination (Con Ed 1992; NYPA 1994) and individual plant examination of external events (Con Ed 1995 and NYPA 1997).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 1.79×10^{-5} per year for IP2 and 1.15×10^{-5} per year for IP3. The CDF values are based on the risk assessment for internally initiated events. Entergy did not include the contributions from external events within the IP2 and IP3 risk estimates; however, it did perform separate assessments of the CDF from external events and did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of approximately 3.8 for IP2 and 5.5 for IP3 (as discussed in Appendix G, Sections G.2.2 and G.6.2). The breakdown of CDF by initiating event for IP2 and IP3 is provided in Table 5-3.

1

Table 5-3. IP2 and IP3 Core Damage Frequency

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
Loss of offsite power ¹	6.7x10 ⁻⁶	38	1.2x10 ⁻⁷	1
Internal flooding	4.7x10 ⁻⁶	26	2.2x10 ⁻⁶	20
Loss-of-coolant accident (LOCA)	1.5x10 ⁻⁶	8	2.2x10 ⁻⁶	19
Transients ¹	1.2x10 ⁻⁶	7	8.5x10 ⁻⁷	7
Anticipated transient without scram	9.9x10 ⁻⁷	6	1.5x10 ⁻⁶	13
Station blackout	8.5x10 ⁻⁷	5	7.2x10 ⁻⁷	6
Steam generator tube rupture	7.2x10 ⁻⁷	4	1.6x10 ⁻⁶	14
Loss of component cooling water	5.8x10 ⁻⁷	3	1.1x10 ⁻⁷	<1
Loss of nonessential service water interfacing systems LOCA	3.0x10 ⁻⁷	2	2.8x10 ⁻⁷	2
Reactor vessel rupture	1.5x10 ⁻⁷	<1	1.5x10 ⁻⁷	1
Loss of 125 volts direct current power	1.0x10 ⁻⁷	<1	1.0x10 ⁻⁷	<1
Total loss of service water system	5.8x10 ⁻⁸	<1	1.0x10 ⁻⁶	9
Loss of essential service water	4.4x10 ⁻⁸	<1	5.4x10 ⁻⁷	5
	1.9x10 ⁻¹⁰	<1	1.9x10 ⁻⁸	<1
Total CDF (internal events)	1.79x10⁻⁵	100	1.15x10⁻⁵	100

¹Contributions from SBO and ATWS events are noted separately and not included in the reported values for loss of offsite power or transients.

As shown in Table 5-3, for IP2, loss of offsite power sequences, including station blackout (SBO) events, and internal flooding initiators are the dominant contributors to CDF. For IP3, internal flooding initiators, loss-of-coolant accidents (LOCAs), steam generator tube rupture (SGTR) events, and anticipated transient without scram (ATWS) events are the dominant contributors to CDF. The differences in the CDF contributions are attributed, in large part, to several significant differences between the IP2 and IP3 units.

Entergy estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.22 person-sievert (Sv) (22 person-rem) per year for IP2, and 0.24 Sv (24 person-rem) per year for IP3. The breakdown of the total population dose by containment failure mode is summarized in Table 5-4. SGTR events and late containment failures, caused by gradual overpressurization by steam and noncondensable gases, dominate the population dose risk for both units.

The NRC staff has reviewed Entergy's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDFs

and offsite doses reported by Entergy.

Table 5-4. Breakdown of Population Dose by Containment Failure Mode

Containment Failure Mode	IP2		IP3	
	Population Dose (Person-Rem ¹ Per Year)	% Contribution	Population Dose (Person-Rem ¹ Per Year)	% Contribution
Intact Containment	<0.1	<1	<0.1	<1
Basemat Melt-through	1.1	5	0.6	3
Gradual Overpressure	7.4	34	4.4	18
Late Hydrogen Burns	0.9	4	0.6	2
Early Hydrogen Burns	2.1	10	0.8	3
In-Vessel Steam Explosion	0.1	1	0.1	0
Reactor Vessel Rupture	1.0	5	0.4	2
Interfacing System LOCA	1.6	7	1.1	4
SGTR	7.7	35	16.6	68
Total	22.0	100	24.3	100

¹One person-rem = 0.01 person-sievert

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA and SAMA analyses performed for other operating plants that have submitted license renewal applications. Entergy identified 231 and 237 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training for IP2 and IP3, respectively.

For IP2, Entergy removed all but 68 of the SAMAs from further consideration because they are not applicable to IP2 as a result of design differences, have already been implemented at IP2, or are similar in nature and could be combined with another SAMA candidate. For IP3, all but 62 of the SAMAs were removed from further consideration based on similar criteria. A detailed cost-benefit analysis was performed for each of the remaining SAMAs.

The staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for IP2 and IP3, and that the set of potential plant improvements identified by Entergy is reasonably comprehensive and, therefore, acceptable.

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

Entergy evaluated the risk-reduction potential of the remaining candidate SAMAs that were applicable to each unit (68 for IP2 and 62 for IP3). The SAMA evaluations were performed using realistic assumptions with some conservatism.

Entergy estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and the use of other licensees' estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they account for inflation.

The staff reviewed Entergy's basis for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on Entergy's risk reduction estimates.

The staff reviewed the basis for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The staff found the cost estimates to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the risk reduction and the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NRC 2004), has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed—one at 3 percent and one at 7 percent (NRC 2004). Entergy provided both sets of estimates (Entergy 2007b).

As described in Section G.6.1, Entergy identified 10 potentially cost-beneficial SAMAs (5 for IP2 and 5 for IP3) in the baseline analysis (using a 7-percent discount rate) and sensitivity analysis (using a 3-percent discount rate) contained in the ER. Based on consideration of analysis uncertainties, Entergy identified two additional potentially cost-beneficial SAMAs for IP2 in the ER (IP2 SAMAs 44 and 56).

In response to an NRC staff request, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was accounted for in the baseline analysis (rather than as a separate sensitivity case) (Entergy 2008a). The revised uncertainty analysis resulted in the identification of two additional potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3 SAMA 53).

The potentially cost-beneficial SAMAs for IP2 include the following:

- SAMA 9—Create a reactor cavity flooding system to reduce the impact of core-concrete interaction from molten core debris following core damage and vessel failure (cost beneficial in revised analysis, with uncertainties).
- SAMA 28—Provide a portable diesel-driven battery charger to improve direct current (dc) power reliability. Safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven auxiliary feed water (AFW) pump on battery depletion.
- SAMA 44—Use fire water as backup for steam generator inventory to increase the availability of steam generator water supply to ensure adequate inventory for the operation of the turbine-driven AFW pump during SBO events (cost beneficial with uncertainties).
- SAMA 53—Keep both pressurizer power-operated relief valve block valves open. This modification would reduce the CDF contribution from loss of secondary heat sink by improving the availability of feed and bleed (cost beneficial in revised analysis, with uncertainties).
- SAMA 54—Install a flood alarm in the 480-volt (V) alternating current (ac) switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.
- SAMA 56—Keep residual heat removal (RHR) heat exchanger discharge valves, motor-operated valves 746 and 747, normally open. This procedure change would reduce the CDF contribution from transients and LOCAs (cost beneficial with uncertainties).
- SAMA 60—Provide added protection against flood propagation from stairwell 4 into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within stairwell 4 adjacent to the 480-V ac switchgear room.
- SAMA 61—Provide added protection against flood propagation from the deluge room into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within the deluge room adjacent to the 480-V ac switchgear room.
- SAMA 65—Upgrade the alternate safe shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.

The potentially cost-beneficial SAMAs for IP3 include the following:

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- 1 • SAMA 30—Provide a portable diesel-driven battery charger to improve dc power
2 reliability. Safety-related disconnect would be used to change a selected battery. This
3 modification would enhance the long-term operation of the turbine-driven AFW pump on
4 battery depletion.
- 5 • SAMA 52—Proceduralize opening the city water supply valve for alternative AFW
6 system pump suction to enhance the availability of AFW system.
- 7 • SAMA 53—Install an excess flow valve to reduce the risk associated with hydrogen
8 explosions inside the turbine building or primary auxiliary building (cost beneficial in
9 revised analysis, with uncertainties).
- 10 • SAMA 55—Provide the capability of powering one safety injection pump or RHR pump
11 using the Appendix R diesel (MCC 312A) to enhance reactor cooling system injection
12 capability during events that cause loss of power from the 480-V ac vital buses.
- 13 • SAMA 61—Upgrade the alternate safe-shutdown system to allow timely restoration of
14 reactor coolant pump seal injection and cooling from events that cause loss of power
15 from the 480-V ac vital buses.
- 16 • SAMA 62—Install a flood alarm in the 480-V ac switchgear room to mitigate the
17 occurrence of internal floods inside the 480-V ac switchgear room.

18 In response to an NRC staff inquiry regarding estimated benefits for certain SAMAs and lower
19 cost alternatives, one additional potentially cost-beneficial SAMA was identified (applicable to
20 SGTR events in both units; unnumbered for each unit because the applicant did not initially
21 identify them), and one SAMA that was previously identified as potentially cost beneficial was
22 found to be no longer cost beneficial based on correction of an error in the ER (IP3 SAMA 30).

23 The staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed
24 above, the costs of the SAMAs evaluated would be higher than the associated benefits.

25 **5.2.6 Conclusions**

26 The staff reviewed Entergy's analysis and concluded that the methods used, and the
27 implementation of those methods, were sound. The treatment of SAMA benefits and costs
28 support the general conclusion that the SAMA evaluations performed by Entergy are reasonable
29 and sufficient for the license renewal submittal. Although the treatment of SAMAs for external
30 events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this
31 area was minimized by improvements that have been realized as a result of the IPEEE process
32 and inclusion of a multiplier to account for external events.

33 Based on its review of the SAMA analysis, the staff concurs with Entergy's identification of
34 areas in which risk can be further reduced in a cost-beneficial manner through the
35 implementation of all or a subset of potentially cost-beneficial SAMAs. Given the potential for
36 cost-beneficial risk reduction, the staff considers that further evaluation of these SAMAs by
37 Entergy is warranted. However, none of the potentially cost-beneficial SAMAs relate to
38 adequately managing the effects of aging during the period of extended operation. Therefore,
39 they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

5.3 References

- 10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."
- 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."
- 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."
- 10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."
- Consolidated Edison (Con Ed). 1992. Letter from Stephen B. Bram to U.S. Nuclear Regulatory Commission, Subject: Generic Letter 88-20, Supplement 1: Individual Plant Examination (IPE) for Severe Accident Vulnerabilities—10 CFR 50.54, Indian Point Unit No. 2, August 12, 1992.
- Consolidated Edison (Con Ed). 1995. Letter from Stephen E. Quinn to U.S. Nuclear Regulatory Commission, Subject: Final Response to Generic Letter 88-20, Supplement 4: Submittal of Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, Indian Point Unit No. 2, December 6, 1995.
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- Entergy Nuclear Operations, Inc. (Entergy). 2008. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-028, May 22, 2008. ADAMS Accession No. ML080420264.
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- New York Power Authority (NYPA). 1997. Letter from James Knubel to U.S. Nuclear Regulatory Commission, Subject: Indian Point 3 Nuclear Power Plant Individual Plant Examination of External Events (IPEEE), September 26, 1997.
- Nuclear Regulatory Commission (NRC). 1996. "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants." NUREG-1437, Volumes 1 and 2, Washington, DC.

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- 1 Nuclear Regulatory Commission (NRC). 1997. "Regulatory Analysis Technical Evaluation
2 Handbook." NUREG/BR-0184, Washington, DC.
- 3 Nuclear Regulatory Commission (NRC). 1999. "Generic Environmental Impact Statement for
4 License Renewal of Nuclear Plants, Main Report," Section 6.3, "Transportation," Table 9.1,
5 "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final
6 Report." NUREG-1437, Volume 1, Addendum 1, Washington, DC.
- 7 Nuclear Regulatory Commission (NRC). 2004. "Regulatory Analysis Guidelines of the U.S.
8 Nuclear Regulatory Commission." NUREG/BR-0058, Rev. 4, Washington, DC. ADAMS
9 Accession No. ML042820192.

6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE AND SOLID WASTE MANAGEMENT

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999.)⁽¹⁾ The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The generic potential radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." The U.S. Nuclear Regulatory Commission (NRC) staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to IP2 and IP3 from the uranium fuel cycle and solid waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.2.2; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.4
Mixed waste storage and disposal	6.1; 6.4.5; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.6
Nonradiological waste	6.1; 6.5; 6.6
Transportation	6.1; 6.3, Addendum 1; 6.6

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses, though it did identify leaks to ground water as a potentially new issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL (except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, as discussed below) and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, for each of these issues follows:

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- Off-site radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste). Based on information in the GEIS, the Commission found the following:

Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part (10 CFR 51.51(b)). Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (individual effects) of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Off-site radiological impacts (collective effects). Based on information in the GEIS, the Commission found the following:

The 100 year environmental dose commitment to the United States (U.S.) population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next one thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.

Nevertheless, despite all of the uncertainty, some judgement as to the National Environmental Policy Act of 1969, as amended (NEPA) implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The NRC staff has not identified any new and significant information during its independent

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review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high-level waste disposal). Based on information in the GEIS, the Commission found the following:

For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for off-site releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards" (NAS 1995), and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem (mrem) (1 mSv) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 mrem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 mrem (1 mSv) per year. The lifetime individual risk from 100 mrem annual dose limit is about 3×10^{-3} .

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the U.S. Department of Energy (DOE) in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 (DOE 1980). The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative

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population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR Part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric ton (MT) repository.

Nevertheless, despite all of the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

On February 15, 2002, based on a recommendation by the Secretary of the DOE, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. Congress approved this recommendation on July 9, 2002, in Joint Resolution 87, which designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 designates Yucca Mountain as the repository for spent nuclear waste.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts related to spent fuel and high-level waste disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found the following:

The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no

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nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found the following:

The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small.

Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found the following:

The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found the following:

The expected increase in the volume of spent fuel from an additional 20 years of

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operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found the following:

No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found the following:

The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 megawatt-days per metric ton of uranium (MWd/MTU) and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in 10 CFR 51.52.

IP2 and IP3 meet the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.2 Greenhouse Gas Emissions

6.2.1 Introduction

The NRC staff received many comments during the scoping period from individuals and groups

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regarding the impact of the proposed relicensing of IP2 and IP3 on the release of carbon dioxide (CO₂) and other greenhouse gas (GHG) emissions relative to potential alternative energy sources, including fossil fuels, renewable energy sources, and conservation programs.

6.2.2 IP2 and IP3

The NRC staff has not identified any studies specifically addressing GHGs produced by IP2 and IP3 or their fuel cycles. Although Entergy developed a study identifying gas emissions that would result if IP2 and IP3 were to be decommissioned and their generating capacity replaced with fossil-fuel based sources (Entergy Nuclear Northeast 2002), Entergy did not evaluate GHG emissions related to the existing facility. This study evaluated emissions of CO₂, sulfur dioxide, nitrogen oxides, particulates (i.e., PM₁₀), carbon monoxide, and volatile organic compounds (VOCs). The study was intended as an evaluation of the impact of IP2 and IP3 shutdown on air quality in the local New York City area, rather than an evaluation of the impact of IP2 and IP3 shutdown on global GHG emissions.

6.2.3 GEIS

The GEIS provided only qualitative discussions regarding the GHG impacts of the nuclear fuel cycle. In the analysis of potential alternatives to nuclear power plant relicensing, the GEIS referenced CO₂ emissions as one of the substantial operating impacts associated with new coal-fired and oil-fired power plants, although no direct quantitative assessment of GHG emissions was presented. The GEIS also did not address GHG impacts of the nuclear fuel cycle relative to other potential alternatives, such as natural gas, renewable energy sources, or conservation programs.

6.2.4 Other Studies

Since the development of the GEIS, extensive further research into the relative volumes of GHGs emitted by nuclear and other electricity generating methods has been performed. In support of the analysis for this draft SEIS, the NRC staff performed a survey of the recent literature on the subject. Based on this survey, the NRC staff found that estimates and projections of the carbon footprint of the nuclear power lifecycle vary widely, and considerable debate exists regarding the relative impacts of nuclear and other electricity generation methods on GHG emissions. These recent studies take two different forms:

- (1) qualitative discussions of the potential use of nuclear power to address GHG emissions and global warming
- (2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle

6.2.5 Qualitative

The qualitative studies primarily consist of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies that commenters referenced during the scoping period or that the NRC staff identified during the

subsequent literature search include the following:

- Studies conducted to evaluate whether investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider 2000; IAEA 2000; NEA 2002; and NIRS/WISE 2005). Ultimately, the parties did not approve nuclear power as a component under the Clean Development Mechanism (CDM), but not because of concerns about GHGs from the nuclear fuel cycle (NEA 2002). Instead, it was eliminated from consideration for the CDM because it was not considered to meet the criterion of helping developing nations achieve sustainable development because of safety and waste disposal concerns (NEA 2002).
- Analyses developed to assist governments (including the U.S. Government) in making long-term investment and public policy decisions in nuclear power (Keepin 1988; Hagen et al. 2001; MIT 2003).

Although the qualitative studies sometimes reference and critique the rationale contained in the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are not directly applicable to the evaluation of GHG emissions that will be associated with the proposed relicensing of IP2 and IP3.

6.2.6 Quantitative

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature. Examples of these studies include Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), POST (2006), AEA (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparison of the different studies is difficult because the assumptions and components of the lifecycles included within each study vary widely. Examples of differing assumptions that make comparability between the studies difficult include the following:

- the type of energy source that may be used to mine uranium deposits in the future
- the amount of reprocessing of nuclear fuel that will be performed in the future
- the type of energy source and process that might be used to enrich uranium in the future
- different calculations regarding the grade and volume of recoverable uranium deposits in the world
- different estimates regarding the GHG emissions associated with declining grades of recoverable coal, natural gas, and oil deposits
- the release of GHG gases other than CO₂, including the conversion of the masses of these gases into grams of CO₂ equivalents per kilowatt-hour (g C_{eq} /kWh)

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- the technology to be used for future fossil fuel power systems, including cogeneration systems
- the projected capacity factors assumed for the different generation alternatives
- the different types of nuclear reactors used currently and in the projected future (light water reactor, pressurized-water reactor, Canadian deuterium-natural uranium reactor, breeder)

In addition, studies are inconsistent in their application of full lifecycle analyses, including plant construction, decommissioning, and resource extraction (uranium ore, fossil fuel). For instance, Storm van Leeuwen and Smith (2005) present comparisons of GHG emissions from nuclear versus natural gas that incorporate GHG emissions associated with nuclear plant construction and decommissioning in the values used for comparison.

In the case of the proposed IP2 and IP3 relicensing, the relicensing action will not involve additional GHG emissions associated with construction because the facility already exists. In addition, the proposed relicensing action will not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. In many of these studies, the contribution of GHG emissions from facility construction and decommissioning cannot be separated from the other lifecycle GHG emissions that would be associated with IP2 and IP3 relicensing. Therefore, these studies overestimate the GHG emissions attributed to the proposed IP2 and IP3 relicensing action.

In an early study on the subject, Dr. Nigel Mortimer conducted an analysis of the GHG emissions resulting from the nuclear fuel cycle in 1990 (Mortimer 1990). In this study, Mortimer stressed that the GHG implications of the nuclear fuel cycle were substantially related to the ore grade of uranium that must be mined to support nuclear power generation. Using ore grades that were current as of 1990, this study concluded that nuclear power offered a dramatic reduction in GHG emissions over conventional coal-fired power plants over an estimated 35-year lifecycle. The analysis estimated that a nuclear power plant would generate 230,000 tons (209,000 metric tonnes (MT)) of CO₂ over a 35-year life span, or about 3.9 percent of the 5,912,000 tons (5,363,000 MT) that an equivalent coal-fired plant would generate (Mortimer 1990). The study also projected that most of this 230,000 tons (209,000 MT) of CO₂ resulted from the use of a coal-fired plant to perform uranium enrichment by gaseous diffusion, and that using nuclear power and alternative enrichment methods in the future could reduce the amount to 21,000 tons (19,000 MT) (Mortimer 1990).

Mortimer's study went on to demonstrate that the GHG impact of the nuclear fuel cycle would increase as the grade of uranium ore mined dropped, and that the net emissions of CO₂ from the nuclear and coal-fired alternatives would become equal once uranium ore grades reached 0.01-percent uranium oxide. However, Mortimer does not address differences in energy consumption from future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements. Based on his cutoff ore grade and projections of ore reserves, Mortimer estimated GHG emissions of nuclear and natural gas generation would occur after a period of 23 years (Mortimer 1990). The analysis also compared GHG emissions associated with the nuclear fuel cycle with other electricity generation and efficiency options, including hydroelectric, wind, tidal power, and new types of insulation and lighting (but not including natural gas). The conclusion was that nuclear power had lower GHG

emissions compared to coal, but that GHG emissions associated with the nuclear fuel cycle still exceeded those for renewable generation and conservation options (Mortimer 1990).

The Mortimer (1990) study is not presented here to support a definitive conclusion regarding whether nuclear energy produces fewer GHG emissions than other alternatives and similar discussions will not be presented in this draft SEIS for each of the available studies. Instead, the NRC staff presents the Mortimer (1990) study to provide an example of the types of considerations underlying the calculations and arguments presented by the various authors. Almost every existing study has been critiqued, and its assumptions challenged, by later authors. Therefore, no single study has been selected to represent definitive results in this draft SEIS. Instead, the results from a variety of the studies are presented in Tables 6-2, 6-3, and 6-4 to provide a weight-of-evidence argument comparing the relative GHG emissions resulting from the proposed IP2 and IP3 relicensing compared to the potential alternative use of coal-fired plants, natural gas-fired plants, and renewable energy sources.

6.2.7 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Because coal is the fuel most commonly used to generate electricity in the United States, and the burning of coal results in the largest emissions of GHGs for any of the likely alternatives to nuclear power, most of the available quantitative studies have focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent coal-fired plant, are presented in Table 6-2.

Table 6-2. Nuclear GHG Emissions Compared to Coal

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO ₂ Coal—5,912,000 tons CO ₂ Note: Future GHG emissions from nuclear to increase because of declining ore grade
Andseta et al. 1998	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro 2000	Nuclear—2.5 to 5.7 g C _{eq} /kWh Coal—264 to 357 g C _{eq} /kWh
Storm van Leeuwen and Smith 2005	Authors did not evaluate nuclear versus coal.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C _{eq} /kWh Coal—950 g C _{eq} /kWh

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POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C _{eq} /kWh Coal—>1000 g C _{eq} /kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C _{eq} /kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C _{eq} /kWh Coal—950 to 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones 2007	Author did not evaluate nuclear versus coal.

6.2.8 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent natural gas-fired plant, are presented in Table 6-3.

Table 6-3. Nuclear GHG Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer 1990	Author did not evaluate nuclear versus natural gas.
Andseta 1998	Author did not evaluate nuclear versus natural gas.
Spadaro 2000	Nuclear—2.5 to 5.7 g C _{eq} /kWh Natural Gas—120 to 188 g C _{eq} /kWh
Storm van Leeuwen and Smith 2005	Nuclear fuel cycle produces 20 to 33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C _{eq} /kWh Cogeneration Combined Cycle Natural Gas—150 g C _{eq} /kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C _{eq} /kWh Natural Gas—500 g C _{eq} /kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C _{eq} /kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C _{eq} /kWh Natural Gas—440 to 780 g C _{eq} /kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones 2007	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15 to 27% of the GHG emissions of natural gas.

6.2.9 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear

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energy and fossil fuels because the efficiencies of the different energy sources vary so much by location. For instance, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved. Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources.

Table 6-4. Nuclear GHG Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO₂ Hydropower—78,000 tons CO₂ Wind power—54,000 tons CO₂ Tidal power—52,500 tons CO₂ Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta 1998	Author did not evaluate nuclear versus renewable energy sources.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Solar PV—27.3 to 76.4 g C_{eq}/kWh Hydroelectric—1.1 to 64.6 g C_{eq}/kWh Biomass—8.4 to 16.6 g C_{eq}/kWh Wind—2.5 to 13.1 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Author did not evaluate nuclear versus renewable energy sources.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25 to 93 g C_{eq}/kWh Solar PV—35 to 58 g C_{eq}/kWh Wave/Tidal—25 to 50 g C_{eq}/kWh Hydroelectric—5 to 30 g C_{eq}/kWh Wind—4.64 to 5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh.
Source	GHG Emission Results

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Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C _{eq} /kWh
	Solar PV—43 to 73 g C _{eq} /kWh
	Hydroelectric—1 to 34 g C _{eq} /kWh
	Biomass—35 to 99 g C _{eq} /kWh
	Wind—8 to 30 g C _{eq} /kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g C _{eq} /kWh
	Solar PV—17 to 49 g C _{eq} /kWh
Dones 2007	Author did not evaluate nuclear versus renewable energy sources.

6.2.10 Conclusions

Estimating the GHG emissions associated with current nuclear energy sources is challenging because of differing assumptions and noncomparable analyses performed by the various authors. The differences and complexities in these assumptions and analyses increase when using them to project future GHG emissions. However, even with these differences, the NRC staff can draw several conclusions.

First, the studies indicate a consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation. Based on the literature review, the lifecycle GHG emissions from the complete nuclear fuel cycle currently range from 2.5 to 55 g C_{eq}/kWh. The comparable lifecycle GHG emissions from the current use of coal range from 264 to 1250 g C_{eq}/kWh, and GHG emissions from the current use of natural gas range from 120 to 780 g C_{eq}/kWh. The existing studies also provided estimates of GHG emissions from five renewable energy sources, based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is very wide, but the general conclusion is that the current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as those for these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and are expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur at all.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed IP2 and IP3 relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the

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following rationale:

- (1) The current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.
- (2) IP2 and IP3 license renewal will involve continued uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).
- (3) Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the IP2 and IP3 periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions between the proposed IP2 and IP3 license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities in both areas. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same range. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power, and because most renewable energy sources lack a fuel component, it is likely that GHG emissions from renewable energy sources would be lower than those associated with IP2 and IP3 at some point during the period of extended operation.

6.3 References

- 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."
- 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."
- 10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy*, Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."
- 40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."
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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in NUREG-0586, Supplement 1, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾ The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Category 1 issues in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) that are applicable to IP2 and IP3 decommissioning following the renewal term are listed in Table 7-1. Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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significant information regarding the environmental impacts of IP2 and IP3 license renewal, though it did identify leaks from spent fuel pools as a potential new issue. The NRC staff addressed this issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff has not identified any information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site visit, the scoping process, or its evaluation of other available information that is both new and significant. Therefore, the NRC staff concludes that there are no impacts related to the Category 1 issues applicable to the decommissioning of IP2 and IP3 beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of IP2 and IP3 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found the following:

Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no radiation dose impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found the following:

Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts from solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found the following
Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on air quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found the following:

The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on water quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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- Ecological resources. Based on information in the GEIS, the Commission found the following:

Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on ecological resources associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found the following:

Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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NUREG-1437, Volume 1, Addendum 1, Washington, DC.

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO LICENSE RENEWAL

This chapter examines the potential environmental impacts associated with (1) the closed-cycle cooling system alternatives to replace the Indian Point Nuclear Generating Unit No. 2 (IP2) and Unit No. 3 (IP3) existing once-through cooling-water systems, (2) denying the renewal of both operating licenses for IP2 and IP3 (i.e., the no-action alternative), (3) replacing the electric generation capacity of both units with alternative electric-generation sources, (4) importing electric power from other sources to replace power generated by IP2 and IP3, and (5) combinations of generation and conservation measures to replace power generated by IP2 and/or IP3. In addition, this chapter discusses other alternatives that were deemed unsuitable for replacement of power generated collectively by IP2 and IP3.

The U.S. Nuclear Regulatory Commission (NRC) staff considered alternatives to the existing IP2 and IP3 cooling-water systems because the New York State Department of Environmental Conservation (NYSDEC) identified closed-cycle cooling (e.g., cooling towers) as the best technology available (BTA) to reduce fish mortality in the draft New York State Pollutant Discharge Elimination System (SPDES) discharge permit (NYSDEC 2003a). These alternatives are described in Section 8.1 of this draft supplemental environmental impact statement (SEIS). IP2 and IP3 have been operating under timely renewal provisions of the New York SPDES permit process since 1992. In 2003, NYSDEC issued a draft SPDES permit for public comment, including the BTA determination. The requirements, limits, and conditions of the draft SPDES permit had not been finalized at the time the NRC staff performed the assessment presented in this draft SEIS.

The environmental impacts of alternatives are evaluated using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed based on the Council on Environmental Quality (CEQ) guidelines and set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). The following definitions are used for each category:

SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.

LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999)⁽¹⁾ with the additional impact

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

categories of environmental justice and transportation.

8.1 Alternatives to the Existing IP2 and IP3 Cooling-Water System

IP2 and IP3 currently use once-through cooling-water systems that withdraw water from and discharge water to the Hudson River as described in Section 2.1.3 of this draft SEIS. The circulating water systems for IP2 and IP3 include two intake structures, each containing seven pumps. The normal design flow rate of 3,180,000 liters per minute (lpm) (840,000 gallons per minute (gpm)) for each unit is achieved using dual-speed pumps for IP2 and variable-speed pumps for IP3.

Warm discharge water from IP2 and IP3 flows from the condensers through six pipes that are 2.4 meters (m) (96 inches (in.)) in diameter and exits beneath the water surface into a discharge canal 12 m (40 feet (ft)) wide. Water flows from the discharge canal to the Hudson River through an outfall structure located south of IP3 at a discharge velocity of about 3.7 meters per second (mps) (10 feet per second (fps)). The design of the outfall is intended to reduce the thermal impact the warm water has on the river. An assessment of the impacts of the current cooling-water system on the environment is presented in Section 4.1 of this draft SEIS.

Surface water withdrawals and discharges at IP2 and IP3 are regulated under the New York SPDES permit program. In 1975, the U.S. Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) permits for the facility. Subsequently, the NYSDEC issued an SPDES permit for the facility in 1987. In 1992, a timely renewal application was filed with the NYSDEC, and terms of the 1992 SPDES have been continued under provisions of the NY State Administrative Procedure Act. Petitioners commenced proceedings in 2002 to mandate that the NYSDEC act on the SPDES permit renewal application. On April 8, 2003, the NYSDEC proposed to modify the SPDES permit to require that IP2 and IP3 reduce the impacts to aquatic organisms caused by the once-through cooling systems and that Entergy Nuclear Operations, Inc. (Entergy), complete a water quality review. A draft SPDES permit identifying closed-cycle cooling as the BTA was issued on November 14, 2003 (NYSDEC 2003a).

The draft SPDES permit requires that immediate and long-term steps be taken to reduce the adverse impacts on the Hudson River estuary once the permit is issued (NYSDEC 2003a). The short-term steps include mandatory outage periods, reduced intake during certain times, continued operation of fish-impingement mitigation measures, the payment of \$25 million to a Hudson River Estuary Restoration Fund, and various studies. In the long term, IP2 and IP3 will have to implement the BTA to minimize environmental impacts to the aquatic ecology. Should the BTA determination in the draft SPDES permit go into effect, final implementation of the BTA is subject to NRC's approval only insofar as the NRC oversees the plant's safety performance and ability to cool itself. Based on NYSDEC's fact sheet addressing the draft SPDES permit, NYSDEC will not require closed cycle cooling if IP2 and IP3 do not receive renewed licenses from the NRC (NYSDEC 2003c).

Specifically, the draft SPDES permit states the following:

Within six months of the effective date of this permit, the permittee must submit to the NYSDEC...its schedule for seeking and obtaining, during its permit term, all necessary approvals from the NRC, Federal Energy Regulatory Commission

(FERC), and other government agencies to enable construction and operation of closed-cycle cooling at Indian Point.

NYSDEC (2003a) has also indicated that an alternative technology or technologies may be proposed for IP2 and IP3 within 1 year of the permit's effective date. These technologies must be able to minimize the adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3 (NYSDEC 2003b).

The NYSDEC identified construction and operation of a closed-cycle cooling system at IP2 and IP3 as its preferred alternative to meet current national performance standards for impingement and entrainment losses. Entergy indicates that Entergy or its predecessors have proposed and NYSDEC has rejected the following alternative cooling technologies as described in the IP2 and IP3 ER (Entergy 2007). As a result, these options are not discussed further in this draft SEIS.

- Evaporative ponds, spray ponds, or cooling canals all require significantly more land area than exists at the site.
- Dry cooling towers, which rely totally on sensible heat transfer, lack the efficiency of wet or hybrid towers using evaporative cooling, and thus require a far greater surface area than is available at the site. Additionally, because of their lower efficiency, dry towers are not capable of supporting condenser temperatures necessary to be compatible with IP2 or IP3 turbine design and, therefore, are not a feasible technology.
- Natural draft cooling towers, while potentially feasible, would be 137 to 152 m (450 to 500 ft) above ground level with significant adverse aesthetic impacts in an important viewshed corridor. This option also would raise plume-related and sound effects concerns. In the original EPA permitting proceeding, New York State opposed natural draft cooling towers on aesthetic grounds.
- Single-stage mechanical-draft wet cooling towers for a number of reasons including, but not limited to, the dense water vapor plumes that may compromise station operations (including visual signaling) and equipment over time, and result in increased noise (Enercon 2003).

The EPA has concluded that, in some circumstances, retrofitting a plant to a closed-cycle cooling system lacks demonstrated feasibility or economic practicality (EPA 2004). In addition, Entergy asserts that retrofitting facilities the size and configuration of IP2 and IP3 with a closed-cycle cooling system is neither tried nor proven (Entergy 2007). Entergy also considers mitigation measures currently implemented to protect aquatic wildlife as part of the once-through cooling system to be adequate in terms of minimizing impacts from current operations and operations during the license renewal period (Entergy 2007).

Entergy expressed a number of concerns regarding financial or technical issues related to a closed-cycle cooling retrofit (Entergy 2007), including high cost, a lengthy forced outage, and lost power output due to parasitic losses from new cooling system components. In the Hudson River Utilities FEIS, NYSDEC indicated that the previous owners' closed-cycle cooling cost estimates were likely generally reasonable (NYSDEC 2003d), while EPA indicated that costs may have been somewhat inflated (EPA 2004). EPA also indicated some uncertainty with regard to outage duration for the plant retrofit.

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1 Entergy notes that replacement power during the outage may carry negative air quality impacts,
2 and that the outage may have negative impacts on electric-system reliability and market pricing.

3 Finally, Entergy indicates that closed-cycle cooling would result in a loss of generating capacity
4 due to lowered thermal efficiency and parasitic loads related to cooling system pumps and
5 auxiliary systems (an average annual loss of 26 MW(e), per unit) because of power demands of
6 the closed-cycle system (Entergy 2007).

7 In the following chapter, the NRC staff will evaluate the environmental impacts associated with
8 installing a closed-cycle cooling system at Indian Point, as well as the environmental impacts
9 associated with a potentially-equivalent combination of plant modifications and restoration
10 activities. Regardless of the NRC staff's findings, the NRC does not have the regulatory
11 authority to implement the requirements of the Clean Water Act, and it is not up to the NRC
12 staff to judge the validity of Entergy's or others' claims in the ongoing NYSDEC SPDES permit
13 process. The NRC staff, however, notes that both NYSDEC (2003b) and EPA (2004) indicated
14 that estimates for cooling conversion by the previous owners of IP2 and IP3 overestimated a
15 variety of costs and selected a more-expensive technology than was necessary. Further, EPA
16 (2004) indicated that Entergy's outage duration was likely exaggerated.

17 In 2004, EPA issued regulations for reducing impingement and entrainment losses at existing
18 electricity-generating facilities (EPA 2004). These regulations, known as the Phase II rule,
19 established standards for compliance with the requirements of Section 316(b) of the Clean
20 Water Act (CWA), which calls for intake structures to reflect the BTA for minimizing adverse
21 environmental impact. The EPA's Phase II rule established two compliance alternatives that
22 reduce impingement mortality by 80 to 95 percent of baseline and reduce organism entrainment
23 by 60 to 90 percent of baseline (EPA 2004). These regulations supported the requirements of
24 the draft New York SPDES permit's requirement that immediate and long-term steps be taken to
25 minimize adverse impacts on the Hudson River estuary.

26 The EPA's rules concerning Phase II of Section 316(b) of the CWA were struck down by the
27 U.S. Court of Appeals in the Second Circuit in January, 2007. The Court also mandated the
28 conduct of a cost-benefit analysis under Section 316(b) of the CWA. That decision is currently
29 on appeal before the U.S. Supreme Court. Specifically, the EPA suspended
30 40 CFR Part 122.2(r)(1)(ii) and (5) and Subpart J, "Requirements Applicable to Cooling Water
31 Intake Structures for Phase II Existing Facilities Under Section 316(b) of the Act," of
32 40 CFR Part 125, "Criteria and Standards for the National Pollutant Discharge Elimination
33 System," with the exception of 40 CFR 125.90(b) (EPA 2007). However, the issued SPDES
34 permit remains in effect, pending the conclusion of related administrative and legal proceedings.

35 8.1.1 Closed-Cycle Cooling Alternative

36 As indicated in Section 8.1, NYSDEC identified closed-cycle cooling as a BTA in its 2003 draft
37 SPDES permit (NYSDEC 2003a, 2003c). Entergy's preferred close-cycle alternative consists of
38 two hybrid mechanical-draft cooling towers (Enercon 2003, Entergy 2007). IP2 and IP3 would
39 each utilize one cooling tower. Entergy rejected single-stage mechanical draft cooling towers,
40 indicating that the dense water vapor plumes from the towers may compromise station
41 operations (including visual signaling) and equipment over time, and single-stage towers may
42 result in increased noise (Enercon 2003).

1 Entergy asserts that a hybrid mechanical-draft cooling tower system, also referred to as a
2 “wet/dry” or “plume-abated” mechanical-draft cooling tower, addresses some of the
3 shortcomings of the cooling system types described in Section 8.1 (Entergy 2007). In the ER,
4 Entergy indicates that hybrid towers are “appreciably more expensive” than single-stage towers
5 (2007).

6 A hybrid tower consists of a standard efficiency wet tower segment combined with a dry heat
7 exchanger section above it. The dry section eliminates visible plumes in the majority of
8 atmospheric conditions. After the plume leaves the lower “wet” section of the tower, it travels
9 upward through a “dry” section where heated, relatively dry air is mixed with the plume in the
10 proportions required to achieve a nonvisible plume. Because of the “dry” section, which is on
11 top of the “wet” section, hybrid towers are slightly taller than comparable wet towers and require
12 a larger footprint (Entergy 2007). Hybrid towers are also appreciably more expensive, both in
13 initial costs and in ongoing operating and maintenance costs (Entergy 2007). A potential exists
14 for increased noise from additional fans in the dry section, although Entergy indicates that
15 sound effects can be attenuated (Entergy 2007).

16 Portions of the site where Entergy could construct cooling towers are heavily forested, with
17 rocky terrain and some steep slopes. Entergy indicates that these areas can be more
18 environmentally sensitive and costly to build on.

19 The NRC staff has previously assessed closed cycle cooling with a hybrid cooling tower in the
20 license renewal SEIS for Oyster Creek Nuclear Generating Station (OCNGS) (NRC 2006). The
21 NRC staff finds that a hybrid cooling tower system is a reasonable design for the purpose of
22 evaluating potential environmental impacts in a NEPA document. However, the NRC staff does
23 not intend for this analysis to prejudice potential requirements imposed by NYSDEC or other
24 authorities.

25 Should hybrid towers prove prohibitively expensive (as determined by other, non-NRC
26 authorities), the NRC staff notes that single-stage mechanical draft towers will produce similar
27 decreases in impacts to aquatic life and may result in less land-clearing or blasting debris than
28 the hybrid cooling tower option. Additionally, single-stage towers will be shorter, though plumes
29 in cool or highly-saturated atmospheric conditions will impose slightly greater aesthetic impacts
30 as well as creating greater deposition of ice or dissolved solids near the towers than the circular,
31 hybrid towers proposed by Entergy would cause.

32 **8.1.1.1 Description of the Closed-Cycle Cooling Alternative**

33 As described in the ER (Entergy 2007), new hybrid cooling towers would be large,
34 approximately 170 m (560 ft) in diameter and 46 to 50 m (150 to 165 ft) high. To provide
35 construction access for tower erection and clearance for air intake, the excavation diameter for
36 each tower would be approximately 700 ft. The locations for the IP2 and IP3 towers are
37 expected to be approximately 305 m (1000 ft) north of the IP2 reactor and approximately 305 m
38 (1000 ft) south of the IP3 reactor, respectively. A detailed description of a round hybrid cooling
39 tower conceptual design is presented in the 2003 cooling tower evaluation (Enercon 2003).
40 Crews excavating areas for the cooling tower basins and associated piping may need to blast
41 substantial amounts of rock during the construction process.

42 As noted in Section 8.1, the closed-cycle cooling alternative would introduce parasitic losses
43 from additional pumps and other equipment. The new circulating pumps would likely be housed
44 in a new pumphouse located along the discharge canal (Enercon 2003). The new, enclosed

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pumphouse would supply circulating water to the new towers via two concrete-lined steel pipes 3 m (10 ft) in diameter. Flow from the cooling tower basin to the condenser is expected via two pipes 3.7 m (12 ft) in diameter (Enercon 2003).

Enercon also reported that two dedicated substations would likely supply electricity to the closed-cycle cooling system from the 138-kilovolt (kV) offsite switchyard. The substation transformers, switch gear, and system controls for each tower and pumphouse would be housed in prefabricated metal buildings (Enercon 2003).

8.1.1.2 Environmental Impacts of the Closed-Cycle Cooling Alternative

In this section, the NRC staff addresses the impacts that would occur if Entergy constructs and operates the closed-cycle cooling system described in Section 8.1.1.1. The NRC staff summarizes anticipated impacts of the closed-cycle cooling alternative summarized in Table 8-1. In the areas of land use, terrestrial ecology, waste, and aesthetics, the environmental impacts of constructing and operating this closed-cycle cooling system would be greater than the impacts associated with the existing once-through cooling system, primarily due to construction-stage impacts. The closed-cycle cooling alternative significantly reduces impacts to aquatic ecology, including impacts from entrainment, impingement, and heat shock. Impacts to aquatic threatened and endangered species are also likely to decline. In the following sections, the NRC staff presents the potential environmental impacts of installing and operating a closed-cycle cooling alternative at Indian Point. The NRC staff addresses impacts for each resource area.

• Land Use

Construction of hybrid mechanical-draft cooling towers would entail significant clearing and excavation of the currently timbered areas within the IP2 and IP3 exclusion area. Each cooling tower requires an excavated area of approximately 3.6 hectares (ha) (9 acres (ac)). Ultimately, approximately 16 ha (40 ac), most of which is presently wooded (though previously disturbed; ENN 2007), would need to be cleared for the two cooling towers, access roads, and support facilities (Enercon 2003). The towers would be located within the property exclusion area boundary adjacent to existing facilities as described in Section 8.1.1.1.

Entergy indicates that roughly 305 m (1000 ft) of river bank would be clear-cut and excavated to allow for the installation of the four large-diameter water pipes (two 3-m-diameter supply pipes and two 3.7-m-diameter pipes to each condenser) required for each tower (Entergy 2007). In addition, Enercon reports that the base of each tower would be constructed on bedrock at an elevation of about 9.1 m (30 ft) above mean sea level. This would entail the removal of approximately 2 million cubic yards (cy) (1.5 million cubic meters (m³)) of material, primarily rock and dirt, using traditional excavation methods as well as a significant amount of blasting (Entergy 2007). Disposal of 2 million cy (1.5 million m³) of material from the excavations for the cooling towers may create offsite land use impacts. Excavated material also may be recycled or reused, which would reduce these impacts.

Entergy's proposed IP3 cooling tower would be located in the permanent right-of-way (ROW) easement granted to the Algonquin Gas Transmission Company (AGTC) for constructing, maintaining, and operating the three natural gas pipelines that traverse the IP2 and IP3 site (Entergy 2007). These pipelines transport natural gas under the Hudson River, across the IP2 and IP3 site, and exit the site between Bleakley Avenue and the Buchanan substation (see

Figure 2-3 in Chapter 2 of this SEIS for a graphical representation).

Entergy indicates that ROW easement agreement calls for AGTC to relocate the pipelines at Entergy's request. The Federal Energy Regulatory Commission (FERC) would first have to review and approve any such action. Entergy must also provide a suitable location for the pipeline on its land or land that it has acquired (Entergy 2007). Entergy indicates that pipeline relocation may require blasting and could also require Entergy to purchase additional land adjacent to the IP2 and IP3 site if onsite areas aren't suitable for the pipeline (Entergy 2007). Feasibility studies and other regulatory approvals may also be necessary (Enercon 2003).

The IP2 and IP3 site is within New York's Coastal Zone. As indicated in Chapter 2, the IP2 and IP3 site is located adjacent to a Significant Coastal Fish and Wildlife Habitat. Construction activities, such as grading, excavating, and filling, would require a coastal erosion management permit. Permitting restrictions would influence the construction of the cooling towers but they would not likely prevent Entergy from building the towers.

Excavation for the cooling towers would cut into the side of the hills east of IP2 and IP3, resulting in the removal of approximately 2 million cy of material, including significant rock as well as dirt (Entergy 2007).

The NRC staff concludes that construction activities associated with cooling tower installation at IP2 and IP3 would result in SMALL to LARGE land use impacts, depending largely on how much material Entergy is unable to reuse or recycle, and where Entergy disposes of excavated material that cannot be reused or recycled.

• Ecology

Aquatic ecology. Land-clearing and construction activities can cause short-term, localized impacts on streams and rivers from increased site runoff. These impacts are generally mitigated through the use of erosion and sediment controls. Because of the size of the construction area needed for the cooling towers at the IP2 and IP3 site, such measures would be necessary to limit erosion and sediment deposition in the Hudson River. Construction impacts, however, would be relatively short-lived, and would be offset to some degree by reduced water consumption during prolonged outages at IP2 and IP3 when Entergy or its contractors would connect the closed-cycle cooling system to the units.

Following construction, the closed-cycle cooling alternative will significantly reduce operational impacts compared to the current once-through cooling system. During the summer months, when water use is at its highest, service and cooling tower makeup water would be withdrawn at a rate of approximately 250,000 to 314,000 lpm (66,000 to 83,000 gpm) for the combined needs of IP2 and IP3. This would be a 93-to-95-percent reduction in water use compared to the existing IP2 and IP3 once-through systems, which have a normal design flow rate of 3,200,000 lpm (840,000 gpm) for each unit. Without modifications to the intake screening technologies, the NRC staff assumes that the reduction in water intake results in an equivalent reduction in entrainment and impingement. The staff concludes that this significant reduction in water demand would likely result in a similarly significant reduction in entrainment- and impingement-related losses compared to the losses created by the current once-through cooling system.

New circulating-water intake pumps would likely continue to utilize the Ristroph traveling screens and fish-return system currently in operation (Entergy 2007), as well as the current intake bay area. The greatest impact of the closed-cycle system would be a reduction in

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1 entrainment and impingement of aquatic species. As described in Section 4.1.3.3 of this draft
2 SEIS, the NRC staff has concluded that the once-through cooling system has a direct impact on
3 some representative important species (RIS), which ranges from SMALL to LARGE depending
4 on the species affected. The reduction in flow may also reduce impingement or entrainment of
5 RIS to which the NRC staff could not assign a specific impact level, including blue crab
6 (*Callinectes sapidus*), the endangered shortnose sturgeon (*Acipenser brevirostrum*), and
7 macroinvertebrates, such as small clams and mussels (bivalves), snails, worms, crustaceans,
8 and aquatic insects. In Section 4.6.2, the NRC staff had indicated that the impacts to the
9 shortnose sturgeon could range from SMALL to LARGE, because of uncertainty due to the lack
10 of current sampling data.

11 Under a closed-cycle cooling system, most discharged blowdown water is unheated. Because
12 the closed-cycle cooling system discharges a smaller volume of water, and because the water is
13 cooler than in a once-through system, the extent of thermal impacts would be significantly
14 reduced. Thus, the effects of thermal shock also decline. However, the discharge water may
15 be higher in salinity and may contain higher concentrations of biocides, minerals, trace metals,
16 or other chemicals or constituents. To maintain compliance with discharge permits, the water
17 may need to be treated.

18 Overall, operation of the closed-cycle cooling alternative would produce substantially fewer
19 impacts to the aquatic environment relative to those caused by the existing once-through
20 system. The NRC staff concludes that the aquatic ecological impacts (including those to
21 threatened and endangered species) from the construction and operation of the hybrid
22 mechanical-draft closed-cycle cooling alternative for IP2 and IP3 would be SMALL.

23 Terrestrial ecology. Construction of the closed-cycle cooling alternative would entail clear-
24 cutting of onsite trees and excavation of areas for the two cooling towers as described in the
25 Land Use section. These activities would destroy fragments of onsite eastern hardwood forest
26 habitat (NYSDEC 2007; NYSDEC 2008a). Effects of removing these habitats could include
27 localized reductions in productivity or relocations of some species.

28 Operation of the cooling towers also could have adverse localized impacts on terrestrial
29 ecology. The cooling towers would be about 46 to 50 m (150 to 165 ft) tall and would produce a
30 visible plume as well as minimal ground fog (Enercon 2003). The potential physical impacts
31 from a cooling tower plume include icing and fogging of surrounding vegetation during winter
32 conditions. Icing can damage trees and other vegetation near the cooling towers. The salt
33 content of the entrained moisture (drift) also has the potential to damage vegetation, depending
34 on concentrations (Enercon 2003). Enercon reported, however, that the predicted deposition
35 rates for the towers are on the order of the natural ambient salt deposition rate (Enercon 2003).
36 The hybrid cooling towers evaluated in this section have a drift rate of 0.001 percent (Enercon
37 2003). This amounts to 2.6 lpm (0.7 gpm (0.00001 x 70,000 gpm of water)) drift for both towers.
38 The amount and effects of drift would vary depending on a number of factors, including the
39 concentration of salt in the droplets, the size of the droplets, the number of droplets per unit of
40 surface area, the species of plant affected, and the frequency of local precipitation.

41 Actual measurements of drift deposition have been collected at only a few nuclear plants.
42 These measurements indicate that, beyond about 1.5 kilometer (km) (about 1 mile (mi)) from
43 nuclear plant cooling towers, salt deposition is generally near natural levels (NRC 1996). The
44 NRC staff reported in the GEIS that the salt-drift rate estimated to cause acute injury to the

eastern/Canadian hemlock (a particularly sensitive species) is in excess of 940 kilograms (kg) per square kilometer (km²) (8.4 pounds per acre) per week (NRC 1996), well above the anticipated deposition rates from the IP2 and IP3 cooling towers.

The NRC staff does not expect bird collisions with cooling towers to be a significant issue. The NRC staff found in the GEIS that impacts from collisions would be small at all plants with existing cooling towers (NRC 1996).

Section 4.6.2 of this draft SEIS discusses the effects of license renewal on threatened or endangered terrestrial species. The section identifies the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the New England cottontail (*Sylvilagus transitionalis*), a candidate species, as being potentially affected. However, because of both the site-specific environment and the lack of evidence of the species existing at the facility, potential impacts to these threatened or endangered species are considered SMALL.

While the effects of this alternative—including onsite land clearing and introduction of cooling tower drift—are greater than the effects of the continued operation of the once-through cooling system and are likely to be noticeable, they are not so great that they will have a destabilizing effect on terrestrial resources in the vicinity of IP2 and IP3. The NRC staff concludes that the overall effect on terrestrial ecology would be SMALL to MODERATE.

• Water Use and Quality

During construction of the alternative closed-cycle cooling systems at IP2 and IP3, changes in water usage would likely be negligible. Increases may be seen in potable water demand for construction workers and, if concrete is mixed on site, there would be additional demands. However, these water needs would be short lived and would be at least partially offset by a reduction in water use while IP2 and IP3 are in outages to install the closed-cycle cooling system. For the term of construction, the additional water demands would need to be met by the Village of Buchanan, which supplies water to the site. The Village of Buchanan purchases public drinking water from surface water supplies.

The NYSDEC requires a construction general permit for storm water discharges from a project such as construction of the hybrid cooling towers. In addition, the NYSDEC will require a stormwater pollution prevention plan describing the use of silt fencing and other erosion-control management practices that will be used to minimize impacts on surface water quality. The construction project could also affect ground water as a result of dewatering excavations.

Evaporation losses (23,000 to 46,000 lpm (6,000 to 12,000 gpm)) from the cooling towers will have a negligible impact on water flow past the site. The estimated flow 150 m (500 ft) off the shoreline is about 34 million lpm (9 million gpm) in a 150-to-180-m (500-to-600-ft)-wide section (Entergy 2007). Therefore, the evaporation loss would be approximately 0.1 percent of the river flow. Further, the estuarine Hudson River is at sea level, and thus the river's water level would not be affected by the cooling towers' consumptive water use.

To compensate for evaporative and discharge losses, makeup water from the Hudson River would be treated to remove silt, suspended solids, biological material, and debris. Makeup water may also need lime softening, a water treatment process that produces a waste sludge that requires disposal. Biocides, such as hypochlorite, are often added to cooling water to diminish the affects of the biofouling organisms (Entergy 2007). Other chemicals, such as acids, dispersants, scale inhibitors, foam suppressants, and dechlorinators may also be needed

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for water treatment (NRC 1979).

To manage the chemicals and elevated concentrations of dissolved solids in the discharge water, treatment would likely be necessary in accordance with the IP2 and IP3 site SPDES permit. The use of biocides or any other chemicals would likely require discharge treatment and additional monitoring.

The IP2 and IP3 site does not utilize ground water for cooling operations, service water, or potable water. As such, the continued operation of the site is not expected to affect local ground water supplies (EPA 2008a). Localized dewatering of ground water from excavations may be necessary during construction operations, but because this ground water is not used by Entergy or entities off site, and because the ground water discharges to the Hudson River after exiting the IP2 and IP3 site, construction is not likely to affect either ground water quality or ground water use.

Proper controls of runoff and treatment of other site discharges will not result in significant impacts on the surface water (Hudson River) and evaporation losses are very small. Also, ground water impacts from construction and operation of the cooling towers are expected to be minor. Therefore, the NRC staff concludes that overall impacts to water resources and water quality from the closed-cycle cooling alternative would be SMALL.

• Air Quality

The IP2 and IP3 site is located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13, "New Jersey-New York-Connecticut Interstate Air Quality Control Region"). The air quality nonattainment issues associated with the portions of these States located within a 50-mi radius are related to ozone (8-hour standard) and particulate matter less than 2.5 microns (μm) in diameter ($\text{PM}_{2.5}$). The entire States of New Jersey and Connecticut are designated nonattainment areas for ozone (8-hour standard). Several counties in Central and Southeastern New York within a 50-mi radius are also in nonattainment status for the 8-hour ozone standard (EPA 2008b). Air quality would be affected by three different factors: replacement power during construction-related outages, construction activities and vehicles (including worker transportation), and cooling tower operations.

Entergy contractors indicate that prolonged outages of IP2 and IP3, such as would be required to install cooling towers (TRC 2002) would require replacement power from existing generating facilities within the New York City metropolitan area. They assert that replacement of IP2 and IP3 energy output during cooling tower installation would result in substantial increases in regulated air pollutants. To the extent that coal- and natural-gas-fired facilities replace IP2 and IP3 output, the NRC staff finds that some air quality effects would occur. The NRC staff finds that these effects would cease when IP2 and IP3 return to service, with the exception of any output lost to new parasitic loads from the closed-cycle cooling system.

Air quality at or near IP2 and IP3 during the construction of the IP2 and IP3 cooling towers would be affected mostly by exhaust emissions from internal combustion engines. These emissions would include carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur oxides (SO_x), carbon dioxide (CO_2), and particulate matter $10\ \mu\text{m}$ or less in diameter (PM_{10}) from operation of gasoline- and diesel-powered heavy-duty construction equipment, delivery vehicles, and workers' personal vehicles (these vehicles would also produce or contribute to production of $\text{PM}_{2.5}$). The amount of pollutants emitted from

1 construction vehicles and equipment and construction worker traffic would likely be small
2 compared with total vehicular emissions in the region.

3 As noted in Section 3.3 of the GEIS, a conformity analysis is required for each pollutant when
4 the total direct and indirect emissions caused by a proposed Federal action would exceed
5 established threshold emission levels in a nonattainment area. In the GEIS, the NRC
6 determined that a major refurbishment activity may increase the facility workforce by up to 2300
7 construction, refurbishment, and refueling personnel during a significant refurbishment outage
8 period. The construction of two new cooling towers at IP2 and IP3 could approximate such
9 conditions; however, Entergy estimates that the construction activities would require an average
10 workforce of 300 additional workers with a maximum of about 600 workers (Enercon 2003).
11 Because IP2 and IP3 are in a nonattainment area for ozone, and emissions from vehicles of the
12 additional workforce may exceed the ozone air quality thresholds, a conformity analysis would
13 be required before construction.

14 Fugitive dust, a contributor to PM₁₀, would be generated from site clearing and construction
15 traffic, blasting, and excavation. Given the size of the disturbed area that would be involved
16 (about 16 ha (40 ac)), and assuming that dust management practices would be applied (e.g.,
17 watering, silt fences, covering soil piles, revegetation), the fugitive dust impacts generated
18 during construction should be minor. Furthermore, the amount of road dust generated by the
19 vehicles traveling to and from the site transporting workers or hauling rock and dirt would
20 contribute to PM₁₀ concentrations. Construction stage impacts, though significant, would be
21 relatively short lived.

22 Operation stage impacts would, overall, be minor. As previously discussed, the cooling towers
23 would emit tower drift consisting of water, salt, and suspended solids. These emissions would
24 be considered PM₁₀, and some portion may include PM_{2.5}. Because IP2 and IP3 are located
25 in a nonattainment area for PM_{2.5}, a conformity analysis for the cooling towers would be
26 necessary and may result in additional restrictions on emissions, additional compensatory
27 measures, or further control of drift from the towers. At a minimum, drift eliminators would likely
28 be required to keep these emissions to a low level.

29 Because air quality effects during construction would be controlled by site practices and
30 compensatory measures required to maintain compliance with the Clean Air Act (CAA) (should
31 a conformity analysis show the need to take other action), because replacement power would
32 be required to also comply with CAA requirements (and it would be short lived), and air quality
33 effects during operations would be minor, the NRC staff concludes that overall impact to air
34 quality is likely SMALL.

35 • **Waste**

36 Construction of the closed-cycle cooling alternative at IP2 and IP3 would generate some
37 construction debris and an estimated 2 million cy (1.5 million m³) of rock and soil (Entergy
38 2007). This material may be affected by onsite spills or other activities. Depending on the
39 characteristics of the material, it may be possible to reuse or recycle it. If the material cannot be
40 reused or recycled, it will have to be properly managed as a waste. Whether reused, recycled,
41 or disposed of, the material will have to be transported off site. If disposed of, the waste will
42 require additional offsite land use.

43 Some solid wastes may be generated by water treatment processes. Any such waste would be

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1 treated and/or disposed of in accordance with State solid waste regulations. During operation,
2 Entergy will have to maintain release of solids and chemicals to the blowdown water and,
3 subsequently, to the discharge canal and the Hudson River in accordance with IP2 and IP3
4 SPDES permits. Other solid wastes from tower operation and maintenance (including sludge
5 from the tower basins) would be managed and disposed of in accordance with applicable State
6 regulations at approved offsite facilities.

7 Based primarily on the large volume of rock and soil that would require offsite transportation and
8 may require disposal, the NRC staff concludes that waste-related impacts associated with the
9 closed-cycle cooling alternative at IP2 and IP3 could range from SMALL to LARGE, depending
10 on whether material can be reused or recycled.

11 • Human Health

12 Human health impacts for an operating nuclear power plant are identified in 10 CFR Part 51,
13 Subpart A, Appendix B, Table B-1. Potential impacts on human health from the operation of
14 closed-cycle cooling towers at nuclear power plants are evaluated in Section 4.3.6 of the GEIS.

15 During construction activities there would be risk to workers from typical industrial incidents and
16 accidents. Accidental injuries are not uncommon in the construction industry and accidents
17 resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use
18 of proper industrial hygiene practices, complying with worker safety requirements, and training.
19 Occupational and public health impacts during construction are expected to be controlled by
20 continued application of accepted industrial hygiene protocols, occupational health and safety
21 controls, and radiation protection practices.

22 Hybrid cooling towers at IP2 and IP3 would likely be equipped with sound attenuators (Entergy
23 2007). The topography of the area would provide additional attenuation of the noise levels. An
24 analysis of potential offsite noise levels resulting from both cooling towers operating
25 continuously indicated that the increase in noise levels at sensitive receptor sites would be
26 1 decibel or less, a level most likely not noticeable by the residents of the Village of Buchanan
27 (Enercon 2003).

28 The GEIS evaluation of health effects from plants with cooling towers focuses on the threat to
29 workers from microbiological organisms whose presence might be enhanced by the thermal
30 conditions found in cooling towers. The microbiological organisms of concern are freshwater
31 organisms that are present at nuclear plants that use cooling ponds, lakes, or canals and that
32 discharge to small rivers (NRC 1996). Because the closed-cycle system at IP2 and IP3 would
33 operate using brackish water, and because the Hudson River does not meet the NRC's
34 definition of a small river, thermal enhancement of microbiological organisms is not expected to
35 be a concern.

36 Furthermore, as described in Section 4.3 of this draft SEIS, the NRC concludes that continued
37 operation of the facility would not increase the impacts of occupational radiation exposures
38 during the relicensing period. Overall, the NRC staff concludes that human health impacts from
39 the closed-cycle cooling alternative are considered SMALL.

40 • Socioeconomics

41 Entergy estimates that construction of the cooling towers would require an average workforce of
42 300 mostly temporary employees or contractors and could take an estimated 62 months.

During the outage phase of the effort, the temporary workforce could peak at 600 (Entergy 2007). For comparison purposes, a workforce of approximately 950 additional workers is on site during a routine refueling outage (Entergy 2007).

As previously described, the impacts of relicensing and refurbishing IP2 and IP3 are addressed in a site-specific case study presented in Appendix C (Section C.4.4) to the GEIS. The case study postulated that major refurbishment activities could result in as many as 2300 workers on site. In the case study, the workers were engaged in a variety of component replacement and inspection activities. The case study employment estimate is significantly larger than Entergy's estimate in the previous paragraph and is considered by the NRC staff to be the maximum potential size of the temporary workforce because the GEIS estimate includes a variety of activities that will not be occurring at Indian Point during an outage to install a closed-cycle cooling system. As of June 2006 the site had approximately 1255 full-time workers (Entergy employees and baseline contractors) during normal plant operations (Entergy 2007).

The GEIS case study concluded that, because the surrounding counties are high population density areas as described in Section 4.4.1 of this draft SEIS, there will be available housing to support the influx of workers. Therefore, the GEIS concluded that any construction-related impact on housing availability would likely be small. With even fewer workers on site than anticipated in the GEIS, impacts would be even less noticeable.

As reported by Levitan and Associates, Inc. (2005), payments-in-lieu-of-taxes (PILOT) are made by Entergy to surrounding taxing jurisdictions. The PILOT amounts would not likely be affected by the construction of new closed-cycle cooling systems or other capital expenditures. In accordance with the PILOT agreements, this payment schedule will remain fixed through the term of the current site licenses (Levitan and Associates, Inc. 2005). Because plant valuation is not likely to change drastically with the installation of closed-cycle cooling (though it may increase), PILOT payments are likely to stay at similar relative levels throughout the renewal term.

The need for replacement power during construction may affect electricity prices, but the size of this effect depends on the cost of replacement power and the duration of the outages. Plant operators would likely schedule outages to avoid—to the extent possible—summer peak demand periods to avoid affecting grid reliability and power transmission into New York City.

The NRC staff concludes that most socioeconomic impacts related to construction and operation of cooling towers at the site would be SMALL.

• **Transportation**

Neither the NRC nor Entergy has conducted a study of the logistics for construction of cooling towers. However, some adverse transportation impacts are likely. The greatest impacts would likely occur during site excavation and would decline during construction. These impacts would return to current levels following construction.

Offsite disposal of approximately 2 million cy (1.5 million m³) of rock and soil from the excavation of the two cooling tower sites would be expected to have a significant impact on local transportation infrastructure. As indicated by Entergy, the excavation phase of construction would be expected to take at least 30 months to complete. In Entergy's estimates, over 300,000 round trips would be needed over a period of 30 months to remove the excavated materials in 6-cy dump trucks (370 truckloads per day at 7 days per week or 530 truckloads per

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day at 5 days per week given 10-hour workdays). Traffic in the area is heavy and the additional traffic from construction and site workers would cause increased traffic delays, particularly along US Highway 9 and State Highway 9A (Entergy 2007).

An alternative to shipments of waste by truck may be to ship waste by barge on the Hudson River. Entergy estimates that if 1000-ton barges were used to transport excavation debris, at least five barges per day would have to be loaded and leave the site, with additional barge staging required for returning barges (Entergy 2007). If shipped by barge, the waste would need to be offloaded and likely would be transported by trucks to a disposal site. This would shift the traffic impacts from the trucks to another location but the impacts could still be significant.

During operations, NRC staff anticipates that the closed-cycle cooling system would have little to no effect on transportation, and would likely be limited to occasional shipments of waste cleaned out from cooling tower basins, occasional deliveries of chemicals used to prevent fouling of the towers, and any replacement components necessary throughout the life of the towers. As noted previously, fogging and icing is not expected to be significant.

Based on independent calculations of expected waste volumes from site excavations that were on the same order of magnitude as the Entergy estimates, the NRC staff concludes that impacts from transportation activities, primarily during excavation of the construction site, could be significant and destabilizing, though temporary, during construction and will not be noticeable during operations. Impacts, then, will be SMALL during operations, but LARGE during construction.

• Aesthetics

IP2 and IP3 are already visible from the Hudson River, scenic overlooks on area highways, and the Palisades Interstate State Park. The addition of the two cooling towers, standing between 46 and 50 m (150 to 165 ft), would make the entire facility more visible as the developed footprint of the facility would be expanded. The clear-cutting of wooded areas for construction of the towers would remove a visual buffer for some site structures, while the towers may screen out other structures. The towers themselves would be clearly visible from offsite vantage points. Entergy has indicated that it would preserve as many trees as possible and that it would plant new trees to reestablish some visual buffers and help attenuate noise (Entergy 2007). Remaining and new trees could act as a partial visual buffer between the construction sites and the river and a visual and noise buffer on land (Entergy 2007). Construction-related impacts would be relatively short lived.

While the hybrid mechanical-draft cooling towers under consideration are designed to reduce fog and ice production in the local area, fog and ice produced during operation could have an impact on the aesthetics of the surrounding area. In particular, visible drift, though attenuated by the hybrid design, may remain. Less noticeable moisture and salt deposition from the plume may increase dampness and corrosion on surrounding property, which could affect the visual environment. The circular hybrid design proposed by Entergy disperses remaining drift over a greater area at a lower intensity than a single-stage wet mechanical-draft cooling tower (Enercon 2003).

The NRC staff concludes that the impact of construction and operation of a closed-cycle cooling system at IP2 and IP3 on aesthetics would likely be MODERATE, based on the physical

dimensions of the cooling towers, the size of deforested buffer areas, and the potential for fog and ice resulting from cooled water vapor.

• **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above ground historic architectural resources are identified on the IP2 and IP3 property. In addition, a Phase 1A survey was conducted on the property in 2006. The NRC staff identified 76 resources listed on the National Register of Historic Places (NRHP) within 5 miles of IP2 and IP3.

There are registered historically significant buildings and sites within several kilometers of IP2 and IP3 and other nonregistered sites or buildings that may be eligible for registration (NRC 1996). However, the NRC case study presented in the GEIS indicated that some unregistered sites may go unprotected because the sites' significance may be discounted because of their proximity to the IP2 and IP3 facility.

Entergy acknowledges that, before construction of cooling towers at the IP2 and IP3 facility can begin, a survey of cultural resources may be needed to identify the potential resources in previously undisturbed areas. The studies would include consultation with the State Historic Preservation Office and appropriate Native American Tribes, as required under Section 106 of the National Historic Preservation Act (NHPA). If historic or archeological resources are present in previously disturbed areas or in undisturbed areas, they would have to be evaluated for eligibility for listing on the NRHP.

Entergy has procedures for addressing historic and archeological resources (as noted in Section 4.4.5.2), it has acknowledged the need to survey for unknown resources before construction, and no significant historical or archeological resources have yet been identified in areas likely to be disturbed. As a result, the NRC staff concludes that the impact from the closed-cycle cooling alternative is likely to be SMALL.

• **Environmental Justice**

The NRC staff addresses environmental justice impacts of continued operations in Section 4.4.6 of this draft SEIS. Construction and operation of cooling towers at IP2 and IP3 would have an impact on environmental justice if environmental impacts of cooling system construction and operation affected minority and low-income populations in a disproportionately high and adverse manner.

Within the 50-mi (80-km) radius of the IP2 and IP3 site, a number of potential environmental impacts (onsite land use, aesthetics, air quality, waste management, and socioeconomic impacts) could affect populations in the immediate vicinity of the site. However, the potentially affected populations for the construction and operation of the closed-cycle cooling alternative, including residents of the Villages of Buchanan and Verplanck, contain low percentages of minority and low-income populations.

Overall, low-income populations within the 50-mi (80-km) radius represent a small percentage of the total population. The low-income population was approximately 11.7 percent of the total population in the combined four-State reference area, or 10.4 percent when the individual States were used as the geographic area. According to 2004 census data, the percentages of people below the low-income criteria in Dutchess and Westchester Counties were 7.7 percent

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and 8.9 percent, respectively.

The 2000 census indicates that 32.1 percent of the population within the 50-mi (80-km) radius and 25.1 percent of the population for the four-State reference area were minority for all races combined. The 2000 census also indicates that the total minority populations of the Villages of Buchanan and Verplanck were 7 percent and 11 percent, respectively.

Therefore, the local populations that would be most directly affected by the proposed action contain lower percentages of minorities and low-income populations than the entire 50-mi (80-km) area and the four-State reference area.

As noted earlier in this section, replacement power required during a 42-week outage could increase air quality effects, depending on the location and characteristics of generator units used to replace IP2 and IP3 output. These effects are likely to be short-lived (most will be no longer than the outage period), and may vary with time of year, scheduled outages at other facilities, and generator pricing on the NYISO grid. Additionally, impacts would occur near existing facilities and would result from incremental increases rather than new effects. As a result, impacts are likely to be small. The NRC staff concludes, then, that the overall environmental justice impacts of constructing and operating a closed-cycle cooling system at the IP2 and IP3 site are likely to be SMALL.

8.1.2 Modified Existing Once-Through Cooling System with Restoration Alternative

The NYSDEC proposal of closed-cycle cooling as the site-specific BTA to protect aquatic life in the draft SPDES permit for IP2 and IP3 (NYSDEC 2003a) is intended to dramatically reduce the entrainment and impingement of aquatic life in the IP2 and IP3 cooling system, thus reducing impacts to fish populations in the Hudson River estuary. Under the terms of the draft SPDES permit, Entergy may propose a different approach that would reduce adverse environmental impacts to an equivalent level (NYSDEC 2003b). The alternative proposed in this section combines the existing once-through cooling system with alternative intake technologies and additional restoration alternatives so that the net impact of the IP2 and IP3 cooling water intake structures is equivalent to the impact from the operation of a new closed-cycle cooling system.

8.1.2.1 Description of the Modified Existing Once-Through Cooling System with Restoration Alternative

This alternative would reduce impingement and entrainment losses by retrofitting the IP2 and IP3 existing once-through cooling systems with improved intake technology, altering operations of the cooling system, and implementing restoration measures within the Hudson River estuary. Under the terms of the draft SPDES permit, the combined impacts of these actions would have to meet the same performance measures as a closed-cycle cooling system. As described in Section 8.1.1.2 (Aquatic Ecology for the closed-cycle cooling alternative), the amount of water withdrawn from the Hudson River for IP2 and IP3 following implementation of the closed-cycle cooling system alternative would be reduced by 93 to 95 percent. To meet the requirements of the draft SPDES permit (NYSDEC 2003a), the modified once-through cooling system and combined restoration alternatives would have to result in a net entrainment and impingement reduction of 93 to 95 percent for species most affected by the existing system. The NRC staff examined other potential mitigation options to reduce impacts to aquatic life in Section 4.1.5 of this draft SEIS and concludes that one or a combination of these mitigation measures could be used as part of this alternative.

Restoration of wetlands or other aquatic habitats in the Hudson River estuary would likely be included as an aspect of any program designed to offset the residual impacts of once-through cooling-water systems. The New York-New Jersey Harbor is one of the 28 National Estuary Programs charged with developing and implementing a plan to protect, conserve, and restore the estuary (NY-NJ HEP Undated-a). A Comprehensive Conservation and Management Plan (CCMP) establishes priorities for activities, research, and funding for the estuary program. The core areas of the estuary stretch north on the Hudson to Piermont Marsh (south of IP2 and IP3; Piermont Marsh is near the southern end of the Tappan Zee river segment in Figure 2-10 in Chapter 2) (NY-NJ HEP Undated-b), but priorities identified in the CCMP could guide possible restoration activities. In addition, restoration activities would also be conducted in accordance with the NYSDEC Hudson River Estuary Program, a regional partnership designed to protect, conserve, restore, and enhance the estuary.

The estuarine wetlands and shallows of the Hudson River provide foraging habitat and shelter, serve as nursery areas for early life stages and juveniles of fish and shellfish, and contribute to the aquatic food web. An increase in wetlands or other aquatic habitats in the Hudson River estuary could support increased populations of some species affected by the IP2 and IP3 cooling-system operations and thus offset entrainment and impingement losses of those species.

Staff, consultants, or contractors would need to determine where restoration projects should take place before a wetland restoration plan could be designed. The restoration plan would indicate the size and location of restoration projects needed to add to aquatic populations at essentially the levels that the modified once-through cooling system depletes them. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland areas in the immediate vicinity of the site. Therefore, wetland restoration activities would likely need to take place away from the site.

The restoration alternative could build on features of the Hudson River Settlement Agreement (HRSA; addressed in greater depth in Section 2.2.5.3 of this draft SEIS). Measures to limit aquatic impacts of Hudson River Power plants discussed in the HRSA include partial outages

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for some Hudson River power plants during key spawning months, funding and operating a striped bass hatchery, conducting biological monitoring, and setting up a \$12-million endowment for a new foundation for independent research on mitigating fish impacts by power plants.

As noted in Chapter 2 of this SEIS, the HRSA was replaced by four consecutive judicially approved consent orders. Each of these consent orders effectively continued the HRSA terms and conditions, with two exceptions. Neither consent order required outages at IP2 or IP3 or the continued operation of the striped bass hatchery.

As described in the draft SPDES permit, financial support of organizations that can have a direct impact on the health of the Hudson River estuary, such as the Hudson River Estuary Restoration Fund (HRERF), is another possible piece of a restoration alternative. The draft SPDES permit would require a payment of \$24 million to the HRERF by Entergy (NYSDEC 2003a, 2003c) until it constructs closed-cycle cooling. An alternative to the construction and operation of the closed-cycle cooling systems could include additional funding to the HRERF and groups like it.

8.1.2.2 Environmental Impacts of the Modified Existing Once-Through Cooling System with Restoration Alternative

In this section, the NRC staff discusses the impacts that would occur if the existing once-through cooling system intakes at IP2 and IP3 were modified, and restoration actions were implemented, as described in Section 8.1.2.1 of this draft SEIS. These actions would need to meet the expected requirements of the NYSDEC-issued SPDES permit. The anticipated environmental impacts of this alternative are summarized in Table 8-1 with discussions on each impact category provided in the following paragraphs.

For most issues, the impacts of operating the modified once-through cooling system and restoration alternative would be the same or lower than the impacts associated with the existing once-through cooling system presented in Section 4.1 of this draft SEIS. Only the impacts on land use would likely be greater with the modified cooling system and restoration alternative than with continued operation of the existing system.

• Land Use

Any restoration plan will have some impact on land use. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland or shallows areas near the site to support restoration activities. Therefore, restoration activities would likely need to take place at locations further away from the site.

There would be noticeable short-term construction impacts on land use in any areas designated for restoration by the restoration plan. Site preparation could include grading and recontouring, removal of contaminated sediments, and/or replacement of sediments. Restoration often requires the removal of invasive and nonnative plant species through the use of herbicides, prescribed burning, biocontrol, or a combination of techniques. Following the removal of invasive species, the planting of native wetland and upland species along a hydrologic gradient is often required. Restoration activities would likely be conducted in accordance with the NYSDEC Hudson River Estuary program.

Once initial restoration activities are complete, restored wetlands usually require periodic maintenance such as prescribed burning, herbicide application, and planting to maintain the desired mix of native plant species. Monitoring may be required for restored nearshore aquatic

habitats. These activities could be required throughout the license renewal period. It is unlikely that “operation” of a restoration site will have long-term effects on land use unless restoration converts previously dry land into wetlands. Operation of the restoration site may have some benefits to nearby landowners or users if the site was previously degraded.

Land also would be needed for construction of a new fish hatchery. The impacts to land use would likely be minimal, especially if the construction site was in a previously developed area.

The NRC staff concludes that the activities related to restoration and maintenance of wetlands, and construction and operation of a new fish hatchery, would likely result in SMALL to MODERATE land use impacts.

• Ecology

Aquatic ecology. Implementation of a well-developed restoration plan would, as designed, have an overall positive impact on aquatic ecology. There may, however, be some short-term negative impacts during the initial stages of restoration and/or construction activities. A restoration plan would indicate specific locations where restoration activities would take place, as well as the types and duration of activities. In the absence of such a plan, only an estimate of impacts is possible. To achieve performance equivalent to the 93-to-95-percent reduction in impingement and entrainment likely to be achieved with closed-cycle cooling, the restoration alternative would likely also need to include some intake modifications as described in Section 4.1.5 of this draft SEIS, and/or modifications to pumping rates, which could reduce impingement or entrainment.

During wetland restoration and construction of the fish hatchery, the NRC staff expects that impacts to aquatic ecology would be negative. Wetland restoration could initially increase rates of runoff and sedimentation, or release pollutants trapped in sediments. Construction of the fish hatchery could create runoff during construction, though this would likely be minor. During operations, however, any fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River.

If this alternative achieves its intended goals—which would require rigorous monitoring—then the NRC staff concludes that the overall net impacts of the cooling system modifications and restoration alternative on aquatic ecology would be SMALL during operation, and MODERATE during construction.

Terrestrial ecology. Implementation of a well-developed restoration plan, cooling system intake modifications, and construction activities will produce few impacts upon the terrestrial environment or threatened or endangered terrestrial species. Impacts to terrestrial ecology would be most noticeable during construction, when any land conversion would take place, and when site crews may need to construct roads or laydown areas for equipment used to restore the wetland or construct the hatchery. Impacts from these activities would be highly site specific, but they are localized and short lived.

Once construction and initial restoration conclude, impacts to terrestrial ecology will be minor, and may be positive for the restoration portion of this alternative. Wetlands can increase the ecological value of nearby land area and provide habitat for some species that are largely terrestrial. Overall, the NRC staff concludes that the terrestrial ecological impacts from the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL to

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MODERATE, as some impacts may be noticeable during construction.

• **Water Use and Quality**

As noted in the Ecology section for this alternative, wetland restoration could initially increase rates of runoff and sedimentation or release pollutants trapped in sediments. Wetland restoration will modify the hydrologic behavior of the restoration site, and often includes measures that can affect surrounding water quality once the site is operational. Hydrologic modifications at a restoration site could include (1) installation of structures that control water flow and affect flow patterns, (2) the removal of dikes or berms, (3) the removal of drainage channels that drain water away from a site, and (4) the creation of new drainage channels or basins. Once operational, wetland restoration sites help to improve surface water quality by allowing natural processes to break down pollutants before being transported into open water.

Construction of the fish hatchery will also create some site runoff, though good construction practices should limit this impact. Once operational, the fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River. Fish hatcheries produce nutrient-rich water that may require treatment before release.

While some construction-stage impacts may be noticeable, the long-term operational effects are minor, and may be beneficial. Operational impacts are SMALL, while construction impacts are MODERATE.

• **Air Quality**

Because the restoration alternative contains only relatively small-scale construction projects and does not involve the installation of any major sources of air emissions, it is unlikely that this alternative would trigger noticeable air quality impacts. As a result, the NRC staff concludes that overall impacts to air quality from this alternative would be SMALL.

• **Waste**

Construction of a new fish hatchery would generate a small amount of construction debris, and wetland restoration may leave some land-clearing debris that crews would likely dispose of on site. Any cooling system modification activities are expected to generate modest amounts of wastes for a short period of time. Ongoing operation of the fish hatchery is also expected to generate small amounts of waste, most of which would probably leave the site in liquid form under the restrictions of a State-issued discharge permit. Therefore, the NRC staff concludes that waste-related impacts associated with the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL.

• **Human Health**

Construction of a new fish hatchery would present some general construction-related occupational hazards, as would installation of cooling system modifications. Wetland restoration activities also would present some occupational and environmental exposure hazards. Restoration activities may have positive effects if they improve the quality of water in portions of the Hudson that supply drinking water, as well as to the extent that they provide unpolluted habitat for fish or shellfish that humans may consume.

As described in Section 4.3 of this draft SEIS, the NRC concludes that continued operation of

the facility would not increase the impacts of occupational radiation exposures during the relicensing period, nor would they likely affect radiation exposures to the public. Furthermore, there would be no significant noise sources associated with construction or operation of the fish hatchery or restoration activities that could not be effectively mitigated to protect site workers or offsite individuals.

Overall, the NRC staff concludes that human health impacts from the cooling system modification and restoration alternative are SMALL.

• **Socioeconomics (including Transportation)**

Section 4.4 of this draft SEIS describes the socioeconomic impacts of the continued operation of the IP2 and IP3 facility. The cooling system modification and restoration alternative at IP2 and IP3 would not significantly change employment at or near IP2 and IP3. There would also be no significant changes in the tax base for the region or in traffic flow or traffic patterns.

Therefore, the NRC staff concludes that overall socioeconomic impacts of the alternative would be SMALL.

• **Aesthetics**

The proposed restoration alternative would have no significant impact on the aesthetic value of the IP2 and IP3 facility. Cooling system modification and restoration likely would not have any onsite impacts that would change the overall appearance of the site. Wetland restorations could have a long-term positive impact on aesthetics, or at least minimal negative impacts.

Construction of a new fish hatchery would have limited visual effects because most structures (tanks or ponds, storage buildings, pumphouses) are unobtrusive. Even if some negative impacts occur during construction, long-term negative impacts during operation are unlikely.

The NRC staff concludes that the impact of the cooling system modification and restoration at IP2 and IP3 on aesthetics would be SMALL.

• **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above-ground historic architectural resources have been identified on the IP2 and IP3 site. In addition, a Phase 1A survey was conducted for the site in 2006. The NRC staff identified 76 resources listed on the NRHP within 5 miles of IP2 and IP3.

The NHPA requires archeological surveys to identify and evaluate historic and archeological resources in areas identified for restoration and construction would be required before initiation of ground-disturbing activities. The studies would include consultation with the State Historic Preservation Office (NYSHPO) and appropriate American Indian Tribes.

Many shell midden sites (ancient shell mounds) or other signs of past human activities occur adjacent to wetland areas, and such sites may be encountered during surveys. Aspects of the NHPA require that lands not previously surveyed be investigated by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. Through consultation, whatever entity constructs the fish hatchery or wetland restoration site would identify ways to reduce or avoid adverse impacts. It is possible that construction may have a noticeable effect on historic and archeological resources.

Once operational, the restoration option would essentially have no impact on historic or

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1 archeological resources. The impact of restoration and construction on historic and
2 archeological resources could range from SMALL during operation to MODERATE during
3 construction, depending on the locations chosen for wetland restoration and construction of a
4 new fish hatchery, the number of sites recorded in those locations, and whether the recorded
5 sites are significant (i.e., eligible for listing on NRHP).

6 • **Environmental Justice**

7 Section 4.4.6 of this draft SEIS discusses the environmental justice impacts of continued plant
8 operation. Modification to the existing once-through cooling system intakes at IP2 and IP3 and
9 restoration of wetlands could have an impact on environmental justice if environmental impacts
10 of modifications affected minority and low-income populations in a disproportionately high and
11 adverse manner.

12 However, as described in Section 8.1.1.1 of this draft SEIS, under the Environmental Justice
13 section, the local populations that would be most affected by the proposed action contain lower
14 percentages of minorities and low-income populations than the entire 50-mi radius area and the
15 four-State reference area. As such, the NRC staff concludes that the environmental justice
16 impacts of the modified once-through cooling system and restoration alternative at the IP2 and
17 IP3 site would be SMALL.

Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative and a Modified Existing Once-Through Cooling System with Restoration Alternative at IP2 and IP3

Impact Category	New Closed-Cycle Cooling Alternative		Once-Through Cooling with Restoration Alternative	
	Impact	Comments	Impact	Comments
Land Use	SMALL to LARGE	Construction of towers requires about 16 ha (40 ac). Waste disposal may require much offsite land.	SMALL to MODERATE	Short-term land disturbances may result from habitat restoration; land use changes at the fish hatchery site.
Ecology: Aquatic	SMALL	Entrainment and impingement of aquatic organisms, as well as heat shock would be reduced substantially.	SMALL to MODERATE	Entrainment and impingement of aquatic organisms reduced, while restoration of habitat benefits many species. Noticeable impacts occur during construction.
Ecology: Terrestrial	SMALL to MODERATE	Onsite forest habitats disturbed while drift from towers may affect vegetation.	SMALL to MODERATE	Impacts may occur from offsite construction and temporary impacts in the restoration area. Operational issues are minor.
Water Use and Quality	SMALL	Releases to surface water would be treated as necessary to meet permit requirements. Runoff from construction activities is likely to be controlled.	SMALL to MODERATE	Short-term impacts from construction and restoration can be controlled using management practices, though noticeable impacts may occur.

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Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Air Quality	SMALL	Primary impacts from vehicles and equipment emissions during construction, as well as replacement power. Existing regulations should limit effects.	SMALL	Minor impacts from fugitive dust and emissions from vehicles and equipment occur during construction.
Waste	SMALL to LARGE	Construction would generate about 2 million cy of soil, rock, and debris requiring offsite disposal.	SMALL	Activities would generate easily managed volumes of waste.
Human Health	SMALL	Workers experience minor accident risk during construction. No impacts on human health during operation.	SMALL	Workers experience minor accident risk during construction. No negative impacts on human health during operation.
Socioeconomics	SMALL	No impact to offsite housing or public services occurs.	SMALL	This alternative creates insignificant changes in area employment levels or tax revenues.
Transportation	SMALL to LARGE	Increased traffic associated with construction (workers and waste disposal) would be significant, though little effect during operations.	SMALL	Insignificant changes in traffic volumes result.
Aesthetics	MODERATE	Construction of two towers, 150 to 165 ft tall, would have a noticeable impact on the aesthetics of the site. Minor plume and noise issues could occur.	SMALL	Onsite aesthetics would not likely change significantly. Wetland restorations would have a long-term positive effect on aesthetics.

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Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Historical and Archeological Resources	SMALL	Existing procedures are adequate to protect resources on the largely-disturbed site.	SMALL to MODERATE	Impacts could reach moderate during construction in sensitive areas.
Environmental Justice	SMALL	No significant impacts are anticipated that could disproportionately affect minority or low-income communities.	SMALL	No significant impacts are anticipated that could disproportionately affect minority or low-income communities.

2 8.2 No-Action Alternative

3 The NRC regulations implementing the National Environmental Policy Act of 1969, as amended
 4 (NEPA) (see 10 CFR Part 51, Subpart A, Appendix A, paragraph 4), specify that the no-action
 5 alternative will be discussed in an NRC environmental impact statement.

6 For license renewal, the no-action alternative refers to a scenario in which the NRC would not
 7 renew the IP2 and IP3 operating licenses and Entergy would then cease operating both units on
 8 or before the expiration of their current operating licenses. Following the shutdown of each unit,
 9 Entergy would initiate decommissioning of the facility in accordance with the NRC
 10 decommissioning requirements in 10 CFR 50.82, "Termination of License." Full dismantling of
 11 structures and decontamination of the site may not occur for up to 60 years after plant
 12 shutdown.

13 Regardless of whether or not the IP2 and IP3 operating licenses are renewed, the facility's
 14 owner will eventually be required to shut down the reactors and decommission the IP2 and IP3
 15 facility. If the operating licenses are renewed, shutdown and decommissioning activities would
 16 not be avoided but would be postponed for up to an additional 20 years.

17 The environmental impacts associated with decommissioning, following a license renewal
 18 period of up to 20 years or following the no-action alternative, would be bounded by the
 19 discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this draft SEIS, and NUREG-0586,
 20 "Final Environmental Impact Statement on Decommissioning of Nuclear Facilities" (NRC 2002).
 21 The impacts of decommissioning after 60 years of operation are not expected to be significantly
 22 different from those occurring after 40 years of operation.

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Table 8-2. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Land Use	SMALL	Impacts are expected to be SMALL because plant shutdown is expected to result in few changes to offsite and onsite land use, and transition to alternate uses is expected over an extended timeframe.
Ecology	SMALL	Negative impacts to aquatic ecology of the Hudson River will cease. The overall impact is SMALL.
Water Use and Quality	SMALL	Impacts are expected to be SMALL as no new impacts occur with plant shutdown.
Air Quality	SMALL	Impacts are expected to be SMALL because emissions related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop and generation of low-level and mixed waste will decrease.
Human Health	SMALL	Impacts are expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, will be reduced.
Socioeconomics	SMALL to MODERATE	Impacts vary by jurisdiction, with some areas experiencing MODERATE effects.
Socioeconomics (Transportation)	SMALL	Impacts are expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to be SMALL because plant structures will remain after plant shutdown.
Historic and Archeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not immediately change land use.
Environmental Justice	SMALL	Impacts are expected to be SMALL because there are no significant disproportionate impacts to minority or low-income populations.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, or its Supplement 1.⁽²⁾ Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts will occur when the units shut down regardless of whether the license is renewed (see Table 8-2).

Plant shutdown will result in a net loss of power generating capacity. The power not generated by IP2 and IP3 during the license renewal term would likely be replaced by (1) power supplied by other producers (either existing or new units) using generating technologies that may differ from that employed at IP2 and IP3, (2) demand-side management and energy conservation, or (3) some combination of these options. The environmental impacts of these options are discussed in Section 8.3 of this draft SEIS. While these options can be alternatives to license renewal (given sufficient resource availability), they also constitute potential consequences of the no-action alternative. Impacts from these options will be addressed in their respective portions of this Section.

This draft SEIS does not assess the specifics of the need for corrections to reactive power that would be required if IP2 and IP3 were shut down. Reactive power (i.e., power stored in magnetic fields throughout the power grid) is essential for the smooth operation of the transmission grid because it helps hold the voltage to desired levels. It may be possible to use the existing generators at IP2 and IP3 as a source of reactive power even if IP2 and IP3 are shut down. As “synchronous condensers,” the generators could add reactive power (but not real power) to the transmission system (National Research Council 2006). Because it is assumed that the generators would be operated as synchronous condensers only until the reactive power could be supported by new, real replacement power generation, their operation is not considered as a significant contributor to the impacts described below. Further, as a shutdown nuclear power plant may not be decommissioned for many years after shutdown, the continued operation of IP2 and IP3 generators would not necessarily slow or impede decommissioning activities.

• Land Use

In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use will not be affected immediately by plant shutdowns. Plant structures and other facilities are likely to remain in place until decommissioning. In the near term, the transmission lines associated with IP2 and IP3 will likely remain in place. In the long term, it is possible that the transmission lines that extend from the onsite switchyard to major transmission corridors will be removed. As a result, the transmission line ROWs will no longer be maintained and the ROW will be available for other uses. Also, as a result of plant shutdowns, there would be a reduction in uranium mining activity on approximately 870 ha (2160 ac), or 405 ha (1000 ac) per 1000 MW(e) (NRC 1996). Therefore, the staff concludes that the impacts on land use from plant shutdown would be SMALL.

• Ecology

In Chapter 4 of this draft SEIS, the NRC staff concluded that aquatic ecological impacts of

⁽²⁾ Appendix J, “Socioeconomic and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations,” to NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure, but the results of the analysis in Appendix J are not incorporated in the analysis presented in the main body of the NUREG.

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continued plant operation were SMALL to LARGE because of the entrainment and impingement of aquatic species, depending on the species. The NRC staff also concluded that thermal shock could have a SMALL to MODERATE impact. Terrestrial ecological impacts were SMALL. Cessation of operations will eliminate cooling water intakes from and discharges to the Hudson River. The environmental impacts to aquatic species, including threatened and endangered species, associated with these changes are generally positive because entrainment and impingement issues will be eliminated, as would impacts from the plant's thermal plume. The NRC staff expects that impacts to aquatic ecology, including to the endangered shortnose sturgeon, would decline to SMALL if the plant shuts down.

The impacts of plant closure on the terrestrial ecosystem could be both negative and positive, depending on final disposition of the IP2 and IP3 site. Currently, there is a fragment of eastern deciduous hardwood habitat in the exclusion area of the facility that Entergy indicates has not been previously developed. This fragment could be destroyed by new development once access is no longer restricted. Plant closure will not directly affect this fragment, however, and a prolonged period prior to site decontamination may also provide protection for this fragment. Overall, the NRC staff concludes that ecological impacts from shutdown of the plant would be SMALL.

• Water Use and Quality

When the plant stops operating and cooling water is no longer needed, there will be an immediate reduction in water withdrawals from and discharge to the Hudson River. This will reduce evaporation from the river in the vicinity of the plant and will result in decreased discharges of biocides and other chemicals. Therefore, the staff concludes that the impacts on surface water use and quality from plant shutdown would be less noticeable than current operations and would remain SMALL.

Ground water at the IP2 and IP3 site contains elevated concentrations of tritium (EPA 2004). In Sections 2.2.7 and 4.5 of this draft SEIS, the NRC staff examined available information on leakage to ground water and determined that the issue, while new, is not significant. The source of the contamination is believed to be historical leakage from the IP1 and IP2 spent fuel pools. Since discovering the leaks, Entergy has removed fuel from the IP1 spent fuel pool and drained it. The no-action alternative would not, on its own, affect ground water contamination. Consequently, the NRC staff concludes that ground water quality impacts from shutdown of the plant would be SMALL.

• Air Quality

In Chapter 4 of this draft SEIS, the NRC staff adopted the findings in the GEIS that the impacts of continued plant operation on air quality would be SMALL. When the plant stops operating, there will be a reduction in emissions from activities related to plant operation (e.g., use of diesel generators and vehicles to transport workers to the site). As such, the NRC staff concludes that the impact on air quality from shutdown of the plant would be SMALL.

• Waste

The impacts of waste generated by continued plant operation are discussed in Chapter 6 of this draft SEIS. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When IP2 and IP3 stop operating, the plant will stop generating high-level waste and generation of low-level and mixed waste associated with plant operation will briefly increase,

and then will decline. Therefore, the staff concludes that the impacts of waste generated after shutdown of the plant would be SMALL.

Wastes associated with plant decommissioning are unavoidable and will be significant whether the plant is decommissioned at the end of the initial license term or at the end of the period of extended operation. The no-action alternative will not have an appreciable affect on waste volumes associated with decommissioning.

• Human Health

In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant operation on human health are SMALL. After cessation of plant operations, the amount of radioactive material released to the environment in gaseous and liquid forms, which are currently within regulatory limits, will be reduced. Therefore, the NRC staff concludes that the impact of plant shutdown on human health also would be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this draft SEIS, the staff concluded that impacts of accidents during operation are SMALL. Therefore, the NRC staff concludes that the impacts of potential accidents following shutdown of IP2 and IP3 also would be SMALL.

• Socioeconomics

In Chapter 4 of this draft SEIS, the NRC staff concluded that the socioeconomic impacts of continued plant operation would be SMALL. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1255 full-time employees and baseline contractors would begin to leave the site); there may also be an immediate reduction in property tax revenues for Westchester County. These impacts, however, would not be considered significant on a countywide basis because of the large population in the area and because plant workers' residences are not concentrated in a single municipality or county.

PILOT payments and other taxes from IP2 and IP3 are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. Entergy paid a combined \$21.2 million in PILOT payments, property taxes, and other taxes to Westchester County, the Town of Cortlandt, the Village of Buchanan, the Verplanck Fire District, and the Hendrick Hudson Central School District in 2005 (Entergy 2007). PILOT payments, property taxes, and other taxes paid by the site account for a significant portion of revenues for these Government agencies.

The Village of Buchanan, which has over 2100 residents, is the principal local jurisdiction that receives direct revenue from IP2 and IP3. In fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed about 39 percent of the Village of Buchanan's total revenue of \$5.08 million (Entergy 2007). The revenues generated from IP2 and IP3 are used to fund police, fire, health, transportation, recreation, and other community services. Additionally in fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District, which serves approximately 3000 students (Entergy 2007).

The shutdown of IP2 and IP3 may result in increased property values of the homes in the communities surrounding the site (Levitan and Associates, Inc. 2005). This would result in some increases in tax revenues. However, to fully offset the revenues lost from the shutdown of

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1 IP2 and IP3, taxing jurisdictions most likely would have to compensate with higher property
2 taxes (Levitan and Associates, Inc. 2005). The combined increase in property values and
3 increased taxes could have a noticeable effect on some area homeowners and business,
4 though Levitan and Associates did not indicate the magnitude of this effect and whether the net
5 effect would be positive or negative.

6 Revenue losses from Indian Point operation would likely affect only the communities closest to
7 and most reliant on the plant's tax revenue and PILOT. If property values and property tax
8 revenues increase, some of these effects would be smaller. The NRC staff concludes that the
9 socioeconomic impacts of plant shutdown would likely be SMALL to MODERATE (MODERATE
10 effects for the Hendrick Hudson Central School District, Village of Buchanan, Town of Cortlandt,
11 and the Verplanck Fire District). See Appendix J to NUREG-0586, Supplement 1 (NRC 2002),
12 for additional discussion of the potential impacts of plant shutdown.

13 • **Transportation**

14 In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant
15 operation on transportation would be SMALL. Cessation of operations will be accompanied by
16 reduced traffic in the vicinity of the plant. Most of the reduction will be associated with a
17 reduction in plant workforce, but there will also be a reduction in shipment of maintenance
18 materials to and from the plant. Therefore, the staff concludes that the impacts of plant closure
19 on transportation would be SMALL.

20 • **Aesthetics**

21 In Chapter 4 of this draft SEIS, the NRC staff concluded that the aesthetic impacts of continued
22 plant operation would be SMALL. Major plant structures and other facilities, such as the
23 containment buildings and turbine buildings, are likely to remain in place until decommissioning
24 begins. The NRC staff also anticipates that the overall appearance of the facility and its
25 grounds would be maintained through the decommissioning. Since no significant changes
26 would occur between shut down and decommissioning, the staff concludes that the aesthetic
27 impacts of plant closure would be SMALL.

28 • **Historic and Archeological Resources**

29 In Chapter 4 of this draft SEIS, the staff concluded that the impacts of continued plant operation
30 on historic and archeological resources would be SMALL. Onsite land use will not be affected
31 immediately by the cessation of operations since plant structures and other facilities are likely to
32 remain in place until decommissioning. Following plant shutdown, there would be no
33 foreseeable need for archeological surveys of the area. Therefore, the NRC staff concludes
34 that the impacts on historic and archeological resources from plant shutdown would be SMALL.

35 • **Environmental Justice**

36 In Chapter 4 of this draft SEIS, the NRC staff concluded that the environmental justice impacts
37 of continued operation of the plant would be SMALL because continued operation of the plant
38 would not have a disproportionately high and adverse impact on minority and low-income
39 populations. Although the NRC staff concluded that the socioeconomic impacts of the plant
40 shutdown would be MODERATE for some jurisdictions, the impacts of the plant shutdown are
41 likely to be felt across the entire community and are not expected to be significantly
42 disproportionate to minority and low-income populations.

As described in Section 2.2.8.6, the site contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District in 2005. The Hendrick Hudson Central School District has only an 18-percent minority population (compared to a 47-percent Statewide average) and only 5 percent of the students are eligible for a free or reduced-price lunch program (compared to a Statewide average of 44 percent). Therefore, the loss of funding to the Hendrick Hudson Central School District would not disproportionately affect minority and low-income populations (GreatSchools 2008).

The site contributed about 39 percent of the Village of Buchanan's total revenue in 2005 (Entergy 2007). In 2000, less than 4 percent of the population were minorities and less than 4 percent of the individuals were below the poverty level (US Census Bureau 2000). Therefore, the loss of funding to the Village of Buchanan would not disproportionately affect minority and low-income populations.

The NRC staff concludes that the environmental justice impacts of plant shutdown would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.3 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace power generated by IP2 and IP3. The order of alternative energy sources presented in this section does not imply which alternative would be most likely to occur or which is expected to have the least environmental impacts.

The following central generating station alternatives are considered in detail in the identified sections of this draft SEIS:

- supercritical coal-fired generation at an alternate site (Section 8.3.1)
- natural gas-fired generation at either the IP2 and IP3 site or an alternate site (Section 8.3.2)

The NRC staff considers the following nongeneration alternatives to license renewal in detail in the identified sections of this draft SEIS:

- purchased power (Section 8.3.3)

The NRC staff also considers two combinations of alternatives that include new or existing generation along with conservation or purchased power in the identified sections of this draft SEIS:

- continued operation of either IP2 or IP3, construction and operation of a gas-fired unit, renewable generation, and conservation programs (Section 8.3.5.1)
- construction and operation of new gas-fired plant, renewable generation, conservation, and purchased power (Section 8.3.5.2)

Alternatives considered by the NRC staff but dismissed from further evaluation as stand-alone alternatives are addressed in Section 8.3.4 of this draft SEIS. Several of the alternatives discussed in Section 8.3.4 are included in the combinations addressed in 8.3.5.

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Alternatives Process

Since IP2 and IP3 have a net electric output of 2158 MW(e), the NRC staff evaluated the impacts of alternatives with comparable capabilities.

Of the alternatives mentioned in this section, the NRC staff expects that only a natural gas-fired generation plant could be developed at the IP2 and IP3 facility because the site is too small to host other alternatives.

While the alternate site considered need not be situated in New York State, the availability of transmission line capacity to deliver power from a location outside the New York metropolitan region to current IP2 and IP3 customers could constrain siting choices. For instance, a recent analysis conducted by the U.S. Department of Energy (DOE) concluded that metropolitan New York southward through northern Virginia is a "critical congestion area" (DOE 2006). The DOE has identified critical congestion areas where it is critically important to remedy existing or growing electrical transmission congestion problems because the impacts of the congestion could be severe. It is conceivable that these transmission congestion patterns would influence selection of an alternate site for generating power that is needed in the New York metropolitan region.

All of New York's constrained transmission paths move power from areas to the west, south, and north of the State to the loads in and around New York City and Long Island. The New York City metropolitan area consumes major quantities of electricity with less generation capacity than load. Therefore, the region is dependent on imports. Because of the area's current dependence on local power generation from natural gas and oil fuels, the area has high electricity rates (DOE 2006). The replacement of limited local generation sources with additional imported power would place even more demands on the constrained transmission system moving power into the New York City area. As noted in Section 8.2, it may be necessary to continue operating the IP2 and IP3 generators as synchronous condensers to supply virtual power to the local transmission system after the IP2 and IP3 reactors shut down.

EIA Projections

Each year the Energy Information Administration (EIA), a component of DOE, issues an annual energy outlook. In its "Annual Energy Outlook 2007 with Projections to 2030," EIA projects that natural gas-fired plants will account for approximately 26 percent of electric generating capacity in 2020, an increase of about 14 percent from 2005 levels (DOE/EIA 2007a). EIA projects that coal-fired plants will account for approximately 32 percent of generating capacity in 2020, increasing nearly 15 percent from 2005 levels (DOE/EIA 2007a). EIA projects that renewable energy sources, primarily hydropower and biomass, will account for 12 percent of capacity in 2020, increasing from 9 percent in 2005 (DOE/EIA 2007a). After 2020, however, new coal and nuclear plants are expected to displace some of the power currently generated at natural-gas-fired plants (DOE/EIA 2007a).

EIA bases its projections on the assumption that providers of new generating capacity will seek to add generating sources that are cost effective and meet applicable environmental requirements. According to EIA, advanced coal-fired and advanced combined-cycle natural gas generating facilities will be approximately competitive with each other in 2015, and advanced coal-fired facilities will likely gain a competitive edge by 2030 (DOE/EIA 2007a). In line with the EIA projections, the alternative of a new advanced coal-fired plant at an alternate location is considered in this draft SEIS. The resulting impacts are presented in Section 8.3.1 of this draft

SEIS. The impacts of a new gas-fired combined-cycle plant located at either the IP2 and IP3 site or an alternate site are presented in Section 8.3.2 of this draft SEIS.

EIA indicated that, because of environmental needs and increasing fuel costs, oil-fired plants will account for little or none of the new generating capacity added in the United States through 2030 (DOE/EIA 2007a). This projection assumed that world oil prices would reach a low of \$50 per barrel in 2014 and rise to \$59 in 2030. After recent sharp price increases and declines, the EIA now projects that oil prices will average \$51 per barrel in 2009 (DOE/EIA 2008b). The NRC staff notes that future oil prices will be driven by supply and demand.

The EIA projects that U.S. generators will increase total nuclear and renewable generation capacity throughout the forecast term, due partly to tax credits and other incentives. As a proportion of installed capacity, however, nuclear generation will decrease slightly through 2030, while renewable generation remains relatively constant (EIA 2007). EIA indicates that changes in electricity generation costs—which are highly dependent on emission control costs—will drive utilities' choices in generating technologies (EIA 2007). About 70 percent of new nuclear generating capacity is expected to be directly related to the availability of production tax credits under the Energy Policy Act of 2005 (EPACT2005; DOE/EIA 2007a).

The NRC staff uses EIA's analyses to help select reasonable alternatives to license renewal. In the following sections of this chapter, the NRC staff will examine several alternatives in depth, and identify a range of others that staff considered but rejected.

8.3.1 Supercritical Coal-Fired Generation

In this section, the NRC staff analyzes new supercritical coal-fired boilers as an alternative to nuclear power generation at the IP2 and IP3 site. Supercritical coal-fired plants are similar to other coal burners except that they operate at higher temperatures and pressures, which allows for greater thermal efficiency. Supercritical coal-fired boilers are commercially proven and represent an increasing proportion of new coal-fired power plants. In evaluating the supercritical coal-fired alternative, the NRC staff assumed that a new plant located at an alternate site would use a closed-cycle cooling system.

The NRC staff recognizes that some coal-fired power plant proposals have recently faced opposition or rejection in some jurisdictions, though other projects continue to move forward. Also, coal-fired generation faces greater regulatory uncertainty and risk from potential future greenhouse gas regulation than other generation alternatives. In New York, coal-fired power plants would need to comply with elements of the Regional Greenhouse Gas Initiative. Nonetheless, given EIA's projections and the progress of some new coal-fired proposals, the NRC staff has decided to include coal-fired generation as an alternative to license renewal.

Construction of a coal-fired plant at an alternate site may necessitate the acquisition of additional ROWs for new transmission lines and construction of new lines to transmit power. Transmission line and ROW length would vary with distance to suitable existing lines. In addition, construction at an alternate site may necessitate the construction of an appropriate railroad spur (or other transportation infrastructure) for coal and limestone (used in scrubbers to remove sulfur oxides) deliveries.

For purposes of this analysis, the NRC staff will rely on data published by EIA indicating that a new, scrubbed coal plant constructed in 2015 will operate at a heat rate of 8661 BTU per

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1 kilowatt hour (BTU/kWh) (DOE/EIA 2007b). (This reduces the level of emissions for this
2 alternative when compared to the coal-fired alternative Entergy analyzed in the ER for IP2 and
3 IP3 ER by approximately 15 percent for some impact areas).

4 Impacts of a coal-fired alternative evaluated by the NRC staff assume that the new plant would
5 have a gross electrical capacity of 2200 MW(e). The NRC staff's analysis of the 2200-MW(e)
6 coal-fired plant is based on the factors used to calculate the impacts of the plant that would
7 replace the 2158 MW(e) of power produced by the IP2 and IP3 plants (Entergy 2007). Because
8 up to 10 percent of gross generation may be consumed on site by the coal-fired plant (or its
9 pollution control equipment), the NRC staff's evaluation of a 2200-MW(e) plant may actually
10 slightly understate impacts from this alternative. This ensures, however, that impact levels for
11 alternatives are not overstated when compared to the proposed action.

12 The NRC staff will present most impacts on an annualized basis. While the renewal period for
13 the IP2 and IP3 operating licenses is only 20 years, the operating lifespan for a new coal-fired
14 plant is likely closer to 40 years, and may even be longer given the lifespans of some existing
15 coal-fired plants. Most impacts will be independent of plant lifespan, though total land area
16 used for waste disposal, for example, will be larger after 40 years than after 20 years. Where
17 these differences exist, the NRC staff will identify them.

18 For replacing IP2 and IP3, the NRC evaluated an alternative that would use four 550-MW(e)-net
19 coal-fired units to replace the power output of IP2 and IP3. Advanced coal and conventional
20 combined-cycle coal plants could operate at even greater efficiencies (about 7477 and 6866
21 BTU/kWh, respectively, or greater) by 2015 (DOE/EIA 2007b).

22 The supercritical coal-fired plant, with a gross output of about 2200 MW(e), would consume
23 approximately 4.9 million metric tonnes (MT) (5.4 million tons) per year of pulverized bituminous
24 coal with an ash content of approximately 7.11 percent and sulfur content of 1.12 percent
25 (based on New York coal consumption) (DOE/EIA 2001). The NRC staff assumed a capacity
26 factor of 0.85 for the supercritical coal-fired alternative.

27 Based on Table 8-1 of the GEIS, a pulverized coal-fired facility requires approximately 0.7 ha
28 (1.7 ac) of land per MW of generating capacity. Based on this relationship, a 1540-ha (3740-ac)
29 site would be needed to replace the nuclear power output of IP2 and IP3 with an equivalent
30 capacity coal-fired facility. In more recent SEIS documents, however, the NRC staff indicated
31 that smaller quantities of land may be sufficient to construct coal-fired facilities based on land
32 use at existing coal-fired power plants. Because the existing IP2 and IP3 site includes only 239
33 ac (98 ha), and much of the area is occupied by plant structures, the NRC staff concludes that
34 there is not sufficient land area at the IP2 and IP3 site to support operations of the alternative.
35 Thus, the coal-fired alternative is analyzed only for an unspecified alternate site. It should be
36 noted that several of the newer coal utilization technologies (e.g., coal-fired integrated
37 gasification combined-cycle systems) could be accommodated on smaller sites than would the
38 conventional pulverized coal concept evaluated here, but likely not a site as small as the IP2
39 and IP3 site.

40 The overall impacts of the coal-fired generating facility are discussed in the following sections
41 and summarized in Table 8-3, at the end of Section 8.3.1 of this draft SEIS. The implications of
42 constructing a new coal-fired plant at an alternate site will depend on the actual location and
43 characteristics of that site. For purposes of this section, the NRC staff assumes that a coal-fired
44 plant located at an alternate site would require the construction of a new transmission line to

connect that plant to the regional transmission grid.

- **Land Use**

In the GEIS, the NRC staff estimated that about 0.7 ha (1.7 ac) of land are needed per MW(e) for the construction and operation of a coal-fired power plant. Constructing a 2200-MW(e) coal-fired facility would take approximately 1540 ha (3740 ac). In more recent SEIS documents, the NRC staff indicated that smaller quantities of land may be sufficient to construct coal-fired facilities based on land use at existing coal-fired power plants. A 2200-MW(e) facility may be able to fit on a site with several hundred acres of land rather than the 1540 ha (3740 ac) indicated in the GEIS.

Committing land resources to a new coal-fired plant could result in the loss of wildlife habitat or agricultural land. The potential need for new transmission line corridors and ROWs also drive land use effects for the coal-fired facility. As a result of the substantial site area that would be dedicated to and disrupted by coal-fired operations, the NRC staff views this alternative as having potentially MODERATE land use impacts from construction.

Additionally, for the coal-fired alternative, land use changes would occur at an undetermined coal mining area where approximately 75 square miles (sq mi) (19,400 ha) would be affected for mining coal and disposing of mining wastes to support a 2200-MW(e) coal-fired power plant (the GEIS estimates that approximately 34 sq mi (8800 ha) would be disturbed for a 1000-MW(e) coal-fired plant (NRC 1996). Offsite land use for coal mining would partially be offset by the elimination of the need for offsite uranium mining. In the GEIS, the NRC staff estimated that approximately 405 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996). Therefore the uranium mining offset would be about 890 ha (2,200 ac) of the 19,400 ha required for the coal-fired alternative. Impacts from the coal fuel cycle would add to the already MODERATE impacts from plant construction.

A coal-fired alternative would likely receive coal and limestone by rail. The coal-fired option would require approximately 10.4 coal unit trains per week (assuming each train has 100 cars with 100 tons of coal per car). For an undeveloped site, a new rail spur would be necessary. For an existing industrial site, a rail spur may exist but could require improvements to handle these deliveries. Impacts from improving an existing rail spur would be small, as the area is already disturbed and used for industrial purposes. Installing a new rail spur could result in relatively minor impacts depending on the length of the rail spur.

Overall, impacts to land use from construction of the coal-fired alternative and its fuel cycle would be MODERATE to LARGE.

- **Ecology**

Siting a coal-fired plant at an alternate site would introduce construction and operating impacts. Converting as much as 1500 ha (3700 ac) of land to industrial use (generating facilities, coal storage, ash and scrubber sludge disposal) could significantly alter terrestrial ecological resources and could affect aquatic ecological resources. Construction and maintenance of a transmission line and rail spur would incrementally add to the terrestrial ecological impacts. Impacts to terrestrial ecology from coal mining also could be substantial, though terrestrial ecology at many coal mining sites has already been disturbed. Therefore, the NRC staff concludes that the impact to terrestrial ecology would be MODERATE to LARGE, depending

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largely on the ecological sensitivity of the plant and mine sites.

Use of surface water resources to provide makeup water for a closed-cycle cooling system would have some impact on local aquatic resources. Aquatic impacts of a supercritical coal-fired alternative would likely be similar to the impacts of the proposed closed-cycle cooling system proposed for the existing nuclear reactors described in Section 8.1.1 of this draft SEIS. The supercritical coal-fired power plant's greater thermal efficiency—when compared to the existing IP2 and IP3—would result in smaller impacts, while the coal-fired alternative has greater potential for deposition of pollutants or runoff from coal, ash, or scrubber waste areas. On the whole, the level of impact would be similar. Therefore, the NRC staff concludes that the impact to aquatic ecology would be SMALL.

Due primarily to the potential effects on terrestrial ecology, the NRC staff concludes that the overall impacts of this alternative would be MODERATE to LARGE.

• Water Use and Quality

For coal-fired operations at an alternate site, impacts to surface waters would result from withdrawal of water for various operating needs of the facility. These operating needs would include cooling tower makeup and possibly auxiliary cooling for equipment and potable water requirements. Discharges to surface water could result from cooling tower blowdown, coal pile runoff, and runoff from coal ash and scrubber byproduct disposal areas. Both the use of surface waters and discharges to surface waters would be regulated by the State within which the coal-fired facility is located.

The NRC staff expects that any new coal-fired facility would comply with requirements of the discharge permits issued for its operation. Thus, the utility would be obligated to ensure that discharges from the plant conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. Overall, the NRC staff concludes that the potential impacts to surface water resources and water quality would be SMALL to MODERATE for a new coal-fired facility located at an alternate site.

Potential impacts to ground water quality at an alternate site may occur as a result of seepage to ground water from coal storage areas and onsite ash and scrubber sludge disposal areas. A coal-fired plant of this size is unlikely to use ground water for cooling tower makeup, however. In all cases, the NRC staff expects that a coal-fired facility would comply with a ground water use and discharge permit issued by the State having jurisdiction over the plant. Complying with permit requirements should ensure a small impact. Therefore, the NRC staff concludes that the potential impacts to water resources would be SMALL to MODERATE.

• Air Quality

A coal-fired power plant emits a variety of airborne emissions, including SO_x, NO_x, particulate matter, CO, hazardous air pollutants (HAPs) (e.g., mercury), and naturally occurring radioactive materials.

A coal-fired alternative built in a nonattainment area (such as exists at the current IP2 and IP3 site) would require a nonattainment area permit and a Title V operating permit under the CAA. A new power plant would also be subject to the new source performance standards for such units in Subpart DA, "Standards of Performance for Electric Utility Steam Generating Units for Which Construction Is Commenced after September 18, 1978," of 40 CFR Part 60, "Standards

1 of Performance for New Stationary Sources.” These regulations establish emission limits for
2 particulates, opacity, sulfur dioxide (SO₂), and NO_x. EPA has various regulatory requirements
3 for visibility protection in Subpart P, “Protection of Visibility,” of 40 CFR Part 51, “Requirements
4 for Preparation, Adoption, and Submittal of Implementation Plans,” including a specific
5 requirement for review of any new major stationary source in an area designated attainment or
6 unclassified under the CAA.

7 NRC discussions of SO_x and NO_x emissions include the most recent relevant regulations,
8 because the Clean Air Interstate Rule (CAIR) was vacated by the D.C. Circuit Court in July of
9 2008. On September 24, 2008, EPA filed for a rehearing of the D.C. Circuit Court decision.
10 Until EPA, Congress, or the courts act, elements of future SO_x and NO_x regulatory approaches
11 remain uncertain.

12 Emissions of specific pollutants from coal-fired alternatives are as follows:

13 Sulfur oxides emissions. The NRC staff calculates that a new coal-fired power plant would emit
14 5236 MT/yr (5754 tons/yr) of SO_x after limestone-based scrubbers remove approximately 99
15 percent of sulfur compounds from plant exhaust. This plant would be subject to the
16 requirements in Title IV of the CAA. Title IV was enacted to reduce emissions of SO_x and NO_x,
17 the two principal precursors of acid rain, by restricting emissions of these pollutants from power
18 plants. Title IV caps aggregate annual power plant SO_x emissions and imposes controls on SO_x
19 emissions through a system of marketable allowances. EPA issues one allowance for each ton
20 of SO_x that a unit is allowed to emit.

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1 New units do not receive allowances but are required to have allowances to cover their SO_x
2 emissions. Owners of new units must, therefore, acquire allowances from owners of other
3 power plants or reduce SO_x emissions at other power plants they own. Allowances can be
4 banked for use in future years. Thus, a new coal-fired power plant would not add to net regional
5 SO_x emissions, although it might contribute to the local SO_x burden.

6 Nitrogen oxides emissions. Title IV of the CAA directed EPA to establish technology-based
7 emission limitations for NO_x emissions (see Section 407), rather than a market-based allowance
8 system as is used for SO_x emissions. A new coal-fired power plant would be subject to the new
9 source performance standards for such plants in 40 CFR 60.44a(d)(1). That regulation, issued
10 September 16, 1998 (Volume 63, page 49453 of the *Federal Register* (63 FR 49453)), limits the
11 discharge of any gases that contain nitrogen oxides (expressed as nitrogen dioxide (NO₂)) to
12 200 nanograms per joule of gross energy output (1.6 pound/megawatt-hour (MW(h))), based on
13 a 30-day rolling average.

14 As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut
15 Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and
16 Connecticut, as well as several counties in Central and Southeastern New York within a 80-km
17 (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour
18 standard) (EPA 2008b). Operators or owners of a coal-fired power plant constructed in a
19 nonattainment area would need to purchase offsets for ozone precursor emissions. In this
20 case, NO_x is the major ozone precursor emitted by a coal-fired power plant. In accordance with
21 NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual
22 emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By
23 design, this regulatory requirement should result in a net reduction in ozone emissions in the
24 region.

25 This new coal-fired plant would likely use a variety of NO_x control technologies, including low-
26 NO_x burners, overfire air, and selective catalytic reduction. EPA notes that when these
27 emissions controls are used in concert, they can reduce NO_x emissions by up to 95 percent
28 (EPA 1998), for total annual emissions of approximately 1230 MT/yr (1352 tons/yr) or
29 0.14 pounds/MW(h). This is significantly less than the amount allowed by Title IV of the CAA.

30 Particulate emissions. The NRC staff estimates that the total annual stack emissions would
31 include 175 MT (192 tons) of total suspended particulates and 40 MT (44 tons) of particulate
32 matter having an aerodynamic diameter less than or equal to 10 µm (PM₁₀) (40 CFR 50.6,
33 "National Primary and Secondary Ambient Air Quality Standards for PM₁₀"). Some of this PM₁₀
34 would also be classified as primary PM_{2.5}.

35 As indicated in the IP2 and IP3 ER, fabric filters or electrostatic precipitators would be used for
36 particulate control. EPA notes that filters or precipitators are each capable of removing more
37 than 99 percent of particulate matter, and that SO₂ scrubbers further reduce particulate matter
38 emissions (EPA 1998). In addition to flue emissions, coal-handling equipment would introduce
39 fugitive particulate emissions from coal piles, reclamation equipment, conveyors, and other
40 sources.

41 Fugitive dust also would be generated during the construction of a coal-fired plant, and
42 construction vehicles and motorized equipment would further contribute to construction-phase
43 air emissions. These emissions would be short lived and intermittent, and construction crews
44 would likely mitigate some impacts through dust control measures.

1 Carbon monoxide emissions. The NRC staff estimates that the total CO emissions from coal
2 combustion would be approximately 1230 MT/yr (1352 tons/yr) based on EPA-calculated
3 emissions factors for coal-fired power plants.

4 Hazardous air pollutants including mercury. Following the D.C. Circuit Court's February 8,
5 2008, ruling that vacated its Clean Air Mercury Rule (CAMR), EPA is working to evaluate how
6 the court's ruling will affect mercury regulation (EPA 2008d). Before CAMR, EPA determined
7 that coal- and oil-fired electric utility steam-generating units are significant emitters of HAPs
8 (EPA 2000a). EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium,
9 dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a).
10 EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between
11 coal combustion and mercury emissions, (2) electric utility steam-generating units are the
12 largest domestic source of mercury emissions, and (3) certain segments of the U.S population
13 (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at
14 potential risk of adverse health effects resulting from mercury exposures caused by the
15 consumption of contaminated fish (EPA 2000a). In light of the recent court decision, EPA will
16 revisit mercury regulation, although it is possible that the agency will continue to regulate
17 mercury as a HAP, thus requiring the use of best available control technology to prevent its
18 release to the environment.

19 Uranium and thorium. Coal contains uranium and thorium, among other naturally occurring
20 elements. According to Alex Gabbard of Oak Ridge National Laboratory, uranium
21 concentrations are generally in the range of 1 to 10 parts per million (ppm), and thorium
22 concentrations are generally about 2.5 times this level (Gabbard 1993). The U.S. Geological
23 Survey (USGS) indicates that Western and Illinois Basin coals contain uranium and thorium at
24 roughly equal concentrations, mostly between 1 and 4 ppm, but also indicates that some coals
25 may contain concentrations of both elements as high as 20 ppm (USGS 1997). Gabbard
26 indicates that a 1000-MW(e) coal-fired plant could release roughly 4.7 MT (5.2 tons) of uranium
27 and 11.6 MT (12.8 tons) of thorium to the atmosphere each year (1993).

28 Both USGS and Gabbard, however, indicate that almost all of the uranium, thorium, and most
29 decay products remain in solid coal wastes, especially in the fine glass spheres that constitute
30 much of coal's fly ash. Modern emissions controls, such as those included for this coal-fired
31 alternative, allow for recovery of greater than 99 percent of these solid wastes (EPA 1998), thus
32 retaining most of coal's radioactive elements in solid form rather than releasing it to the
33 atmosphere. Even after concentration in coal waste, the level of radioactive elements remains
34 relatively low—typically 10 to 100 ppm—and consistent with levels found in naturally occurring
35 granite rocks, shales, and phosphate rocks (USGS 1997). The levels of uranium and thorium
36 contained in coal wastes and discharged to the environment exceed the levels of uranium and
37 thorium released to the environment by IP2 and IP3.

38 Carbon dioxide: A coal-fired plant would have unregulated CO₂ emissions that could contribute
39 to global warming. Under the current regulatory framework, a coal-fired plant would have
40 unregulated CO₂ emissions during operations as well as during coal mining and processing, and
41 coal and lime transportation. Burning bituminous coal in the United States emits roughly 93.3
42 kg (205.3 pounds) of CO₂ per million BTU (DOE/EIA 2008a). The four-unit 2200-MW(e)
43 supercritical coal-fired plant would emit approximately 13.1 million MT (14.5 million tons) of CO₂
44 per year assuming a heat rate of 8661 BTU/kWh (DOE/EIA 2007b). Section 6.2 of this draft
45 SEIS contains a discussion of current and likely future relative GHG emissions from several

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energy alternatives, including coal, natural gas, nuclear, and renewables. In Section 6.2, the NRC staff found that GHG emissions from coal would likely exceed those from other energy alternatives throughout the period of extended operation.

Visibility Regulations: Section 169A of the CAA (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from manmade air pollution. EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a coal-fired alternative were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. New York has no Class I areas; of the neighboring States, New Jersey and Vermont each have one—the Brigantine Wilderness Area and the Lye Brook Wilderness, respectively. Brigantine is located about 225 km (140 mi) south of IP2 and IP3, while Lye Brook is roughly 215 km (135 mi) north-northeast. A coal-fired alternative located near these areas or any other Class I area may need additional pollution controls to keep from impairing visibility.

Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but implied that air impacts would be substantial. The GEIS also mentioned global warming from unregulated CO₂ emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). The NRC staff's analysis shows that emissions of air pollutants, including SO_x, NO_x, and CO, would be significant and would be greater than all other alternatives. Operational emissions of CO₂ are also greater under the coal-fired alternative than under any other alternative.

The NRC analysis for a coal-fired alternative at an alternative site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Thus, the appropriate characterization of air impacts from coal-fired generation would be MODERATE.

• Waste

A four-unit, 2220-MW(e) coal-fired plant with a heat rate of 8661 BTU/kWh (DOE/EIA 2007b) would annually consume approximately 5.4 million tons of coal having an ash content of 7.11 percent (Entergy 2007). After combustion, 99.9 percent of this ash, approximately 345,800 MT (380,000 tons) per year, would be collected and disposed of at either an onsite or offsite landfill, or recycled. Based on industry-average recycling rates, approximately 155,610 MT (171,000 tons), or 45 percent, of the ash content would be recycled, leaving a total of approximately 190,190 MT (209,000 tons) for disposal (ACAA 2007). In addition, approximately 300,300 MT (330,000 tons) of scrubber waste would be disposed of or recycled each year. Based on industry-average recycling rates, approximately 237,000 MT (260,700 tons), or 79 percent, of gypsum scrubber waste would be recycled (ACAA 2007). As mentioned in the Air Quality section, this waste also would contain levels of uranium and thorium in concentrations similar to those found in naturally occurring granites, shales, and phosphate rocks (USGS 1997). In addition to coal combustion wastes, a supercritical coal-fired alternative

1 also would produce small amounts of domestic and hazardous wastes.

2 Disposal of the waste could noticeably affect land use and ground water quality, but with
3 appropriate management and monitoring, it would not destabilize any resources. After closure
4 of the waste site and revegetation, the land could be available for other uses.

5 In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the
6 Combustion of Fossil Fuels" (EPA 2000b). EPA concluded that some form of national
7 regulation is warranted to address coal combustion waste products because (1) the composition
8 of these wastes could present danger to human health and the environment under certain
9 conditions, (2) EPA has identified 11 documented cases of proven damages to human health
10 and the environment by improper management of these wastes in landfills and surface
11 impoundments, (3) disposal practices are such that, in 1995, these wastes were being managed
12 in 40 to 70 percent of landfills and surface impoundments without reasonable controls in place,
13 particularly in the area of ground water monitoring, and (4) EPA identified gaps in State
14 oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue
15 regulations for disposal of coal combustion waste under Subtitle D of the Resource
16 Conservation and Recovery Act (RCRA). EPA has not yet issued these regulations.

17 In addition to the waste streams generated during plant operations, considerable debris would
18 be generated during construction of a coal-fired facility. Crews would likely dispose of land-
19 clearing debris on site.

20 For all of the preceding reasons, the NRC staff considers the impacts of managing waste
21 generated by a coal facility (construction and operating phases) to be MODERATE—the
22 impacts would be clearly noticeable, but would likely not destabilize any important resource.

23 • **Human Health**

24 Coal-fired power generation introduces risks to workers at many points in the fuel cycle. These
25 risks include risks from mining coal and limestone, transportation of raw materials, plant
26 construction and operation, and waste management. There also may be public health risks
27 from a coal-fired plant's operation (routine emissions and coal-pile fires) and fuel cycle (mining
28 and transportation).

29 During construction activities there would be risk to workers from typical industrial incidents and
30 accidents. Accidental injuries are not uncommon in the construction industry and accidents
31 resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use
32 of proper industrial hygiene practices, complying with worker safety requirements, and training.
33 Occupational and public health impacts during construction are expected to be controlled by
34 continued application of accepted industrial hygiene protocols, occupational health and safety
35 controls, and radiation protection practices.

36 In the GEIS, the NRC staff stated that human health impacts (cancer and emphysema) could
37 arise from chronic exposures to coal-fired plant emissions. Emissions contain pollutants such
38 as toxins, particulates, and low levels of naturally occurring radioactive elements. However,
39 Federal and/or State agencies regulate these emissions and enforce emissions standards that
40 are designed to be protective of human health. As a result, power plants install appropriate
41 emission controls to meet regulatory standards.

42 Coal-fired generation would introduce mechanical sources of noise that would be audible off
43 site. Sources contributing to total noise produced by plant operations are both continuous and

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intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the coal-handling equipment, solid-waste disposal systems, outside loudspeakers, and commuting activities of plant employees. Noise impacts associated with rail delivery of coal and lime to the generating station site would be most significant for residents living along the new rail spur leading to the plant. Although passing trains significantly raise noise levels near rail corridors, the short duration of the noise tends to minimize impacts.

Based on the cumulative potential impacts of construction activities, emissions, and noise on human health, the NRC staff considers the impact of constructing and operating a new coal-fired facility to be MODERATE.

• **Socioeconomics**

Construction of a coal-fired facility at an alternate site would take approximately 4 years (DOE/EIA 2007b). Based on estimates given in Table 8.1 of the GEIS, the peak workforce is estimated to range from 1.2 to 2.5 additional workers per MW(e) during the construction period. For the 2200-MW(e) plant utilized in this analysis, the peak workforce would range from approximately 2640 to as many as 5500 workers during the 4-year construction period (NRC 1996). During construction, the surrounding communities would experience demands on housing and public services unless some of the workforce is composed of local residents. In the GEIS, the NRC staff stated that socioeconomic impacts would depend on the location of the new plant. For example, at a rural site more of the peak construction workforce would need to relocate (temporarily or permanently) to the area to work. Therefore, socioeconomic impacts could range from SMALL to LARGE depending on whether workers would relocate to be near the site, as well as depending on the size and makeup of the existing community.

At the end of construction, the local population would be affected by the loss of as many as 5000 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment rate of 0.25 workers per MW(e) based on Table 8.2 of the GEIS, or a total of 550 total workers. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the site.

The coal-fired plant would provide new tax revenue to its community. Because this plant would be located in another community, it would have a positive impact on its community while the shutdown of IP2 and IP3 will have a negative impact on the tax base of the IP2 and IP3 community.

The NRC staff concludes that the overall socioeconomic impacts of changes in the local population from the influx of the construction workforce and changes to community tax revenues could be SMALL to LARGE during construction and SMALL to MODERATE during operation, depending on the size and economic structure of the affected communities.

• **Transportation**

During the 4-year construction period of the coal-fired unit, as many as 2600 to 5500 construction workers may be working at the site. During this same time period, trucks and trains would likely be delivering construction materials to the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic could have a MODERATE to LARGE impact on nearby roadways, particularly if

the alternate site is in a rural area. Impacts associated with plant operating personnel commuting to work are likely to be SMALL.

For rail transportation of coal and limestone to the alternate site, impacts are likely to range from SMALL to LARGE, depending on local rail characteristics. On average, more than ten 100-car trains per week would deliver coal to the new generating station, and two 10-car trains per week would deliver limestone to the facility. Transportation impacts associated with coal and limestone delivery could range from SMALL to LARGE

Overall, transportation impacts could range from MODERATE to LARGE during construction, and SMALL to LARGE during operation.

• Aesthetics

At an alternate site, plant buildings, exhaust stacks, cooling towers, and cooling tower plumes would create aesthetic impacts. The coal-fired alternative's four power plant units would be up to 200 ft (61 m) tall and may be visible off site in daylight hours. The three exhaust stacks could be up to 600 ft (183 m) high (at least 500 ft (152 m) for good engineering practice). If the coal-fired alternative makes use of natural-draft cooling towers, then additional visual impacts will occur from the towers, which may be several hundred feet tall and topped with condensate plumes. Mechanical-draft towers would also generate condensate plumes, but would be markedly shorter than natural-draft towers (or they may use hybrid towers like the alternative described in Section 8.1 of this draft SEIS). Other buildings on site may also affect aesthetics, as could construction of new transmission lines. Noise and light from plant operations, as well as lighting on plant structures, may be detectable off site.

Aesthetic impacts at the plant site would be minimized if the plant were located in an industrial area adjacent to other power plants or industrial facilities. Development of a new coal-fired facility at an undeveloped alternate site, however, would entail construction of a new transmission line and a new rail spur to bring coal and lime to the plant. The rail spur and transmission line could extend many miles from the site to tie-in points with existing rail and transmission systems. The visual intrusion of these two linear elements, particularly the transmission line, could be significant.

Overall the aesthetic impacts associated with locating at an alternate site would be categorized as MODERATE to LARGE for an undeveloped site, and may be SMALL to MODERATE at a site previously developed for industrial uses.

• Historic and Archeological Resources

A cultural resource inventory would be needed for any property that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs).

Historic and archeological resource impacts can generally be effectively managed and, as such, would be considered SMALL to MODERATE at a new undeveloped site, depending on the sensitivity of the site. For a previously developed site, most of which have already been

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intensively developed, impact on cultural and historic resources would also be SMALL. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

• Environmental Justice

As described in Section 8.2 of this draft SEIS, no environmental impacts were identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if IP2 and IP3 were shut down.

Impacts at the location of the new four-unit coal-fired plant would depend upon the site chosen and the nearby population distribution, but would likely be SMALL to MODERATE for most alternate sites, but could reach LARGE. For previously developed industrial sites, impacts could be larger or smaller, depending on the relative proximity of low-income populations.

Table 8-3. Summary of Environmental Impacts of the Coal-Fired Plant Alternative Located at an Alternate Site

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Uses up to 1500 ha (3700 ac) for plant, offices, parking, and waste disposal; additional impacts from transmission line and rail spur, as well as coal and limestone mining.
Ecology	MODERATE to LARGE	Impacts to terrestrial ecology would likely be MODERATE to LARGE, while impacts to aquatic ecology would likely be SMALL.

Table 8-3 (continued)

Impact Category	Impact	Comment
Water Use and Quality	SMALL to MODERATE	With closed-cycle cooling, the impact would likely be SMALL, though it would depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Air Quality	MODERATE	• SO_x: 5230 MT/yr (5748 tons/yr) • NO_x: 1129 MT/yr (1351 tons/yr) • Total suspended particulates: 175 MT/yr (192 tons/yr) • PM₁₀: 40 MT/yr (44 tons/yr) • CO: 1129 MT/yr (1315 tons/yr) • Small amounts of mercury and other hazardous air pollutants Extensive emissions controls and regulations limit impacts to MODERATE.
Waste	MODERATE	Total waste production would be approximately 645,000 MT/yr (710,000 tons/yr) of ash (after some is recycled) and scrubber sludge requiring approximately 150 ha (370 ac) for disposal during the 40-year life of the plant. The plant would also generate relatively small amounts of conventional, hazardous, and universal wastes during operation.
Human Health	MODERATE	Impacts are uncertain, but considered MODERATE as the plant would comply with health-informed standards in the CAA and other relevant emissions regulations. Minor risk to workers associated with construction and industrial accidents.
Socioeconomics	SMALL to LARGE	Construction impacts depend on location, but would be LARGE if the plant is located in an area that is rural or is growing less quickly than areas near IP2 and IP3. IP2 and IP3 communities may lose tax revenue and employment, though economic growth would likely offset much of this loss. Impacts from placement of a plant near to an urban area may be MODERATE. Impacts during operation would be smaller than during construction.
Transportation	MODERATE to LARGE	Transportation impacts could be MODERATE to LARGE, during construction, though operational impacts may be smaller during operations.
Aesthetics	SMALL to LARGE	The greatest impacts would be from new transmission lines, plant stacks, and rail lines to transport coal and lime. Impacts would be largest at an undeveloped site.

Table 8-3 (continued)

Impact Category	Impact	Comment
Historic and Archeological Resources	SMALL to MODERATE	Construction at an alternate location would necessitate cultural resource studies; construction would likely avoid highly sensitive areas.
Environmental Justice	SMALL to LARGE	Impacts would vary depending on population distribution and location of the new plant site.

8.3.2 Natural Gas-Fired Combined-Cycle Generation

In this section, the NRC staff examines the environmental impacts of the natural gas-fired alternative at both IP2 and IP3 and at an alternate site. The NRC staff assumed that a natural gas-fired plant would use a closed-cycle cooling system.

This replacement natural gas-fired plant would likely use combined-cycle technology. Compared to simple-cycle combustion turbines, combined-cycle plants are significantly more efficient, and thus provide electricity at lower costs. Combined-cycle gas-fired power plants also tend to operate at markedly higher thermal efficiencies than other fossil-fuel or nuclear power plants, and require less water for condenser cooling than other thermoelectric alternatives. As such, the gas-fired alternative would require smaller cooling towers and substantially less makeup water than the cooling system proposed in Section 8.1.1 of this draft SEIS. Typically, these plants support intermediate loads but they are capable of supporting a baseload duty cycle; thus they provide an alternative to renewing the IP2 and IP3 operating licenses. Levitan and Associates indicated that gas-fired generation was the most likely alternative to take the place of IP2 and IP3 (2005).

The NRC evaluated environmental impacts from gas-fired generation alternatives in the GEIS, focusing on combined-cycle plants (NRC 1996). In a combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery steam generator, which then powers a steam turbine electrical generator. The combination of two cycles can be as much as 60 percent efficient.

Combined-cycle gas turbines that are currently on the market can operate at a heat rate as low as 5700 BTU/kWh for units with net output of 400 MW(e) (GE Energy 2005). These units are more efficient than the 408-MW(e) units Entergy considered in its ER, and would consume about 30 percent less fuel, while producing approximately 30 percent fewer emissions per unit of electrical output. Using five, 400-MW(e) units would slightly underestimate the total impact to some resources, but it provides a useful approximation using more-current technology. Other options would include four, 530-MW(e) units with heat rates of approximately 6000 BTU/kWh (GE Energy 2005), resulting in 2120 MW(e) net output.

The NRC staff discusses the overall impacts of the natural gas-fired generating system in the following sections and summarizes them in Table 8-4 of this draft SEIS. The extent of impacts at an alternate site would depend on the location of the site selected.

1 • **Land Use**

2 Existing facilities and infrastructure would be used to the extent practicable if a gas-fired
3 complex were to be developed at IP2 and IP3. Specifically, the NRC staff assumed that this
4 alternative would use the existing switchyard, offices, and transmission line ROWs. However, a
5 new mechanical-draft cooling tower would need to be constructed to support the new closed-
6 cycle cooling system.

7 The GEIS estimated that 45 ha (110 ac) are needed for a 1000-MW(e) natural gas-fired facility.
8 Scaling up for the 2000-MW(e) facility would indicate a land requirement of approximately 90 ha
9 (220 ac). The NRC staff notes that some existing combined-cycle facilities require less space
10 than the GEIS indicates, and may be more on the order of 16 ha (40 ac) per 1000 MW(e).
11 (Entergy's withdrawn proposal for combined-cycle capacity on the IP2 and IP3, for example,
12 required only 2 ha (5 ac) for 330 MW(e) of capacity (as noted in Levitan and Associates 2005)).
13 The IP2 and IP3 site is only 98 ha (239 ac) with some land unsuitable for construction. Also,
14 much of the site is covered by the IP2 and IP3 containment structures, turbine buildings, other
15 IP2 and IP3 support facilities, and AGTC gas pipeline. Land covered by some IP2 and IP3
16 facilities would not be available until decommissioning, though land covered by some support
17 facilities may be available prior to the end of the current license. The AGTC pipeline ROW
18 would remain unavailable. Based on previous Entergy proposals and experience at other
19 combined-cycle plants, however, the NRC staff finds it possible that a gas-fired alternative could
20 be constructed and operated on the IP2 and IP3 site.

21 As reported by Levitan and Associates, Inc. (2005), the existing Algonquin pipeline that passes
22 through the IP2 and IP3 site may be adequate for a 330-MW(e) simple-cycle plant that would
23 operate in peaking mode during the summer season, when gas supplies are less constrained by
24 winter-season heating demands. Levitan and Associates (2005) concluded that substantial and
25 expensive pipeline upgrades would probably be necessary to supply natural gas to a combined-
26 cycle alternative throughout the winter heating season and for the additional baseload capacity
27 throughout the year. Given firm demand for natural gas during the winter heating season, it is
28 possible that the gas-fired alternative may need to burn fuel oil during several weeks of the year,
29 should conditions of limited supply emerge. This practice is common at gas-fired power plants
30 in the northeastern United States.

31 The environmental impacts of locating the gas-fired generation facility at an alternate location
32 would depend on the past use of the location. If the site is a previously undisturbed site the
33 impacts would be more significant than if the site was a previously developed site. Construction
34 and operation of the gas-fired facility at an undeveloped site would require construction of a new
35 cooling system, switchyard, offices, gas transmission pipelines, and transmission line ROWs. A
36 previously industrial site may have closer access to existing infrastructure, which would help to
37 minimize environmental impacts. A gas-fired alternative constructed at the IP2 and IP3 site
38 would have direct access to a transmission system, an existing pipeline ROW, and an existing
39 dock to receive major components.

40 Regardless of where a gas-fired alternative is built, the GEIS indicates that additional land
41 would be required for natural gas wells and collection stations. According to the GEIS, a 1000-
42 MW(e) gas-fired plant requires approximately 1500 ha (3600 ac) for wells, collection stations,
43 and pipelines, or about 3000 ha (7300 ac) for a 2000-MW(e) facility (NRC 1996).

44 Overall, land use impacts of the gas-fired alternative are considered SMALL to MODERATE at

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the IP2 and IP3 site. Gas-fired generation land use impacts at a new previously industrial site are considered to be SMALL to MODERATE; while gas-fired generation at a new undeveloped site would have MODERATE to LARGE impacts.

• Ecology

At the IP2 and IP3 site, there would be terrestrial ecological impacts associated with siting a gas-fired facility. These impacts would be similar to those described in Section 8.1.1.2 of this draft SEIS, which discusses the ecological impacts of the construction of a closed-cycle cooling system to support IP2 and IP3. The gas-fired facility would likely utilize most previously undeveloped property on site. Improvements to the existing pipeline network would also be necessary, with some impacts along the already-disturbed ROW. Levitan and Associates (2005) indicated that no transmission system improvements would be necessary to accommodate the gas-fired alternative at the IP2 and IP3 site. Overall, construction effects are limited in both scope and duration. Impacts to terrestrial ecology of constructing the gas-fired alternative on site are likely to be SMALL.

Ecological impacts at an alternate site would depend on the nature of the land used for the plant and the possible needs for a new gas pipeline and/or transmission lines. Construction of the transmission line and construction and/or upgrade of the gas pipeline to serve a new plant at an alternate site would have substantial ecological impacts, though these would be temporary. Ecological impacts to the plant site and utility ROWs could include impacts on threatened or endangered species, habitat loss or fragmentation, reduced productivity, and a local reduction in biological diversity. Impacts to terrestrial ecology, however, are likely to be smaller than for a coal-fired facility and would likely be SMALL to MODERATE, depending on site characteristics.

Operation of the gas-fired alternative at the IP2 and IP3 site or another site would likely not introduce new terrestrial ecological effects after construction.

The gas-fired alternative is unlikely to create significant impacts for aquatic ecology during construction, regardless of location. Because the plant has a relatively small footprint, and because crews would likely implement some measures to control site runoff, it is unlikely that impacts to aquatic ecology would be noticeable. Noticeable effects could occur during construction if new transmission line ROWs or gas pipelines would need to cross streams or rivers.

During operations, aquatic ecological resources would experience significantly smaller effects than they would from a comparable nuclear or coal-fired power plant. The combined-cycle gas plant using closed-cycle cooling would require less than half the cooling water of IP2 and IP3 using closed-cycle cooling. Construction of intake and discharge structures at an alternate site could trigger some impacts to aquatic ecology, but because these impacts are very limited in scope and time, they will likely not affect any important resource characteristics. Thus, aquatic ecological impacts of the gas-fired alternative are likely to be SMALL.

At an alternate site, impacts to ecology may range from SMALL to MODERATE, while they are likely to be SMALL if constructed at the existing IP2 and IP3 site.

• Water Use and Quality

Surface Water: Combined-cycle gas-fired plants are highly efficient and require less cooling water than other generation alternatives. Plant discharges would consist mostly of cooling

tower blowdown, with the discharge having a slightly higher temperature and increased concentration of dissolved solids relative to the receiving water body, as well as intermittent, low concentrations of biocides (e.g., chlorine). All discharges from a new plant at the IP2 and IP3 site would be regulated through a New York SPDES permit, which would be issued by NYSDEC. Finally, some erosion would probably occur during construction (NRC 1996), though the GEIS indicates this effect would be SMALL. Plant construction crews would employ at least basic runoff control measures. Because crews would likely not have to construct entirely new intake structures, transmission lines, or a gas pipeline, most activities that could affect water use and quality will not occur for an alternative constructed at the IP2 and IP3 site. Like the existing IP2 and IP3, a gas-fired alternative located on the site would likely not rely on ground water. Overall, impacts to water use and quality at the IP2 and IP3 site from a gas-fired alternative would likely be SMALL for both construction and operation.

At an alternate site, a gas-fired alternative would likely rely on surface water for cooling makeup water and blowdown discharge. Intake and discharge would involve relatively small quantities of water compared to once-through cooling and less than the nuclear or coal-fired alternatives. The impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. If a gas-fired plant discharges to surface water, the plant would have to meet the requirement of a SPDES permit. The NRC staff expects that any new facility would comply with requirements of the discharge permits issued for its operation. Thus discharges from the plant would be legally obligated to conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. The impacts would be SMALL to MODERATE during operations depending on receiving water characteristics. During construction, some erosion would probably occur though the GEIS indicates this would have a SMALL effect (NRC 1996).

Ground Water: IP2 and IP3 currently use no ground water. It is likely that a gas-fired alternative at the IP2 and IP3 site would also use no ground water. Impacts at the IP2 and IP3 site would thus be SMALL. Ground water impacts from operations at an alternate site may vary widely depending on whether the plant uses ground water for any of its water needs, though it would be unlikely that a plant on an alternate site would use ground water for cooling system makeup water given the quantity of water required. Ground water impacts at an alternate site could range from SMALL to MODERATE, depending on the quantity of ground water used and characteristics of aquifers used. Construction-stage impacts at both the existing site and a new site are likely to be SMALL.

• Air Quality

Natural gas is a clean-burning fuel relative to coal. The gas-fired alternative would release emissions similar to those from the coal-fired alternative, but in lesser quantities.

The NRC staff calculates that approximate emissions from the five-unit, 2000-MW gas-fired alternative using combined-cycle gas units with a heat rate of about 5700 BTU/kWh would be:

- SO_x—135 MT/yr (148 tons/yr)
- NO_x—444 MT/yr (475 tons/yr)
- CO—93 MT/yr (135 tons/yr)

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- Filterable particulates (PM₁₀)—75 MT/yr (83 tons/yr)⁽³⁾

Gas-fired power plants primarily emit pollutants as a result of combustion conditions. These pollutants include NO_x, CO, and particulates. Regulations in place to reduce potential health effects from air emissions, especially those promulgated in response to the CAA, drive the types of emissions controls this gas-fired alternative would use to limit its effects on air quality. CAA mechanisms like new source performance standards, nonattainment areas, State implementation plans, and specialized programs, including one that limited overall NO_x emissions throughout the Eastern United States, all drive emissions control technologies used in this gas-fired alternative.

NO_x is typically the pollutant of greatest concern for a gas-fired power plant. Given the proper atmospheric conditions, NO_x helps to form ozone, as well as smog. The gas-fired alternative in this case relies on selective catalytic reduction (SCR) to reduce NO_x emissions. As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and Connecticut, as well as several counties in Central and Southeastern New York within a 80-km (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour standard) (EPA 2008b). Operators or owners of a gas-fired power plant constructed in a nonattainment area would need to purchase offsets for ozone precursor emissions. In this case, NO_x is the major ozone precursor emitted by a coal-fired power plant. In accordance with NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By design, this regulatory requirement should result in a net reduction in ozone emissions in the region.

A new gas-fired generating plant located in a nonattainment area (like that at the IP2 and IP3 site) would need a nonattainment area permit and a Title IV operating permit under the CAA. The plant would need to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart DA. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO₂ (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)).

In December 2000, EPA issued regulatory findings on emissions of HAPs from electric utility steam-generating units (EPA 2000a). Natural gas-fired power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000a). Unlike coal- and oil-fired plants, EPA did not determine that emissions of HAPs from natural gas-fired power plants should be regulated under Section 112 of the CAA.

A natural gas-fired plant would have unregulated CO₂ emissions of about 117 pounds per MMBtu (DOE/EIA 2008a). The NRC staff calculates that a five-unit gas-fired alternative with technologically advanced turbines rated at 5700 BTU/kWh would emit approximately 4,965,000 MT (5,462,000 tons) of CO₂ per year. Section 6.2 of this draft SEIS contains a discussion of current and future relative GHG emissions from several energy alternatives including coal, natural gas, nuclear, and renewables. Other emissions and losses during natural gas production or transportation could also increase the relative GHG impact.

Construction activities also would result in some air effects, including those from temporary fugitive dust, though construction crews likely would employ dust control practices to limit this impact. Exhaust emissions also would come from vehicles and motorized equipment used

⁽³⁾ Additional particulate emissions associated with the cooling towers were not quantified.

during the construction process, though these emissions are likely to be intermittent in nature and will occur over a limited period of time. As such, construction stage impacts would be SMALL.

The overall air quality impact for operation of a new natural gas-fired plant at the IP2 and IP3 or at an alternate site would be SMALL to MODERATE, depending on air quality in the surrounding airshed. Air quality impacts during construction would be SMALL.

• **Waste**

Burning natural gas fuel generates small amounts of waste. However, a plant using SCR to control NO_x will generate spent SCR catalyst and small amounts of solid waste products (i.e., ash). In the GEIS, the NRC staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Waste generation impacts would be minor and would not noticeably alter any important resource attribute.

Constructing a gas-fired alternative would generate small amounts of waste, though many construction wastes can be recycled. Land-clearing debris from construction at an alternate location could be land filled on site. Overall, the waste impacts would be SMALL for a natural gas-fired plant sited at an alternate site.

Cooling towers for a new gas-fired alternative would be much smaller than those proposed in 8.1.1, and would not need to be constructed on slopes near the Hudson. Waste generation from plant construction, then, is much less than in 8.1.1. The waste-related impacts associated with construction of a five-unit gas-fired plant with closed-cycle cooling systems at the IP2 and IP3 site would be SMALL.

• **Human Health**

Human health effects from the operation of a gas-fired alternative with SCR emissions controls would likely not be detected or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource.

During construction activities there would be a risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry, and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices. Fewer workers would be on site for a shorter period of time to construct a gas-fired plant than other new generation alternatives, and so exposure to occupational risks tends to be lower than other alternatives.

Overall, the impacts on human health of a natural gas-fired alternate sited at IP2 and IP3 or at an alternate site would be considered SMALL.

• **Socioeconomics**

Construction of a natural gas-fired plant would take approximately 3 years (DOE/EIA 2007b). Peak labor force would be approximately 1090 workers (NRC 1996). The NRC staff assumed that construction of an offsite alternative would take place while IP2 and IP3 continue operation and would be completed by the time the plants permanently cease operations. Entergy

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indicates that a gas-fired facility could be producing power before IP2 and IP3 shut down (Entergy 2007).

At the end of construction, the local population would be affected by the loss of as many as 1090 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the IP2 and IP3 site. A new gas-fired plant at the IP2 and IP3 site would offset a small portion of lost employment, though, according to Levitan and Associates, it may provide more revenues to the surrounding jurisdictions than IP2 and IP3 do (2005). The large and diverse economic base of the region would help to offset or minimize the significance of job losses.

The NRC staff concludes that the overall socioeconomic impacts from the gas-fired alternative could be SMALL to MODERATE during construction and could be SMALL to MODERATE during operation at most sites, depending largely on tax impacts.

• **Transportation**

Impacts associated with transportation of the construction and operating personnel to the plant site would depend on the population density and transportation infrastructure in the vicinity of the site. During the 3-year construction period of the gas-fired facility, approximately 1090 construction workers may be working at the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic would have a SMALL to MODERATE impact on nearby roadways, depending on road infrastructure and existing traffic demands. Rural areas would typically experience a greater impact than urban or suburban areas. Impacts associated with plant operating personnel commuting to and from work are considered SMALL at all sites. Because the gas-fired alternative relies on pipelined fuel, transportation impacts from natural gas supply are not likely to be noticeable, though plant operators will have to ensure that sufficient gas transportation capacity exists.

• **Aesthetics**

The combustion turbines and the heat-recovery boilers of the gas-fired plant would be relatively low structures compared to existing plant facilities, but could be visible from the Hudson River if located at the current IP2 and IP3 site. Some facility structures could be visible from offsite locations as well. The impact on aesthetic resources of a gas-fired plant is likely less than the impact the current nuclear plant, excepting when cooling towers produce noticeable plumes. Overall, aesthetic impacts from a gas-fired plant constructed at the IP2 and IP3 site would likely be SMALL.

At an alternate site, new buildings, cooling towers, cooling tower plumes, and electric transmission lines would be visible off site. Visual impacts from new transmission lines or a pipeline ROW would also be significant, though these may be minimized by building near existing transmission lines or on previously developed land. Additionally, aesthetic impacts would be minimized if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with the gas-fired alternative at alternate site could be SMALL to LARGE.

• **Historic and Archeological Resources**

According to the IP2 and IP3 relicensing case study in the GEIS, archeological sites at or near the power plant were disturbed before construction of the plant, and so the impacts from plant construction and operation were not significant (NRC 1996). Section 2.2.9.2 of this draft SEIS also supports this conclusion.

A cultural resource inventory would be needed for any property at a new site or adjacent to the IP2 and IP3 site that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs).

The impacts to historic and archeological resources for the gas-fired alternative at the IP2 and IP3 site would be similar to those described in Section 8.1.1.2 of this draft SEIS for the closed-cycle cooling alternative, can generally be effectively managed, and are considered SMALL.

Historic and archeological resource impacts can generally be effectively managed and, as such, would be considered SMALL to MODERATE at a new, undeveloped site. For a previously developed site, impact on cultural and historic resources would also be SMALL. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

• Environmental Justice

As described in Section 8.1.1.2 of this draft SEIS, impacts to the environment or community from actions at the IP2 and IP3 site, including the construction of a gas-fired plant, are not likely to disproportionately affect minority or low-income populations because these populations in the area around the site are proportionately small compared to the the geographical region's population. Therefore, the gas-fired alternative constructed at the IP2 and IP3 site would have SMALL impacts on environmental justice.

Impacts at an alternate site would depend upon the site chosen, nearby population characteristics, and economic conditions. These impacts would range from SMALL to LARGE, depending on impacts and the distribution of low-income and minority populations.

Table 8-4. Summary of Environmental Impacts of the Natural Gas-Fired Plant Alternative Located at IP2 and IP3 and an Alternate Site

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	Comments	Impact	Comments
Land Use	SMALL to MODERATE	Onsite land used; most has been previously disturbed.	SMALL to LARGE	About 92 ha (224 ac) needed for plant construction; additional land may be needed for pipeline and transmission line ROWs.

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Ecology	SMALL	Both terrestrial and aquatic impacts would be SMALL because the plant uses mostly disturbed land and uses relatively little water.	SMALL to MODERATE	Impacts would depend on the nature of the land used for the plant and whether a new gas pipeline and/or transmission lines are needed; cooling water would have SMALL aquatic resource impacts.
Water Use and Quality	SMALL	Minor erosion and sedimentation may occur during construction. The plant would use no groundwater.	SMALL to MODERATE	With closed-cycle cooling, the impact would likely be SMALL. Impact depends on the volume of used and characteristics of the water body; impacts from water use conflicts could be MODERATE.
Air Quality	SMALL to MODERATE	• SO_x: 135 MT/yr (148 tons/yr) • NO_x: 444 MT/yr (475 tons/yr) • PM₁₀: 75 MT/yr (83 tons/yr) • CO: 93 MT/yr (102 tons/yr) • CO₂: 5 million MT/yr (5.5 million tons/yr)	SMALL to MODERATE	Operational impacts are the same as onsite plant but more emissions from additional construction activities.

Table 8-4 (continued)

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	Comments	Impact	Comments
Waste	SMALL	Small amounts of construction waste would be generated.	SMALL	Small amounts of construction waste with some recycling options; land-clearing debris could be land filled on site.
Human Health	SMALL	Minor risk to workers associated with construction and industrial accidents. Health effects from operational emissions are likely to be SMALL.	SMALL	Same as onsite plant.
Socioeconomics	SMALL to MODERATE	Impacts on housing and jobs in the area surrounding IP2 and IP3 during onsite construction and operation would be relatively minor based on the large population of the area surrounding IP2 and IP3.	SMALL to MODERATE	Construction impacts would likely be no larger than MODERATE at most sites. The largest impacts occur during construction.
Transportation	SMALL to MODERATE	Increased traffic associated with construction could be noticeable, though the number of construction workers is smaller than the number of workers currently at IP2 and IP3.	SMALL to MODERATE	Transportation impacts associated with construction and operating personnel to the plant site would depend on the population density and infrastructure in the vicinity of the site.
Aesthetics	SMALL	The impact is likely less than the impacts of the current nuclear plant; more land would be cleared and new structures built.	SMALL to LARGE	The greatest impacts would be from new transmission lines, gas line ROW, and plant structures. Impacts depend on the nature of the site.

1

Table 8-4 (continued)

Impact Category	5 Units Located at IP2 and IP3 Site		5 Units Located at Alternative Site	
	Impact	Comments	Impact	Comments
Historical and Archeological Resource	SMALL	A cultural resources inventory would be needed to identify, evaluate, and mitigate potential impacts from construction.	SMALL to MODERATE	An alternate location would necessitate cultural resource studies; construction would likely avoid highly sensitive areas. Impacts likely would be managed or mitigated.
Environmental Justice	SMALL	No significant impacts are anticipated that could disproportionately affect minority or low-income communities.	SMALL to LARGE	Impacts would vary depending on population distribution and location of the new plant site.

2 8.3.3 Purchased Electrical Power

3 Based on currently scheduled retirements and demand growth projections, the New York
 4 Independent System Operator (NYISO) predicted in 2006 that up to 1600 MW(e) from new
 5 projects not yet under construction would be needed by 2010 and a total of up to 3300 MW(e)
 6 by 2015 (National Research Council 2006).

7 Within the New York Control Area (NYCA), State power regulators require that load-serving
 8 entities (LSE), or power buyers, purchase enough generating capacity to meet their projected
 9 needs plus a reserve margin (National Research Council 2006). Entergy is not an LSE. In New
 10 York, Entergy owns and operates power plants, but not transmission or distribution systems;
 11 therefore, Entergy does not purchase power from other power generators. To replace the
 12 output from IP2 and IP3, LSEs, like Consolidated Edison, would need to purchase additional
 13 electric power from other sources, which could include new coal- and gas-fired power plants or
 14 renewable alternatives, or it could purchase power from existing facilities at other sites outside
 15 the NYCA (National Research Council 2006).

16 Power sources within NYCA have an installed capacity of about 38,000 MW(e) and more than
 17 6,300 km (4,000 mi) of high-voltage transmission lines (National Research Council 2006). The
 18 current power transmission infrastructure makes it difficult to purchase power from outside the
 19 southern regions of the NYCA (namely the New York City and Long Island load zones) because
 20 there are power transmission constraints or "bottlenecks" between the southern load zones and
 21 other power generating areas to the east and north, including Canada. These neighboring
 22 areas would be needed to supply additional purchased power to replace power generated by
 23 IP2 and IP3. Because of the bottlenecks in the transmission lines, new transmission capacity
 24 would likely be necessary to efficiently move purchased power into the southern load zones and

1 provide a partial solution to the retirement of IP2 and IP3 (National Research Council 2006).
2 Such new transmission capacity would likely come in the form of either an expansion of the
3 existing high-voltage alternating current transmission system or the addition of new high-voltage
4 direct current transmission facilities (National Research Council 2006).

5 The National Research Council found that improvements in transmission capability could
6 significantly relieve congestion in the NYCA and increase delivery capacity from existing and
7 potential electric generation resources to the southern load zones. The Council has proposed a
8 550-MW(e) west-to-east line across the Hudson River and a new north-to-south transmission
9 line (up to 1000 MW) for better access to upstate New York and Canadian electric resources to
10 provide useful capacity in the 2010 and 2015 time period (National Research Council 2006).
11 However, a variety of institutional and financial obstacles often stand in the way of such plans.
12 In 2006, the Council determined that a “concerted, well-managed, and coordinated effort would
13 be required to replace IP2 and IP3 by 2015. Replacement in the 2008–2010 time frame would
14 be considerably more difficult, probably requiring extraordinary, emergency-like measures to
15 achieve” (National Research Council 2006).

16 As of March 2008, New York Regional Interconnect, Inc. (NYRI), was seeking the approval of
17 the New York Public Service Commission (NYPSC) to build a 306-km (190-mi) transmission line
18 with a rated power flow of 1200 MW(e) from the Town of Marcy in Oneida County to the towns
19 of Hamptonburgh and New Windsor in Orange County, New York. In accordance with the NYRI
20 application to the NYPSC, overhead transmission lines will make up approximately 89 percent
21 of the proposed route, and underground cable will constitute the remainder of the route (NYRI
22 2008). NYRI has placed the proposed route within or parallel to existing or inactive railroads
23 and energy ROWs for approximately 78 percent of its distance. For the remaining 22 percent of
24 its distance, NYRI will construct the transmission lines in undeveloped areas or areas where
25 there are no existing ROWs. The proposed transmission corridor includes 1155 ha (2855 ac).
26 If approved, NYRI will clear 768 ha (1899 ac) of forested habitat during construction. While the
27 proposed route minimizes the amount of land clearing and habitat destruction necessary, the
28 proposed route also crosses sensitive habitats such as streams and wetlands (NYRI 2008).

29 While NYRI has proposed to construct additional transmission capacity that could be used to
30 import power into the southern load zones for the NYCA, the proposed 1200-MW(e) capacity is
31 not sufficient to completely replace the generating capacity of IP2 and IP3. Also, the project
32 faces many hurdles before construction can begin. Since the NYRI project is, at this time, the
33 only serious transmission project proposed in the NYCA that would supply additional power to
34 the New York City area, the NRC staff does not consider purchased power as a viable stand-
35 alone replacement option for IP2 and IP3. The NRC staff does, however, recognize that
36 positive steps are being taken toward increasing the transmission capacity into the southern
37 load zones of the NYCA. NYRI has evaluated the environmental impacts of its proposed project
38 in Exhibit 4 of its petition to the NYPSC. Because the NRC staff does not consider purchased
39 power as a viable stand-alone option for replacing IP2 and IP3, the staff did not conduct an
40 independent evaluation of the NYRI findings. The NRC staff does, however, include purchased
41 power across new transmission lines in the combination alternatives addressed in Section 8.3.7
42 of this draft SEIS.

8.3.4 Other Alternatives

Other generation technologies the NRC staff considered but determined to be individually inadequate to serve as alternatives to IP2 and IP3 are discussed in the following paragraphs.

• Conservation

In this section, the NRC staff evaluates conservation⁽⁴⁾ as an alternative to license renewal. According to the American Council for an Energy-Efficient Economy (ACEEE) State Energy Efficiency Scorecard for 2006, New York ranks seventh in the country in terms of implementation of energy efficiency programs, suggesting that the State's conservation efforts are significant when compared to other States (ACEEE 2006). New York scored well (2 out of 3) on tax incentives and appliance standards. The State scored low on energy efficiency resource standards (0 out of 5) and utilities' per-capita spending on energy efficiency (5 out of 15), suggesting there is room for improvement in these areas.

The IP2 and IP3 ER (NYSDEC 2003a) dismissed conservation as a replacement alternative for IP2 and IP3 because conservation does not meet the criterion of a "single, discrete source." Also, because Entergy is a generator of electricity and not a distributor, it indicated that it does not have the ability to implement regionwide conservation programs (Entergy 2007). However, because of efforts made by the State of New York, and because additional conservation could be a consequence of the no-action alternative, the NRC staff examines conservation in this draft SEIS as an alternative to replace at least part of the output of IP2 and IP3.

The New York State Energy Research and Development Authority (NYSERDA) is pursuing initiatives in conservation. Within NYSERDA, the Energy Efficiency Services Program and Residential Efficiency and Affordability Program deploy programs and services to promote energy efficiency and smart energy choices (NYSERDA 2007). According to the NYSERDA, implementation of conservation in the following program areas has resulted in significant energy savings.

- existing buildings and structures
- new buildings and structures
- market/workforce development
- distributed generation and renewables
- industrial process
- transportation

In 2006, the National Research Council's Committee on Alternatives to Indian Point for Meeting Energy Needs developed a report that specifically addressed alternatives to IP2 and IP3 for meeting Statewide power needs (National Research Council 2006). The document reports that in 2005, NYSERDA estimated that its energy efficiency programs had reduced peak energy demands in New York by 860 MW(e). NYSERDA further forecasted that the technical potential

⁽⁴⁾ The NRC staff notes that conservation typically refers to all programs that reduce energy consumption, while energy efficiency refers to programs that reduce consumption without reducing services. For this section, some conservation measures considered by the NRC staff are also energy efficiency measures.

of its efficiency programs in New York would result in a cumulative 3800 MW(e)-reduction of peak load by 2012 and 7400 MW(e) by 2022 (National Research Council 2006). "Technical potential" refers to the complete deployment of all applications that are technically feasible.

In addition to the currently anticipated peak load reductions resulting from the NYSERDA energy efficiency initiatives, additional conservation measures and demand-side investments in energy efficiency, demand response, and combined heat and power facilities could significantly offset peak demand Statewide. The National Resource Council report estimates that peak demand could be reduced by 1000 MW(e) or more by 2010 and 1500 MW(e) by 2015 (National Research Council 2006).

The National Research Council estimates that economic potential peak demand in the IP2 and IP3 service area could be expanded by approximately 200 MW(e) by 2010 and 300 MW(e) by 2015 assuming a doubling of the program budgets (National Research Council 2006).

"Economic potential" is defined as that portion of the technical potential that the National Research Council judged to be cost effective. This estimate is based partly on the experience with three NYSERDA programs that avoided the need for 715 MW(e) of Statewide peak demand in 2004. Cost-effectiveness is based on a conservation option's ability to lower energy costs (consumers' bills) while energy prices continue to increase using EIA price forecasts. The National Research Council concludes that energy efficiency and demand-side management have great economic potential and could replace at least 800 MW(e) of the energy produced by IP2 and IP3 and possibly much more (National Research Council 2006).

The NRC staff notes that while Statewide conservation efforts could result in a peak demand reduction of about 75 percent of the power output of both IP2 and IP3 by 2015, the National Research Council predicted that only about 800 MW(e) could be reduced from the IP2 and IP3 service area (National Research Council 2006). As such, the NRC staff does not expect that conservation efforts alone will be sufficient to replace either of the IP2 or IP3 units and for this reason has not evaluated conservation or efficiency programs as replacements for the full output for IP2 or IP3. The NRC staff has, however, considered conservation as part of a combination of alternatives presented in Section 8.3.5 of this draft SEIS.

• Wind Power

New York State is recognized as having about 5000 MW(e) of land-based wind potential, enough to generate about 13 million MW(h) or equivalent to 10 percent of the State's electricity consumption. There are also substantial offshore wind resources. The NYSERDA New York Energy \$martSM program is currently supporting extensive wind resource prospecting efforts to identify promising new sites for wind development. Furthermore, NYSERDA is currently working with three developers to develop four projects totaling 425 MW (Power Naturally 2008). Wind currently accounts for only about 1 percent of the generating capacity, or 391 MW(e), Statewide (NYISO 2008). The NYSIO is managing wind generation projects that are proceeding through the grid interconnection process. These projects have a potential of generating almost 7000 MW(e) (NYISO 2008); however, there is no assurance that a project in this process will go into service.

Generally, wind power, by itself, is not suitable for large baseload capacity. As discussed in Section 8.2.1 of the GEIS, wind has a high degree of intermittency, and average annual capacity factors for wind facilities are relatively low (on the order of 30 to 40 percent). Wind power, in conjunction with energy storage mechanisms or other readily dispatchable power

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sources like hydropower, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive to allow wind power to serve as a large baseload generator.

Areas of class 3 or higher wind energy potential occur throughout much of the northeastern United States (DOE 1986, 2008). The primary areas of good wind energy resources are the Atlantic coast, the Great Lakes, and exposed hilltops, ridge crests, and mountain summits. Winter is the season of maximum wind power throughout the Northeast when all except the most sheltered areas have class 3 or better wind resource; exposed coastal areas and mountain summits can expect class 6 or 7 wind resource. In summer, the season of minimum wind power, class 3 wind resource can be found only on the outer coastal areas and highest mountain summits (DOE 1986).

Wind power of class 3 and higher is estimated for the high elevations of the Adirondack Mountains of northeastern New York (DOE 1986, 2008). Annual average wind power of class 3 or 4 is found along the coastal areas of both Lake Erie and Lake Ontario, while class 5 winds are estimated to exist in the central part of both lakes (DOE 1986, 2008).

The National Research Council estimates that offshore wind could meet most of the IP2 and IP3 load by 2014 (National Research Council 2006). Currently, Winergy Power of Hauppauge, New York, is proposing to complete construction of a wind farm about 19 km (12 mi) off the south shore of Long Island by 2014. Winergy has recently increased the size of its project to 940 MW(e) (WINS 2008). This would mean building as many as 260 wind turbines off the shore of Long Island. Winergy says the number of turbines would decrease if turbine technology improves at the time construction begins in 2012.

It is currently unknown whether the Winergy project will be completed. The proposed 420-MW(e), 130-turbine Cape Wind project off Cape Cod—the East Coast's offshore wind farm project that is farthest along in its approval process—faces opposition.

Because of the scale of a single wind farm project that would be needed to replace the power from IP2 and IP3 and the obstacles that the project would face, the NRC staff does not consider wind power to be a suitable stand-alone alternative that could be implemented before the IP2 and IP3 licenses expire. The staff does, however, recognize that New York has utility-scale wind resources and that NYSERDA is actively pursuing economic potential in wind-derived power supplies. Therefore, the NRC staff includes wind power in the combination alternatives addressed in Section 8.3.7 of this draft SEIS.

• Wood and Wood Waste

Wood-burning electric generating facilities can provide baseload power. However, the economic feasibility of a wood-burning facility is highly dependent on the availability of fuel sources and the location of the generating facility. Most wood-fired and other biomass plants are independent power producers and cogenerating stations with capacities on the order of 10 to 25 MW(e), with some plants operating in the 40 to 50 MW(e) range. In the 2006 New York Renewable Electricity Profile (DOE/EIA 2008b), New York's power industry reported only 37 MW(e) of generating capacity for wood or wood waste derived power.

Wood-burning energy generation continues to be developed in the northeastern U.S. In 2005, about 16 percent of the nation's energy derived from wood and wood wastes was generated in the New England and Middle Atlantic census divisions (DOE/EIA 2007). Within the region,

about 12 percent of the generating capacity is from wood and wood wastes. In New York, the Laidlaw Energy Group, Inc. (Laidlaw 2008), is planning to convert a retired gas-fired cogeneration facility into a 7-MW(e) wood-fired power plant in Ellicottville, Cattaraugus County. The plant will supply about 1 MW(e) to a lumber drying business located adjacent to the plant and export about 6 MW(e) to the power grid (Laidlaw 2008). However, the project has not yet been finalized, and the future of the plant is uncertain.

Walsh et al estimated New York's wood resources in a study published in 1999 (Walsh et al 1999). The study presents the amount of resourced available in tons per year given a specified price per dry ton delivered. Wood feedstock categories included forest residues, defined as "logging residues; rough, rotten, and salvable dead wood; excess saplings; and small pole trees," and primary mill residues (Walsh 1999). The annual resources available for each of these categories at a delivery cost of less than \$50 per dry ton are 1,746,400 and 1,274,000 tons, respectively (Walsh 1999). These volumes, respectively, account for about 4 percent and 1.5 percent of the total resource available in the 48 contiguous States. The neighboring States of New Jersey, Connecticut, Massachusetts, and Vermont have significantly less wood resource. Pennsylvania, however, has comparable resources to New York available. Assumptions in the analysis include transportation distances of less than 50 mi and accessibility of 50 percent of the forest residues from existing roads.

The NRC staff finds that New York has utility-scale wood waste resources, but given uncertainties in supply estimates, as well as the small size and high number of installed facilities necessary to replace IP2 and IP3, the NRC staff does not find wood biomass to be a suitable alternative to IP2 and IP3 operating license renewals. The NRC staff will include wood waste facilities in combinations of alternatives addressed in Section 8.3.7 of this draft SEIS.

• **Hydropower**

New York State receives an abundant supply of hydroelectric power from Niagara Falls and other sites. Hydropower accounts for 5990 MW(e)—or about 15 percent—of the State's generating capacity (NYISO 2008).

The Idaho National Energy and Environmental Laboratory (INEEL) estimated that the undeveloped hydropower potential total for New York is 1309 MW(e) with 134 undeveloped potential hydroelectric sites in the Hudson River basin (INEEL 1998). Development of these sites could result in more than 300 MW(e) of baseload capacity (INEEL 1998). The Statewide potential is 40 percent less than IP2 and IP3's current capacity, and the regional potential is 86 percent less than the IP2 and IP3 capacity. Therefore, the NRC staff does not consider hydropower to be a viable stand-alone alternative to license renewal.

• **Oil-Fired Generation**

Oil accounts for about 8 percent of the generating capacity—or 3515 MW(e)—Statewide (NYISO 2008). EIA projects that oil-fired plants will account for very little new generation capacity in the United States during the next 20 years, and higher fuel prices will lead to a decrease in overall oil consumption for electricity generation (DOE/EIA 2007a).

EIA had indicated that oil prices are expected to make oil-fired generation an unlikely option for future generation additions (EIA/DOE 2007a), as discussed in Section 8.3. The relatively high cost of oil—even prior to 2008's record high prices—had prompted a steady decline for use in electricity generation. The NRC staff has not evaluated oil-fired generation as an alternative to

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the renewal of the IP2 and IP3 operating licenses, though the NRC staff notes that oil may temporarily be burned in a gas-fired alternative should gas capacity become constrained during winter heating season.

• **Solar Power**

New York has enacted demand-side policies aimed at encouraging the adoption of photovoltaic (PV) technology for residents and businesses. These policies had resulted in the installation of more than 1.5 MW(e) of demand-side PV energy as of summer 2005 (National Research Council 2006). Through its Clean Energy Initiative, the Long Island Power Authority had issued rebates for PV systems totaling more than 2.63 MW(e) (National Research Council 2006). The National Research Council indicates that PV systems may be in the economic interests of New York customers because of high retail electricity rates and the falling prices of PV-generated electricity (National Research Council 2006).

The National Research Council reports that PV-generated electricity can provide high-value peak-time distributed generation power with minimal environmental emissions, and PV can contribute significantly to grid stability, reliability, and security (National Research Council 2006). Distributed generation refers to the production of electricity at or close to the point of use. Under an aggressive development scenario, the National Research Council estimates that 70 MW(e) of distributed PV could be installed in the NYCA by 2010 and 335 MW(e) by 2015. However, the National Research Council states that there would have to be “reductions in PV costs and a long-term commitment to expand New York’s PV programs” in order to reach these goals (National Research Council 2006). Finally, the National Research Council considers most of the projected PV distributed generation as demand-side reductions in peak energy demands. Therefore, the energy-saving impacts of solar power are included in the conservation estimates described in Section 8.3.4 of this draft SEIS.

The NRC staff does not consider solar power to be a suitable stand-alone alternative to the renewal of the IP2 and IP3 operating licenses. The NRC staff does, however, recognize that solar energy is an important component of the NYSERDA demand-side reductions in peak load demands from generating facilities, including IP2 and IP3. Therefore, the NRC staff includes solar power in the combination alternatives addressed in Section 8.3.7 of this draft SEIS as a part of the conservation-derived demand reductions (as described in Section 8.3.4).

• **New Nuclear Generation**

Given the expressed industry interest in new nuclear construction, the NRC staff has previously evaluated the construction of a new regional nuclear power plant as an alternative to license renewal in SEISs for other nuclear power plant license renewal requests. Based on the NRC’s current proposed schedule, no combined license (COL) application review is expected to be complete until the middle of 2010, at the earliest. Necessary reviews include the acceptance review as well as the safety and environmental reviews. Upon completion of the reviews, a public hearing process is initiated that is estimated to take at least 1 year. This brings the earliest approval of the submitted COL applications out to the middle of 2011.

While some plant construction activities can begin before issuing the COL, construction of a new plant is not expected to be completed until several years beyond the date the COL is issued. In late 2007, NRG Energy was the first to submit a full COL application to the NRC for its South Texas Project. The target for completion of the construction of the first of two units is

2014, after the end of the IP2 operating license.

Given the current COL application schedule, the time needed to review an application, and the anticipated length of construction, the NRC staff does not consider the construction and operation of a new nuclear power plant specifically for the purpose of replacing IP2 and IP3 to be a feasible alternative to license renewal at this time.

- **Geothermal Energy**

Geothermal plants are most likely to be sited where hydrothermal reservoirs are prevalent, such as in the western continental United States, Alaska, and Hawaii. There are no feasible eastern locations for geothermal capacity to serve as an alternative to IP2 and IP3 (NRC 1996), and the New York Renewable Electricity Profile did not indicate any geothermal energy production in New York in 2006 (DOE/EIA 2008). As such, the NRC staff concludes that geothermal energy would not be a feasible alternative to renewal of the IP2 and IP3 operating licenses.

- **Municipal Solid Waste**

According to the Integrated Waste Services Association (IWSA), fewer than 90 waste-to-energy plants are operating in the United States, generating approximately 2700 MW(e) of electricity or an average of approximately 30 MW(e) per plant (IWSA 2007). The existing net capacity in the region of IP2 and IP3 is 156 MW(e) generated by six plants, while the technical potential within the region is 1096 MW(e) by 2014 (National Research Council 2006). The 2014 estimate includes production from fuels containing municipal solid waste and construction and demolition wood (a portion likely to be at least partially captured in Walsh et al and referenced in the Wood Waste section of 8.3.4).

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid waste plants are greater than for comparable steam turbine technology at coal facilities or at wood waste facilities because of the need for specialized waste separation and handling equipment.

The decision to burn municipal waste to generate energy (waste-to-energy) is usually driven by the need for an alternative to landfills rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; with energy prices increasing, however, it is possible that municipal waste combustion facilities may become attractive. Congress has included waste-to-energy in the Production Tax Credit legislation to encourage development of waste-to-energy and other renewable technologies (IWSA 2008).

Given the small average installed size of municipal solid waste plants, it would take about 70 plants to replace IP2 and IP3. Furthermore, NYSERDA estimates that the Statewide economically achievable potential for summer peak load from municipal solid-waste-derived energy by 2022, well into the relicensing period for IP2 and IP3, is only 190 MW(e) (NYSERDA 2003). Therefore, the NRC staff does not consider municipal solid waste combustion to be a feasible alternative to license renewal.

- **Other Biomass Derived Fuels**

In addition to wood and wood waste fuels, there are several other biomass fuels used for

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generating electricity. These include burning crops, converting crops to a liquid fuel such as ethanol, gasifying crops, and biogas. Additionally, the National Research Council identifies animal and avian “manure” and wastewater methane as biomass derived fuel sources. The National Research Council estimates that the NYCA has a potential capacity of 41 MW(e) from biogas by 2014 (National Research Council 2006). NYSERDA estimates that the Statewide economically achievable annual load from biomass-derived energy by 2022, well into the relicensing period for IP2 and IP3, is 1.7 million MW(h) (NYSERDA 2003) or about 190 MW(e). In the period between 2005 and 2007, IP2 and IP3 produced more than 16 million MW(h) annually (Blake 2008). Furthermore, the New York Renewable Electricity Profile did not indicate any energy production in New York from biomass fuels other than wood and wood waste in 2006 (DOE/EIA 2008), which is considered above. For these reasons, the NRC staff concludes that power generation from biomass fuels does not offer a feasible alternative to the renewal of the IP2 and IP3 operating licenses.

• Fuel Cells

Fuel cells work by oxidizing fuels without combustion and the accompanying environmental side effects. The only byproducts are heat, water, and, if the fuel is not pure hydrogen, CO₂. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

The only current program that was identified as being initiated by one of the three major power providers in downstate New York is a program being conducted by the New York Power Authority that involves nine fuel cell installations totaling 2.4 MW(e) using waste gas produced from sewage plants (National Research Council 2006).

At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. NYSERDA estimates that the Statewide technical potential for annual supply from fuel cells by 2022 is more than 37 million MW(h); however, NYSERDA indicated that the economical potential for 2022 is zero (NYSERDA 2003). NYSERDA defines economic potential as “that amount of technical potential available at technology costs below the current projected costs of conventional electric generation that these resources would avoid.” Therefore, while it may be possible to use a distributed array of fuel cells to provide an alternative to IP2 and IP3, it currently would be prohibitively costly to do so. Since fuel cells are not currently economically feasible on such a large scale, the NRC staff concludes that fuel cell-derived power is not a feasible alternative to the IP2 and IP3 license renewals.

• Delayed Retirement

Based on currently scheduled power plant retirements and demand growth projections by the NYISO, 1200 to 1600 MW(e) from new projects that are not yet under construction could be needed by 2010, and a total of 2300 to 3300 MW(e) could be needed by 2015 (National Research Council 2006). In 2006, there were six new generation projects adding 2228 MW(e) of new capacity and scheduled retirements of 2363 MW of generating capacity (National Research Council 2006). Recent or scheduled retirements included the New York Power Authority’s 885-MW(e) Poletti Unit 1 and Lovett Units 3, 4, and 5 totaling 431 MW(e). Astoria Units 2 and 3, with a total capacity of 553 MW(e), also are scheduled for retirement before the end of the current IP2 and IP3 license periods.

Plants scheduled for retirement are aging and have higher emissions than newer plants. Keeping older plants online may not be technically or economically achievable when emissions controls or necessary environmental mitigation measures are taken into account. Furthermore, given that the demand for electricity is increasing and, in the near term, planned new sources within the NYCA are just keeping pace with retirements, the NRC staff does not consider additional delays in the retirements of existing plants to be a feasible alternative to compensate for the loss of power from IP2 and IP3.

8.3.5 Combination of Alternatives

Even though individual alternatives to license renewal might not be sufficient on their own to replace the 2158-MW(e) total capacity of the IP2 and IP3 units because of the lack of resource availability, technical maturity, or regulatory barriers, it is conceivable that a combination of alternatives might be sufficient. Such alternatives may also include the continued operation of either IP2 or IP3 combined with other alternatives.

There are many possible combinations of alternatives that could be considered to replace the power generated by IP2 and IP3. In the GEIS, NRC staff indicated that consideration of alternatives would be limited to single, discrete generating options, given the virtually unlimited number of combinations available. In this section, the NRC staff examines two possible combinations of alternatives in part because other efforts to examine alternatives to IP2 and IP3, including Levitan and Associates (2005) and the National Research Council (2006), have addressed combinations of alternatives. The National Research Council (2006) noted, for example, that “. . . the additional 2 GW required if IP2 and IP3 were to be closed could be met by some suitable combination of new generation in the New York City area, efficiency improvements and demand-side management, and new transmission capability from upstate.”

The NRC staff presents two possible combinations based partly on analysis by the National Research Council. In one of these combinations, the NRC has included the continued operation of either IP2 or IP3, and the second combination includes only alternative energy sources. The second combination is based entirely on new generation, efficiency improvements or demand-side management (jointly addressed as conservation), and new transmission capacity carrying power from upstate. These combinations include several alternatives that the NRC staff found to be unable to replace the entirety of IP2 and IP3 electrical capacity.

Combination Alternative 1

- continuing operation of either IP2 or IP3
- constructing a 330-MW(e) combined-cycle gas-fired plant at IP2 and IP3
- obtaining 200 to 400 MW(e) from renewable energy sources (primarily wood and wind)
- implementing 300 to 500 MW(e) of conservation programs based on the potential identified by the National Research Council and NYSERDA

Combination Alternative 2

- constructing a 400-MW(e) gas combined-cycle plant at the IP2 and IP3 site
- obtaining 200 to 400 MW(e) from renewable energy sources (primarily wood and wind)

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- implementing 500 to 800 MW(e) of conservation programs based on the potential identified by the National Research Council and NYSERDA
- importing a net 800 MW(e) from upstate New York and Canada following the installation of a new transmission line

The following sections analyze the impacts of the two options outlined above. In some cases, detailed impact analyses for similar actions are described in previous sections of this Chapter. When this occurs, the impacts of the combined alternatives are discussed in a general manner with reference to other sections of this draft SEIS. A summary of the impacts from the two combined alternative options is presented in Table 8-5.

8.3.5.1 Impacts of Combination Alternative 1

Each component of the first combination alternative produces different environmental impacts, though several of the options would have impacts similar to—but smaller than—alternatives already addressed in this SEIS. Constructing closed-cycle cooling for one of the existing Indian Point generating units (either IP2 or IP3) would create impacts roughly equal to half of the impacts addressed in 8.1.1. Continued operations of either IP2 or IP3 would incur roughly half the impacts of continued operations described in Chapters 3, 4, and 6. (Decommissioning impacts, as described in Chapter 7 of this SEIS, as well as NUREG-0586, would still occur but may occur later than they would if both units retired at the end of their current Operating Licenses.) Constructing 330 MW(e) of gas-fired capacity would create roughly one-sixth the impacts of the on-site alternative described in 8.3.2, and would likely be able to make use of the AGTC pipeline on site without additional pipeline modifications (Levitan and Associates, Inc. 2005).

The NRC staff has not yet addressed in any depth in this SEIS the impacts of wind power, wood-fired generation, or conservation. A wind installation capable of yielding 100 to 200 MW(e) of capacity would likely entail placing wind turbines off Long Island on the Atlantic coast, in upstate New York, or on Lake Erie or Lake Ontario. A wind installation capable of delivering 100 to 200 MW(e) on average would require approximately 52 to 104 turbines with a capacity of 3.5 to 5 MW (Cape Wind Associates 2007). Because wind power installations do not provide full power all the time, the total installed capacity exceeds the capacity stated here.

As noted in Section 8.3.4, under Wood Waste, the wood-fired alternative would have impacts similar to a coal-fired plant of similar capacity. Unlike a coal-fired plant, however, the wood-fired plant does not release heavy metals (including mercury, uranium, and thorium) in fly ash. Wood-fired plants also tend to be slightly less efficient with slightly lower capacity factors.

Impacts from conservation measures are likely to be negligible, as the NRC staff indicated in the GEIS (1996). The primary concerns NRC staff identified in the GEIS related to indoor air quality and waste disposal. In the GEIS, NRC staff indicated that air quality appeared to become an issue when weatherization initiatives exacerbated existing problems, and were expected not to present significant effects. The NRC staff also indicated that waste disposal concerns related to energy-saving measures like fluorescent lighting could be addressed by recycling programs. The NRC staff considers the overall impact from conservation to be SMALL in all resource areas, though measures that provide weatherization assistance to low-income populations may have positive effects on environmental justice.

• Land Use

Impacts from this alternative would include the types of impacts discussed for land use in Section 8.1.1.2 and Section 8.3.2.1 of this draft SEIS. Construction of two hybrid cooling towers would have a SMALL to MODERATE impact on land use, depending on where Entergy disposes of excavated material, and construction of one tower would be expected to have approximately half of the impact. Section 8.3.2 states that the land use impacts from the construction of five gas-fired units at the IP2 and IP3 site would be SMALL to MODERATE. The combined alternative would need only one combined-cycle unit, which would fit on the existing site without purchasing offsite land. If the plant operator constructed a new cooling tower for the remaining IP unit the land use impacts will also be SMALL to MODERATE, depending on where Entergy disposes of excavated material from the one cooling tower. If not cooling tower was constructed for the remaining unit, the land use impact would be SMALL.

The GEIS notes that gathering fuel for wood-fired plants can have significant environmental impacts. However, the NRC staff believes that the operation of 100 to 200 MW(e) of wood-fired generation would have minor impacts, especially if the plants were widely distributed and feedstocks were primarily preexisting waste streams. Construction impacts of the wood-fired plants on land use would be SMALL to MODERATE depending on plant cooling configurations and plant locations. These impacts would be minimized by locating plants on previously disturbed land near other industrial applications, including paper/pulp mills or other forest-product operations where fuels may be readily available. To fully utilize the power generated in these plants, they would need to be constructed inside the transmission bottlenecks leading to the NYCA discussed in Section 8.3.5 of this draft SEIS. Otherwise, new transmission capacity would have to be constructed resulting in additional land use impacts.

Impacts from the wind power portion of this alternative would depend largely on whether the wind facility is located onshore or offshore. Onshore wind facilities will incur greater land use impacts than offshore, simply because all towers and supporting infrastructure will be located on land. NRC observations indicate that onshore installations could require several hundred acres, though turbines and infrastructure would actually occupy only a small percentage of that land area. Land around wind installations could remain in use for activities like agriculture (a practice consistent with wind farm siting throughout the U.S.).

Overall, the NRC staff considers that the land use impacts from the first combination alternative would be SMALL to MODERATE.

• Ecology

As described in Section 8.1.1.2 of the draft SEIS, the construction of two hybrid cooling towers would have a SMALL impact on aquatic ecology and a SMALL impact on terrestrial ecology. Because the combined alternative would involve construction and operation of only one cooling tower, the NRC staff considered the resulting impacts from the construction and operation of a single cooling to be SMALL on both the aquatic and terrestrial ecology. (If the remaining IP unit were to continue operating with once-through cooling, the impacts of impingement and entrainment would likely be at least MODERATE for some species, though the NRC staff have not analyzed the specific level of impact for this option. Thermal shock would also be less significant. Not constructing a cooling tower would mean a smaller terrestrial impact.)

The SMALL to MODERATE impacts from the construction of five gas-fired units at the IP2 and

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IP3 site (described in Section 8.3.2 of this draft SEIS) would be reduced to SMALL because only one smaller gas-fired unit is proposed under this alternative.

Offsite construction and operation of wood-fired plants may have a SMALL to MODERATE impact on both aquatic and terrestrial ecology, depending heavily on the location of the plants.

The principal ecological impacts of an offshore wind farm as described earlier in this section would be to aquatic ecological resources. An onshore wind farm located in upstate New York would primarily affect terrestrial ecology. Neither wind farm would be likely to destabilize ecological resources. The NRC staff concludes that SMALL to MODERATE ecological impacts could occur during the construction phase but could be managed by choice of construction methods (e.g., avoiding particularly sensitive habitats).

Overall, the NRC staff considers that the ecological impacts, both aquatic and terrestrial, from this combination alternative would be SMALL to MODERATE.

• **Water Use and Quality**

The primary water use and quality issues from this alternative would occur from wood-fired generation and the gas-fired unit. While construction impacts could occur from a wind farm, particularly if located offshore, these impacts are likely to short lived. An offshore windfarm is unlikely to located immediately adjacent to any water users, though construction may increase turbidity. An onshore wind farm could create additional erosion during construction, as would wood-fired plants and a gas-fired unit on the IP2 and IP3 site. In general, site management practices keep these effects to a small level.

During operations, only the wood-fired and gas-fired plants would require water for cooling. Because the wood-fired plants are less efficient than the gas-fired unit and rely on a steam cycle for the full measure of their output, the effects of the wood-fired plant is roughly similar to the effect of the larger gas-fired unit. All of these units would likely use closed-cycle cooling, however, and this would limit the effects on water resources. As the NRC staff indicated for the coal-fired and gas-fired alternatives, the gas-fired and wood-fired portions of this alternative are likely to rely on surface water for cooling (or, as is the case in some locations, treated sewage effluent).

Effects from the continued operation of one IP unit with closed-cycle cooling would be SMALL, as would continued operation of one unit with the existing cooling system.

The NRC staff considers impacts on water use and quality to be SMALL for this combination alternative. The onsite impacts at the IP2 and IP3 facility would be expected to be similar to the impacts described in Sections 8.1.1.2 and 8.3.2 of this draft SEIS.

• **Air Quality**

The first combined alternative will have some impact on air quality as a result of emissions from the wood-fired plants and the onsite gas turbine. Because of the size of the units, an individual unit's impacts would be SMALL. Section 8.1.1.2 of this draft SEIS describes the impacts on air quality from the construction and operation of two hybrid cooling towers to be SMALL. For the construction and operation of a single tower, the impacts would be SMALL. The continued operation of one of the nuclear power units and construction and operation of the wind farm will have only minor impacts on air quality.

Overall, the NRC staff considers that the air quality impacts from the first combination alternative would be SMALL.

- **Waste**

The primary source of waste under this option would be from the construction of the new hybrid cooling tower. Constructing a wind farm, wood-fired generation, and a new gas turbine facility would also create waste, though significantly less than the 2 million cy (1.5 million m³) created during excavation of two cooling towers (roughly half would be attributable to one cooling tower). Operational wastes would come primarily from the wood-fired power plant. Most of the ash from burned wood waste could be recycled or reused. The waste contribution from the remaining IP2 or IP3 unit would be roughly half of the waste generated by the current plant.

Section 8.1.1.2 of this draft SEIS describes the impacts from waste generated during construction of two towers to be SMALL to LARGE, depending on whether excavation waste could be reused or recycled. Waste impacts could be substantial during construction of the alternatives, and would remain SMALL to LARGE, depending on how the various sites handled wastes. If the remaining IP unit were to continue operation with the existing once-through cooling system, waste impacts would be SMALL. During operations, waste volumes would have only SMALL impacts.

- **Human Health**

The primary health concerns under this option would be occupational health and safety risks during the construction of the new gas turbine, the new cooling tower, the wood-fired plants, and the wind farm. As described in previous sections (for coal-fired and gas-fired alternatives), if the risks are appropriately managed, the human health impacts from these or similar alternatives are SMALL. Impacts from emissions are uncertain, but considered SMALL as the plants would comply with the CAA health-informed standards and other relevant emissions regulations. Continued operation of one IP unit with the existing once-through cooling system would not change this assessment.

Therefore, the NRC staff concludes that the overall human health impact from the first combination alternative would be SMALL.

- **Socioeconomics**

This combination alternative involves the shutdown of either IP2 or IP3. As detailed in Section 8.2 of this draft SEIS, the socioeconomic impacts of shutting down the plants would be SMALL to MODERATE because of the loss of PILOT payments to local municipalities. Under this option, those payments would be expected to decrease but would not be completely eliminated. Some IP2 or IP3 jobs would be lost, but some would be replaced with jobs associated with the construction and operation of the gas-fired plant. The gas-fired plant may generate additional PILOT payments, which may offset shutdown effects. Levitan and Associates (2005) indicates that PILOT payments from a gas-fired facility smaller than IP2 and IP3 may supply PILOT payments near those provided by the existing plant. Other jobs would be generated by the construction of the offsite power alternatives. Overall, the NRC staff concludes that the socioeconomic impacts from the first combined alternative would be SMALL.

- **Socioeconomics (Transportation)**

As described in Section 8.1.1.2 of this draft SEIS, the construction of two hybrid cooling towers

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would have a LARGE impact on transportation in the area around IP2 and IP3 during construction because of the large volume of rock and debris that would need to be transported off site. Approximately half as much excavated material will need to leave the IP2 and IP3 site under this combination alternative (if the IP unit continued to operate with once-through cooling, no excavated material would need to leave the site and transportation impacts would be eliminated). The other aspects of this alternative will create modest transportation effects during construction. Given that the wood-waste facility and wind farm are likely not be located in the same place, construction-stage impacts are less intense than if they were part of one collocated facility. Construction of the gas turbine facility will require fewer workers than the gas-fired alternative considered in Section 8.3.2 of this draft SEIS.

During operation, only the wood-waste facility is likely to create noticeable impacts (in gathering wood wastes), and these may not affect any important aspects of local transportation. No other transportation impacts for this alternative are considered to be as severe. Overall, the impact from this combined alternative would likely be MODERATE.

• Aesthetics

As described in Section 8.1.1.2 of this draft SEIS, the construction of two hybrid cooling towers would have a MODERATE impact on aesthetics. Aesthetic impacts from one cooling tower may be slightly smaller, though it would likely still affect the scenic value of the Hudson Valley.

Aesthetic impacts would occur during construction and operation of an offshore wind installation and would depend on its distance from the shore and on its orientation in regard to shoreline communities. The NRC staff estimates that the construction and operational impacts of the facility could be managed, though some may consider the impact to be LARGE, depending on the location of the turbines. An onshore wind facility would also have the potential to create LARGE effects. The aesthetic impacts from new wood-fired generating plants would likely not have a major effect on visual resources, because the plants are small. Impacts would depend on the plants' locations.

The NRC staff concludes that the overall aesthetic impacts from the first combination alternative could range from SMALL to LARGE, depending on the aesthetic effects of the wind power portion.

• Historic and Archeological Resources

Onsite impacts to historical and cultural resources from the construction of a hybrid cooling tower and a single gas turbine plant are expected to be SMALL. The offsite impacts from the construction of wood-fired units and a wind farm are also expected to be small given the opportunity to evaluate and select the sites in accordance with applicable regulations and the ability to minimize impacts before construction. Therefore, the NRC staff concludes that the overall impacts on historic and archeological resources from the first combination alternative would be SMALL.

• Environmental Justice

No impacts are anticipated in the IP2 and IP3 area that could disproportionately affect minority or low-income communities. Impacts from offsite activities would depend on the location of the activity. Many conservation measures, especially those involving weatherization or efficiency improvements to low-income households, can have disproportionately positive effects for low-

income families. Overall, though, environmental justice impacts from the first combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding populations. Impacts could range from SMALL to LARGE.

Impacts of Combined Alternative 2

The second combination alternative differs from the first in that it completely replaces IP2 and IP3 capacity. In contrast to the first combination alternative, a 400-MW(e) gas-fired plant is considered because it can be constructed on the site, making use of existing transmission lines and the natural gas pipeline that transects the IP2 and IP3 site; however, modifications to the pipeline would be necessary to provide firm year-round service to the site without removing the service rights of other customers in New York and Connecticut served by the pipeline (Levitan and Associates, Inc. 2005). Quantifying pipeline service adequacy and upgrade costs was beyond the scope of the Levitan report.

Like the first combination alternative, the second combination alternative employs 200 to 400 MW(e) from renewable energy sources (primarily wood and wind). The impacts of these sources are described in the discussion of Combination Alternative 1 in Section 8.3.7.1 of this draft SEIS.

This option requires more aggressive energy conservation programs that would result in an energy savings of 500 to 800 MW(e), the maximum potential expected by 2014 (National Research Council 2006). As described in Section 8.3.4 of this draft SEIS and in the GEIS, these conservation efforts would have overall SMALL impacts.

This alternative also includes importing 800 MW(e) from upstate New York or Canada, as described in Section 8.3.5 of this draft SEIS. This power would be purchased by an LSE for distribution in the New York City metropolitan area. However, to support such power imports, new transmission capacity would have to be established.

• Land Use

Siting a single 400-MW(e) gas-fired unit with a closed-cycle cooling system at the IP2 and IP3 site would require about 18 ha (45 ac) and would likely have SMALL impacts on land use as the existing site as the unit could likely be constructed on previously-disturbed land.

The construction of new transmission lines to support the purchased-power portion of this alternative would result in MODERATE to LARGE impacts as the lines may be several hundred miles in length. As described in Section 8.3.5 of this draft SEIS, a current plan for new transmission lines would impact 1155 ha (2855 ac).

The GEIS notes that gathering fuel for wood-fired plants can have significant environmental impacts. However, the NRC staff believes that the operation of 100 to 200 MW(e) of wood-fired generation would have minor impacts, especially if the plants were widely distributed and feedstocks were primarily preexisting waste streams. Construction impacts of the wood-fired plants on land use would be SMALL to MODERATE depending on plant cooling configurations and plant locations. These impacts would be minimized by locating plants on previously disturbed land near other industrial applications, including paper/pulp mills or other forest-product operations where fuels may be readily available. To fully utilize the power generated in these plants, they would need to be constructed inside the transmission bottlenecks leading to the NYCA discussed in Section 8.3.5 of this draft SEIS, or in a location to access new

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transmission from upstate areas described in the previous paragraph. Otherwise, new transmission capacity would have to be constructed resulting in additional land use impacts.

Impacts from the wind power portion of this alternative would depend largely on whether the wind facility is located onshore or offshore. Onshore wind facilities will incur greater land use impacts than offshore, simply because all towers and supporting infrastructure will be located on land. NRC calculations indicate that onshore installations could require xx ha (xx ac) (reference). Land around wind installations could remain in use for activities like agriculture (a practice consistent with wind farm siting throughout the U.S.).

Overall, the NRC staff considers that the land use impacts from this combination alternative would be MODERATE to LARGE.

• Ecology

As described in Section 8.3.2 of this draft SEIS, the impacts from the construction of five gas-fired units at the IP2 and IP3 site would have a SMALL to MODERATE impact on aquatic and terrestrial ecology. Because the second combination alternatives would use only one gas-fired unit, the NRC staff concluded the resulting impacts on both the aquatic and terrestrial ecology to be SMALL.

Offsite construction and operation of wood-fired plants and new transmission lines would have a SMALL to MODERATE impact on both aquatic and terrestrial ecology, depending heavily on the location of the plants and transmission lines. Transmission lines and their associated ROWs may noticeably affect terrestrial habitats if they contribute to habitat fragmentation. They may affect aquatic ecology when they cross water bodies, particularly if it is necessary to construct pylons in the water bodies.

The principal ecological impacts of an offshore wind farm as described earlier in this section would be to aquatic ecological resources. An onshore wind farm located in upstate New York would primarily affect terrestrial ecology. Neither type of wind farm would be likely to destabilize ecological resources. The NRC staff concludes that SMALL to MODERATE ecological impacts could occur during the construction phase but could be managed by choice of construction methods (e.g., avoiding particularly sensitive habitats).

Overall, the NRC staff considers that the ecological impacts from the second combination alternative would be SMALL to MODERATE.

• Water Use and Quality

The primary water use and quality issues from this alternative would occur from wood-fired generation and the gas-fired unit. While construction impacts could occur from a wind farm, particularly if located offshore, these impacts are likely to shortlived. An offshore windfarm is unlikely to located immediately adjacent to any water users, though construction may increase turbidity. An onshore wind farm could create additional erosion during construction, as would wood-fired plants and a gas-fired unit on the IP2 and IP3 site. In general, site management practices keep these effects to a small level. Construction of the transmission line would also like have minor, if any effects on water use and quality. Erosion controls would likely minimize sedimentation.

During operations, only the wood-fired and gas-fired plants would require water for cooling. Because the wood-fired plants are less efficient than the gas-fired unit and rely on a steam cycle

for the full measure of their output, the effects of the wood-fired plant is roughly similar to the effect of the larger gas-fired unit. All of these units would likely use closed-cycle cooling, however, and this would limit effects on water resources. As the NRC staff indicated for the coal-fired and gas-fired alternatives, the gas-fired and wood-fired portions of this alternative are likely to rely on surface water for cooling (or, as is the case in some locations, treated sewage effluent).

The overall effects on water use and quality of the second combination alternative would likely be SMALL.

- **Air Quality**

The second combination alternative will have some impact on air quality as a result of emissions from the wood-fired plants and the onsite gas-fired unit. Because of the size of the wood-fired units and the gas-fired unit, an individual unit's impacts would be SMALL. However, the NRC staff concludes that the cumulative impacts from all of the new plants would be SMALL to MODERATE.

- **Waste**

The primary source of waste under the second combination alternative would be from the construction of the new power generation facilities, both on site and off site. Waste could include land clearing debris from all aspects of this combination alternative, excepting the wind farm if built offshore. Additional wastes would result from operation of the wood-fired plants. Additional wastes could be generated during operations of the gas-fired plants, or during maintenance at the wind power installations and the new transmission line. Overall, the NRC staff concludes that the impacts will be SMALL to MODERATE.

- **Human Health**

The primary health concerns under this option would be occupational health and safety risks during the construction of the new gas turbine, transmission lines, the wood-fired plants, and the wind farm. As described in previous sections (for coal-fired and gas-fired alternatives), if the risks are appropriately managed, the human health impacts from these or similar alternatives are SMALL. Impacts from emissions are uncertain but considered SMALL because the plants would comply with health-informed standards in the CAA and other relevant emissions regulations.

Therefore, the NRC staff concludes that the overall human health impact from the second combination alternative would be SMALL.

- **Socioeconomics**

The second combination alternative involves the complete shutdown of IP2 and IP3. As detailed in Section 8.2 of this draft SEIS, the socioeconomic impacts of shutting down the plants would be MODERATE because of the loss of PILOT payments to local municipalities. Under this option, those payments would be lost, but because of the gas plant that would be constructed on site, some new tax revenues would replace the PILOT payments. Levitan and Associates (2005) indicated that a smaller gas-fired plant may replace a significant portion of the PILOT payments currently provided by IP2 and IP3. Some IP2 and IP3 jobs would be lost but replaced with decommissioning jobs and jobs associated with the construction and operation of the gas turbine plant. Other jobs would be generated by the construction of the

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1 offsite power alternatives as well as the transmission line. While many of these jobs would
2 cease at the end of construction, a fraction would remain during operation. Overall, the NRC
3 staff concludes that the socioeconomic impacts from the second combination alternative would
4 be SMALL to MODERATE because of the significant loss in revenues from the PILOT payments
5 and the loss of IP2 and IP3 jobs.

6 • **Socioeconomics (Transportation)**

7 The aspects of this alternative will create modest transportation effects during construction.
8 Given that the wood-waste facility and wind farm are likely not be located in the same place,
9 construction-stage impacts are less intense than if they were part of one collocated facility.
10 Similarly, impacts associated with constructing the transmission line will be spread over a large
11 area, and are not likely to be intense in any location. Also, construction of the gas turbine
12 facility will require fewer workers than the gas-fired alternative considered in Section 8.3.2 of
13 this draft SEIS.

14 During operation, only the wood-waste facility is likely to create noticeable transportation
15 impacts (in gathering wood wastes), and these may not affect any important aspects of local
16 transportation. The gas-fired unit may create noticeable impacts on gas transmission, but
17 upgrades to the pipeline system should compensate for these effects. Because winter heating
18 customers take priority over utility generation customer, the plant is unlikely to have noticeable
19 effects for others, though it may need to burn fuel oil during peak demand periods.

20 Transportation impacts for this alternative would be minimal because the construction and
21 operation workforce would be spread over multiple locations. No single project would have a
22 significant long-term impact. Overall, the NRC staff concludes that the impact would be SMALL.

23 • **Aesthetics**

24 As described in Section 8.3.5 of this draft SEIS, new transmission lines would be 305 km
25 (190 mi) long or longer. Transmission lines have a significant impact on visual aesthetics.

26 Aesthetic impacts would occur during operation of the wind farm installation and would depend
27 on its distance from the shore and on its orientation in regard to shoreline communities. The
28 NRC staff estimates that the construction and operational impacts of the facility could be
29 managed, though some may consider the impact to be LARGE, depending on the location of
30 the turbines. An onshore wind facility would also have the potential to create LARGE effects.
31 The aesthetic impacts from new wood-fired generating plants could also be MODERATE,
32 depending on the plants' locations.

33 Therefore, the NRC staff concludes that the overall aesthetic impacts from the second
34 combination alternative would be MODERATE to LARGE, depending on the locations of
35 transmission lines and the wind farm.

36 • **Historic and Archeological Resources**

37 Onsite impacts to historical and cultural resources from the construction of a single gas turbine
38 plant are expected to be SMALL. The offsite impacts from the construction of wood-fired units,
39 a wind farm, and new transmission lines are also expected to be SMALL given the opportunity
40 to evaluate and select the sites in accordance with applicable regulations and the ability to
41 minimize impacts before construction. Therefore, the NRC staff concludes that the overall
42 impacts on historic and archeological resources from the second combination alternative would

be SMALL.

- **Environmental Justice**

No impacts are anticipated in the IP2 and IP3 area that could disproportionately affect minority or low-income communities. Impacts from offsite activities would depend on the location of the activity. Many conservation measures, especially those involving weatherization or efficiency improvements to low-income households, can have disproportionately positive effects for low-income families. Overall, though, environmental justice impacts from the second combination alternative would depend substantially on the location of the installations and the characteristics of the surrounding populations. Impacts could range from SMALL to LARGE.

Table 8-5. Summary of Environmental Impacts of Combination Alternatives

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Land Use	SMALL to MODERATE	Impacts would depend on location of wind farm and the site selection for the wood-fired plants, as well as land-disposal if a cooling tower is constructed at the remaining IP unit.	MODERATE to LARGE	Impacts would depend on the site selection for the wood-fired plants, and the placement of new transmission lines and the wind farm.
Ecology	SMALL to MODERATE	Impacts would depend on location of wind farm and the site selection for the wood-fired plants.	SMALL to MODERATE	Impacts would depend on site selection for the wood-fired plants, the wind farm, and transmission line.
Water Use and Quality	SMALL	Minor impacts occur if the wind farm is located offshore.	SMALL	SMALL impacts at the IP2 and IP3 site because of less onsite power production; minor impacts at offshore wind farms, and locations of wood-fired plants and transmission lines.
Air Quality	SMALL	Air emissions of the small wood-fired plants and gas-fired unit would be minor considering their size and possible multiple locations. A wind farm would not impact air quality. A cooling tower could have a minor effect on air quality.	SMALL to MODERATE	Emissions estimated in Table 8-4 reduced about 80 percent because only one gas-fired unit would operate at the IP2 and IP3 site. Air emissions of the small wood-fired plants would be minor considering their size and possible multiple locations. A wind farm would not impact air quality.

Table 8-5 (continued)

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Waste	SMALL to LARGE	There would be construction waste from the IP2 and IP3 site if a cooling tower is constructed; construction of other alternatives would increase waste volumes. Operational wastes are SMALL.	SMALL to MODERATE	There would be far less construction waste from the IP2 and IP3 site. The other alternatives would not generate significant waste volumes except during construction.
Human Health	SMALL	Emissions and occupational risks would be managed in accordance with applicable regulations.	SMALL	Emissions and occupational risks would be managed in accordance with applicable regulations.
Socioeconomics	SMALL	Some PILOT payments and jobs may be lost.	SMALL to MODERATE	IP2 and IP3 jobs and PILOT payments lost; some new jobs and taxes; minimum impacts from other power alternatives.
Socioeconomics (Transportation)	MODERATE	Minor impacts from commuting plant personnel. More significant short-term impacts from offsite transportation of construction waste, including large volumes of soil and rock.	SMALL	Minor impacts from commuting plant personnel. Short-term impacts from offsite transportation of construction waste.
Aesthetics	SMALL to LARGE	Visual impacts from new wind turbines, depending on the location. Limited impact from wood-fired and gas plants.	MODERATE to LARGE	Visual impacts from new wind turbines and visual impacts of new transmission lines, depend on the location chosen. Limited impact from wood-fired and gas plants.
Historic and Archeological Resources	SMALL	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.	SMALL	Cultural resources inventories would be needed to identify, evaluate, and mitigate potential impacts from construction.

Table 8-5 (continued)

Impact Category	Combination 1		Combination 2	
	Impact	Comments	Impact	Comments
Environmental Justice	SMALL to LARGE	Impacts would depend on plant locations.	SMALL to LARGE	Impacts would depend on plant and transmission line locations.

8.4 Summary of Alternatives Considered

In this draft SEIS, the NRC staff has considered alternative actions to license renewal of IP2 and IP3 including the no-action alternative (discussed in Section 8.2), new generation or energy conservation alternatives (supercritical coal-fired generation, natural gas, nuclear, and conservation alternatives discussed in Sections 8.3.1 through 8.3.4), purchased electrical power (discussed in Section 8.3.5), alternative power-generating technologies (discussed in Section 8.3.6), and two combinations of alternatives (discussed in Section 8.3.7).

As established in the GEIS, the need for power from IP2 and IP3 is assumed by the NRC in the license renewal process. Should the NRC not renew the IP2 and/or IP3 operating licenses, their generating capacity or load reduction (e.g., by conservation) would have to come from an alternative to license renewal.

Furthermore, even if the NRC renews the operating licenses, Entergy could elect not to operate either IP2 or IP3 for the full terms of the renewed licenses. Decisions about which alternative to implement, regardless of whether or not the NRC renews the IP2 and IP3 operating licenses, are outside the NRC's authority and are subject to consideration by Entergy, other power producers, and State-level decisionmakers (or non-NRC Federal-level decisionmakers where applicable).

The environmental impact levels of the alternatives considered by the NRC staff in this draft SEIS are similar to the impact levels of continued IP2 and IP3 operation under a renewed license with or without modifications to the existing once-through cooling system combined with aquatic ecology restoration activities designed to comply with the site's draft SPDES permit, though impacts differ significantly across resource areas.

Impacts from combinations of alternatives including conservation and generation technologies (e.g., coal, gas, wind) are also likely to be similar to the impacts of renewing the IP2 and IP3 operating licenses and implementing modifications to the open-cycle cooling system and participating in and/or funding aquatic resource restoration activities.

8.5 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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- 1 40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50,
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- 3 40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51,
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9.0 SUMMARY AND CONCLUSIONS

Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2 (IP2), LLC, and Entergy Nuclear Indian Point 3 (IP3), LLC, are joint applicants for the renewal of the IP2 and IP3 operating licenses (joint applicants will be referred to as Entergy). On April 30, 2007, Entergy submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the IP2 and IP3 operating licenses for an additional 20 years each under Title 10, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," of the *Code of Federal Regulations* (10 CFR Part 54) (Entergy 2007a). If the operating licenses are renewed, State and Federal (other than NRC) regulatory agencies and Entergy would ultimately decide whether the plant will continue to operate based on factors such as the need for power, power availability from other sources, regulatory mandates, or other matters within the agencies' jurisdictions or the purview of the owners. If the NRC decides not to renew the operating licenses, then the units must be shut down upon the expiration of the current operating licenses, subject to the conclusion of the license renewal process. If the license renewal review is ongoing at the time of license expiration, the units will be allowed to continue operating until the NRC makes a determination. The IP2 operating license will expire on September 28, 2013; the IP3 operating license will expire on December 12, 2015.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA), requires an environmental impact statement (EIS) for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." As identified in 10 CFR Part 51, certain licensing and regulatory actions require an EIS. In 10 CFR 51.20(b)(2), the NRC requires preparation of an EIS or a supplement to an EIS for renewal of a reactor operating license. Furthermore, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).⁽¹⁾

Upon acceptance of the license renewal application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing, on August 10, 2007, a Notice of Intent to prepare an EIS and conduct scoping (Volume 72, page 45075, of the *Federal Register* (72 FR 45075)). The NRC staff held two public scoping meetings on September 19, 2007, and visited the IP2 and IP3 site to conduct site audits on September 10–14, 2007, and September 24–27, 2007. The NRC staff reviewed the Entergy environmental report (ER) (Entergy 2007b) and compared it to the GEIS, consulted with other agencies, and conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal" (NRC 2000). The NRC staff also considered the public comments received during the scoping process for preparation of this draft supplemental environmental impact statement (SEIS) for IP2 and IP3. Public comments and NRC staff responses are available in the Scoping Summary Report prepared by the NRC staff (ADAMS

⁽¹⁾ The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

Summary and Conclusions

1 Accession Number ML083360115).

2 The NRC staff plans to hold public meetings in Cortlandt Manor, New York, in February of 2009
3 to present the preliminary results of the NRC environmental review, answer questions from the
4 public, and receive comments on this draft SEIS. When the comment period ends, the NRC
5 staff will consider and address all of the comments received. These comments will be
6 addressed in Part 2 of Appendix A to the final SEIS.

7 This draft SEIS includes the NRC staff's preliminary analysis that considers and weighs the
8 environmental effects of the proposed action (including cumulative impacts), the environmental
9 impacts of alternatives to the proposed action, and mitigation measures available for reducing or
10 avoiding adverse effects. This draft SEIS also includes the NRC staff's preliminary
11 recommendation regarding the proposed action.

12 The NRC has adopted the following statement of purpose and need for license renewal from the
13 GEIS:

14 The purpose and need for the proposed action (renewal of an operating license)
15 is to provide an option that allows for power generation capability beyond the
16 term of a current nuclear power plant operating license to meet future system
17 generating needs, as such needs may be determined by State, utility, and, where
18 authorized, Federal (other than NRC) decisionmakers.

19 The evaluation criterion for the NRC staff's environmental review, as defined in
20 10 CFR 51.95(c)(4) and the GEIS, is to determine the following:

21 whether or not the adverse environmental impacts of license renewal are so
22 great that preserving the option of license renewal for energy planning
23 decisionmakers would be unreasonable.

24 Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that
25 there are factors, in addition to license renewal, that would contribute to the NRC's ultimate
26 determination of whether an existing nuclear power plant continues to operate beyond the
27 period of the current operating licenses.

28 NRC regulations (10 CFR 51.95(c)(2)) contain the following statement regarding the content of
29 SEISs prepared at the license renewal stage:

30 The supplemental environmental impact statement for license renewal is not
31 required to include discussion of need for power or the economic costs and
32 economic benefits of the proposed action or of alternatives to the proposed
33 action except insofar as such benefits and costs are either essential for a
34 determination regarding the inclusion of an alternative in the range of alternatives
35 considered or relevant to mitigation. In addition, the supplemental environmental
36 impact statement prepared at the license renewal stage need not discuss other
37 issues not related to the environmental effects of the proposed action and the
38 alternatives, or any aspect of the storage of spent fuel for the facility within the
39 scope of the generic determination in 10 CFR 51.23(a) and in accordance with

10 CFR 51.23(b).⁽²⁾

The GEIS contains the results of a systematic evaluation of the consequences of renewing an operating license and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed on the basis of the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51:

SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For 69 of the 92 environmental issues considered in the GEIS, the NRC staff analysis in the GEIS shows the following:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

⁽²⁾ The title of 10 CFR 51.23 is "Temporary Storage of Spent Fuel after Cessation of Reactor Operations—Generic Determination of No Significant Environmental Impact."

Summary and Conclusions

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the NRC staff relied on conclusions as amplified by supporting information in the GEIS for issues designated as Category 1 in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific SEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized.

This draft SEIS documents the NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the operating licenses for IP2 and IP3), alternative methods of power generation, and conservation. When possible, these alternatives were evaluated assuming that the replacement power generation plant, if any, could be located at either the IP2 and IP3 site or some other unspecified location.

9.1 Environmental Impacts of the Proposed Action—License Renewal

The NRC staff has established an independent process for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. The NRC staff has not identified any information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this draft SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). Therefore, the NRC staff relied upon the conclusions of the GEIS for all Category 1 issues that are applicable to IP2 and IP3.

Entergy's license renewal application contains an analysis of the Category 2 issues that are applicable to IP2 and IP3, plus environmental justice and chronic effects from electromagnetic fields for 23 total issues. The NRC staff has reviewed the Entergy analysis and has conducted an independent review of each issue. Six of the Category 2 issues are not applicable because they are related to cooling systems, water use conflicts, and ground water use not found at IP2 and IP3.

As discussed in Chapter 3, scoping comments revealed—and Entergy indicated—that Entergy may replace reactor vessel heads and control rod drive mechanisms in both units. As a result, the NRC staff addressed the impacts of these replacement activities in Chapter 3. This includes three Category 2 issues that apply only to refurbishment, six Category 2 issues that apply to

1 refurbishment and continued operation, and one uncategorized issue, environmental justice,
2 that applies to both refurbishment and continued operations. The NRC staff determined that all
3 effects from refurbishment are of SMALL significance.

4 The NRC staff addresses twelve Category 2 issues related to impacts from continued
5 operations and postulated accidents during the renewal term, as well as environmental justice
6 and chronic effects of electromagnetic fields. Research is continuing in the area of chronic
7 effects on electromagnetic fields, and a scientific consensus has not been reached. Therefore,
8 no further evaluation of this issue is required. The NRC staff concludes that the potential
9 environmental effects for 8 of the 12 categorized issues are of SMALL significance in the
10 context of the standards set forth in the GEIS. The NRC staff concludes that the combined
11 impacts from impingement and entrainment (each a separate issue) range from SMALL to
12 LARGE, depending on fish species affected. Impacts from heat shock could range from SMALL
13 to MODERATE. Finally, given a lack of current impingement monitoring data, impacts to the
14 endangered shortnose sturgeon could range from SMALL to LARGE (see Chapter 4 of this draft
15 SEIS).

16 For severe accident mitigation alternatives (SAMAs), the NRC staff concludes that a
17 reasonable, comprehensive effort was made by Entergy to identify and evaluate SAMAs.
18 Based on its review of the SAMAs for IP2 and IP3, and the plant improvements already made,
19 the NRC staff concludes that several candidate SAMAs may be cost-beneficial. However, these
20 SAMAs do not relate to adequately managing the effects of aging during the period of extended
21 operation. Therefore, they need not be implemented as part of license renewal pursuant to
22 10 CFR Part 54.

23 Mitigation measures were considered for each Category 2 issue. For all issues of SMALL
24 significance, current measures to mitigate the environmental impacts of plant operation were
25 found to be adequate. For issues of MODERATE or LARGE significance (i.e., issues related to
26 aquatic ecology), mitigation measures are addressed both in Chapter 4 and in Chapter 8 as
27 alternatives based on determinations in the draft New York State Department of Environmental
28 Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) permit. These
29 alternatives included plant operation with a new closed-cycle cooling system (Section 8.1.1) and
30 operation of the existing once-through cooling system with enhanced controls and restoration
31 efforts (Section 8.1.2).

32 Cumulative impacts of past, present, and reasonably foreseeable future actions were
33 considered, regardless of what agency (Federal or non-Federal) or person undertakes such
34 other actions. The NRC staff concludes that the cumulative impacts to the environment around
35 IP2 and IP3 license renewal would be LARGE for some affected resources, given historical
36 environmental impacts, current actions, and likely future actions. With the exception of aquatic
37 resources, the contribution of IP2 and IP3 to cumulative impacts is SMALL.

38 The following sections discuss unavoidable adverse impacts, irreversible or irretrievable
39 commitments of resources, and the relationship between local short-term use of the
40 environment and long-term productivity.

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9.1.1 Unavoidable Adverse Impacts

An environmental review conducted at the license renewal stage differs from the review conducted in support of a construction permit because the plant is in existence at the license renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have already occurred, have been mitigated, or have been avoided. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the renewal term.

Unavoidable adverse impacts of continued operation from heat shock and the combined effects of entrainment and impingement of fish and shellfish are considered SMALL to MODERATE and SMALL to LARGE, respectively. Unavoidable adverse impacts from license renewal may be SMALL to LARGE for the endangered shortnose sturgeon as a result of limited data. Other unavoidable adverse impacts are considered to be of SMALL significance.

Unavoidable adverse impacts of likely alternatives to the operation of IP2 and IP3 vary greatly. All have smaller impacts to aquatic resources than the current IP2 and IP3, though all also have larger impacts than the current IP2 and IP3 in at least one other resource area.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of IP2 and IP3 during the current license period was made when the plant was built. The resource commitments to be considered in this draft SEIS are associated with continued operation of the plant for an additional 20 years. These resources include materials and equipment required for plant maintenance, operation, and refurbishment; the nuclear fuel used by the reactors; and ultimately, permanent offsite storage space for the spent fuel assemblies.

Entergy may be required to commit additional resources should the final NYSDEC SPDES permit require closed-cycle cooling (as the draft SPDES permit does in its current form) and Entergy decides to (1) build and operate a closed-cycle cooling system to meet the permit's required reductions in impacts to aquatic ecology, or (2) to invest in cooling water intake modifications and restoration activities. However, regardless of the future status of the SPDES permit, significant resource commitments will be required during the renewal term for additional fuel and the permanent spent fuel storage space. IP2 and IP3 replace a portion of their fuel assemblies during every refueling outage, which typically occurs on a 24-month cycle (Entergy 2007a). Additional resources may also be committed to constructing and installing new reactor vessel heads and control rod drive mechanisms.

The likely energy alternatives would also require a commitment of resources for construction of the replacement facilities, implementation of conservation measures, and in some cases, fuel to run plants. Significant resource commitments would also be required for development of transmission capacity. These resource commitments, however, would not necessarily come from Entergy because Entergy currently has no obligation to support power production in the New York area should IP2 and IP3 shut down.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between local short-term uses of the environment and maintenance and enhancement of long-term productivity at IP2 and IP3 was set when the plant was approved and construction began. Renewal of the operating licenses for IP2 and IP3 and continued operation of the plant would not alter the existing balance, but may postpone the availability of the site for other uses. Denial of the application to renew the operating licenses would lead to a shutdown of the plant that will alter the balance in a manner that depends on subsequent uses of the site. Furthermore, new replacement energy sources or conservation options will establish new balances at their respective locations.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the operating licenses for IP2 and IP3. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 through 7 discuss environmental issues associated with renewal of the operating licenses. Environmental issues associated with the no-action alternative and alternatives such as new power generation, purchased power, conservation, and cooling system modifications are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewal of the operating licenses), the no-action alternative (denial of the application), alternatives involving altering plant operations to comply with the NYSDEC draft SPDES discharge permit, construction of coal- or gas-fired generating capacity at alternate sites, gas-fired generation of power at IP2 and IP3, and two combinations of alternatives are compared in Table 9-1. All new fossil-fueled alternatives presented in Table 9-1 are assumed to use closed-cycle cooling systems given current regulations for new power plants.

Table 9-1 shows the significance of the plant-specific environmental effects of the proposed action (renewal of IP2 and IP3 operating licenses) as well as environmental effects of alternatives to the proposed action. Impacts from license renewal would be SMALL for all impact categories except aquatic ecology, which includes the impacts of heat shock, entrainment, and impingement. Chapter 4 of this draft SEIS describes the SMALL to LARGE impacts of plant operation on aquatic ecology through impingement and entrainment (impact levels vary by species), and the SMALL to MODERATE impacts from thermal shock. Overall, impacts to aquatic ecology from continued operation of IP2 and IP3 without cooling system modifications or restoration actions is SMALL to LARGE. A single significance level was not assigned for the collective offsite radiological impacts from the fuel cycle and from high-level radioactive waste spent fuel disposal (see Chapter 6).

NRC staff analysis indicates that the no-action alternative has the smallest effect, but it would necessitate additional actions to replace generation capacity (whether with newly-constructed power plants or purchased power) and/or to institute conservation programs. Impacts of the likely consequences of the no-action alternative would be similar to those of the energy alternatives that the NRC staff considered. All other alternative actions have impacts in at least four resource areas that reach SMALL to MODERATE or higher significance. Often, these

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1 impacts are the result of constructing new facilities or infrastructure.

2 **9.3 Conclusions and Recommendations**

3 Based on (1) the analysis and findings in the GEIS, (2) the ER submitted by Entergy,
4 (3) consultation with Federal, State, and local agencies, (4) the NRC staff's consideration of
5 public scoping comments received, and (5) the NRC staff's independent review, the preliminary
6 recommendation of the NRC staff is that the Commission determine that the adverse
7 environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the
8 option of license renewal for energy planning decisionmakers would be unreasonable.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation

Impact Category	Proposed Action	No-Action Alternative ^(b)		License Renewal with		Coal-Fired Plant ^(d)
	License Renewal	Denial of Renewal	New Closed-Cycle Cooling	Once-Through Cooling with Restoration	Alternate Site	
Land Use	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE	
Ecology—Aquatic	SMALL to LARGE ^(a)	SMALL	SMALL	SMALL to MODERATE	SMALL	
Ecology—Terrestrial	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE to LARGE	
Water Use and Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	
Air Quality	SMALL	SMALL	SMALL	SMALL	MODERATE	
Waste	SMALL	SMALL	SMALL to LARGE	SMALL	MODERATE	
Human Health	SMALL ^(c)	SMALL	SMALL	SMALL	SMALL to LARGE	
Socioeconomics	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL to LARGE	
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL	MODERATE to LARGE	
Aesthetics	SMALL	SMALL	MODERATE	SMALL	SMALL to LARGE	
Historical and Archeological Resources	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	
Environmental Justice	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	

Table 9-1 (continued)

Impact Category	Natural-Gas-Fired Generation ^(d)			Combination of Alternatives	
	Five 400-MW(e) Units at IP2 and IP3	Five 400-MW(e) Units at IP2	Five 400-MW(e) Units at Alternate Site	Option 1: One IP unit, onsite gas, offsite renewables, and conservation	Option 2: Onsite gas, offsite renewables, additional imported power, and conservation
Land Use	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water Use and Quality	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL
Air Quality	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Waste	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Transportation	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	MODERATE	SMALL

Summary and Conclusions

Table 9-1 (continued)

	Natural-Gas-Fired Generation ^(c)	Combination of Alternatives	Natural-Gas-Fired Generation ^(d)
Aesthetics	SMALL	SMALL to LARGE	MODERATE to LARGE
Historical and Archeological Resources	SMALL	SMALL to MODERATE	SMALL
Environmental Justice	SMALL	SMALL to LARGE	SMALL to LARGE
(a) NRC staff analysis indicates that impingement and entrainment impacts vary by species, and may be SMALL to LARGE. Thermal shock effects may be SMALL to MODERATE, and impacts to the endangered shortnose sturgeon may range from SMALL to LARGE given uncertainties in the data. (b) The no-action alternative does not, on its own, meet the purpose and need of the GEIS. No-action may necessitate other generation or conservation actions which may include—but are not limited to—the alternatives addressed in this table. (c) For the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, a specific significance level was not assigned. See Chapter 6 for details. (d) Analysis was based on use of a closed-cycle cooling system.			

9.4 References

- 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."
- 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."
- 72 FR 45705. "Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process." August 10, 2007
- Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210512.
- Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to Indian Point, Units 2 and 3, License Renewal Application). April 23, 2007. ADAMS Accession No. ML071210530.
- National Environmental Policy Act of 1969, as amended (NEPA). 42 USC 4321, et seq.
- Nuclear Regulatory Commission (NRC). 1996. NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants (GEIS)." Washington, DC. May 1996.
- Nuclear Regulatory Commission (NRC). 1999. NUREG-1437, Volume 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report," Section 6.3, "Transportation," Table 9.1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." Washington, DC.
- Nuclear Regulatory Commission (NRC). 2000. NUREG-1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal." Washington, DC.

NRC FORM 335 (9-2004) NRCMD 3.7		U.S. NUCLEAR REGULATORY COMMISSION		1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG-1437, Supplement 38, Vol. 1	
BIBLIOGRAPHIC DATA SHEET (See instructions on the reverse)					
2. TITLE AND SUBTITLE Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) Supplement 38 Regarding Indian Point Nuclear Generating Unit Numbers 2 and 3 Draft Report for Comment Main Report				3. DATE REPORT PUBLISHED	
				MONTH December	YEAR 2008
				4. FIN OR GRANT NUMBER	
5. AUTHOR(S) See Appendix B of Volume 2 of this Report				6. TYPE OF REPORT Technical	
				7. PERIOD COVERED (Inclusive Dates)	
8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.) Division of License Renewal Office of Nuclear Reactor Regulation U.S. Nuclear Regulatory Commission Washington, D.C. 20555-0001					
9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.) Same as 8 Above					
10. SUPPLEMENTARY NOTES Docket Nos. 05000247 and 05000286					
11. ABSTRACT (200 words or less) This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to the NRC to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This draft SEIS contains the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action. The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report submitted by Entergy, (3) consultation with other Federal, State, and Local agencies; (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process.					
12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.) Indian Point Nuclear Generating Unit Numbers 2 and 3 IP2 IP3 IPEC Supplement to the Generic Environmental Impact Statement DSEIS National Environmental Policy Act NEPA License Renewal GEIS NUREG-1437, Supplement 38				13. AVAILABILITY STATEMENT unlimited	
				14. SECURITY CLASSIFICATION (This Page) unclassified	
				(This Report) unclassified	
				15. NUMBER OF PAGES	
				16. PRICE	

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Draft Report for Comment Appendices

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

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Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

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A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

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Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

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Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 38

Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3

Draft Report for Comment Appendices

Manuscript Completed: December 2008
Date Published: December 2008

COMMENTS ON DRAFT REPORT

Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number NUREG-1437, Supplement 38, draft, in your comments, and send them by March 11, 2009, to the following address:

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop TWB-05-B01
Washington, DC 20555-0001

Electronic comments may be submitted to the NRC by e-mail at IndianPoint.EIS@nrc.gov.

For any questions about the material in this report, please contact:

Drew Stuyvenberg
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U.S. Nuclear Regulatory Commission
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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear power plant operating licenses for a 20-year period in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS),⁽¹⁾ and codified the results in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff identified 92 environmental issues and reached generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to the NRC to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This draft SEIS includes the NRC staff's analysis which considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither Entergy nor the NRC staff has identified information that is both new and significant for any issues that applies to IP2 and/or IP3. In addition, the NRC staff determined that information provided during the scoping process was not new and significant with respect to the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the operating licenses for IP2 and IP3 will not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the NRC staff's conclusion in the GEIS is that the impact is of SMALL⁽²⁾ significance (except for the collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to IP2 and IP3 are addressed in this draft SEIS. The NRC staff determined that several of these issues were not applicable because of the type of facility cooling system or other reasons detailed within this SEIS. For the remaining applicable issues, the NRC staff concludes that the significance of potential environmental impacts related to operating license renewal is SMALL, with four exceptions—entrainment,

(1) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

(2) Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

Abstract

1 impingement, heat shock from the facility's heated discharge, and impacts to aquatic
2 endangered species. Overall effects from entrainment and impingement may be SMALL to
3 LARGE, depending on the species affected. Impacts from heat shock likely range from SMALL
4 to MODERATE depending on the conclusions of thermal studies proposed by the New York
5 State Department of Environmental Conservation (NYSDEC). NRC staff did not find data that
6 suggest the effect of heat shock is likely to rise to LARGE. Given the uncertainties in the data
7 NRC staff reviewed, impacts to the endangered shortnose sturgeon could range from SMALL to
8 LARGE.

9 The NRC staff's preliminary recommendation is that the Commission determine that the adverse
10 environmental impacts of license renewals for IP2 and IP3 are not so great that preserving the
11 option of license renewal for energy planning decisionmakers would be unreasonable. This
12 recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental
13 report submitted by Entergy, (3) consultation with other Federal, State, and local agencies; (4)
14 the NRC staff's own independent review, and (5) the NRC staff's consideration of public
15 comments received during the scoping process.

16 **Paperwork Reduction Act Statement**

17 This NUREG does not contain information collection requirements and, therefore, is not subject
18 to the requirements of the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). These
19 information collections were approved by the Office of Management and Budget, approval
20 numbers 3150-0004, 3150-0155, 3150-0014, 3150-0011, 3150-0021, 3150-0132, and
21 3150-0151.

22 **Public Protection Notification**

23 The NRC may not conduct or sponsor, and a person is not required to respond to, a request for
24 information or an information collection requirement unless the requesting document displays a
25 currently valid OMB control number.

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Appendix A

Comments Received on the Environmental Review

Appendix A

Comments Received on the Environmental Review

Comments Received During Scoping and Scoping Summary Adoption

In this appendix, the NRC staff adopts the Scoping Summary Report for Indian Point Nuclear Generating Unit Nos. 2 and 3 as prepared by the NRC staff in response to comments received on the scope of the environmental review. The NRC staff issued the scoping summary report on December 12, 2008. The Scoping Summary Report is available for public inspection in the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS).

The ADAMS Public Electronic Reading Room is accessible at <http://www.nrc.gov/reading-rm/adams/web-based.html>. The scoping summary report is listed under Accession No. ML083360115.

Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdrc@nrc.gov.

On August 10, 2007, the NRC published a Notice of Intent in the Federal Register (72 FR 45075) to notify the public of the Staff's intent to prepare a plant-specific supplement to the GEIS (SEIS) regarding the renewal application for the IP2 and IP3 operating license. As outlined by NEPA, the NRC initiated the scoping process with the issuance of the Federal Register Notice. The NRC invited the applicant, federal, state, local, and tribal government agencies, local organizations, and individuals to participate in the scoping process by providing oral comments at scheduled public meetings and/or submitting written suggestions and comments no later than October 12, 2007.

The scoping process included two public scoping meetings, which were both held on September 19, 2007, at Colonial Terrace, 119 Oregon Road, Cortlandt Manor, New York. The NRC issued press releases and distributed flyers locally. Both sessions began with NRC staff members providing a brief overview of the license renewal process and the NEPA process. Following the NRC's prepared statements, the meetings were open for public comments. Approximately 50 attendees provided oral comments that were recorded and transcribed by a certified court reporter.

The meeting summary, which was issued on October 24, 2007, and the associated transcripts can be found in the NRC PDR or in ADAMS at Accession No. ML072851079. The transcripts of the meetings can be found in ADAMS at Accession Numbers ML072830682 and ML072890209.

Appendix A

- 1 The scoping summary contains all comments received on the review, as well as the NRC staff's
- 2 responses to those comments. Comments received on the draft SEIS will be included in this
- 3 Appendix of the final SEIS.

Appendix B

Contributors to the Supplement

Appendix B

Contributors to the Supplement

The Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, had overall responsibility for the preparation of this supplement, assisted by staff from other NRC organizations, AECOM, and Pacific Northwest National Laboratory.

Name	Function or Expertise
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Dennis Logan	Ecology
Briana Balsam	Ecology
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Jennifer Davis	Historical/Archeological Resources
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Kevin Taylor	Alternatives
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Matthew Goodwin	Historical/Archeological Resources
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Appendix B

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Valerie Cullinan	Aquatic Ecology
Lance W. Vail	Hydrology/Water Use

1

Appendix C

**Chronology of NRC Staff Environmental Review
Correspondence Related to the Entergy Nuclear
Operations, Inc.**

**Application for License Renewal of Indian Point
Nuclear Generating Unit Nos. 2 and 3**

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to the Entergy Nuclear Operations, Inc., Application for License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and Entergy Nuclear Operations, Inc., (Entergy) and other correspondence related to the NRC staff's environmental review, under Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51), of Entergy's application for renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3. All documents, with the exception of those containing proprietary information, have been placed in the NRC's Public Document Room, at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, and are available electronically from the Public Electronic Reading Room found on the Internet at <http://www.nrc.gov/reading-rm.html>. From this site, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents in the Publicly Available Records component of ADAMS. The ADAMS accession numbers for each document are included below.

April 23, 2007	Letter to NRC from Entergy forwarding the application for renewal of operating licenses for Indian Point Nuclear Generating Units 2 and 3, requesting extension of operating licenses for an additional 20 years. (Accession No. ML071207512)
April 23, 2007	Letter to NRC from Entergy forwarding a copy of reference documents used in preparing the Environmental Report (Appendix E) for the Indian Point Nuclear Generating Units 2 and 3 license renewal application. (Accession No. ML071210108)
May 7, 2007	Letter to Entergy from NRC, "Receipt and Availability of the License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 and 3." (Accession No. ML071080133)
May 7, 2007	Letter to Ms. Patricia Thorsen, White Plains Public Library, from NRC, "Maintenance of Reference Materials at the White Plains Public Library Related to the Review of the Entergy Nuclear Operations, Inc., License Renewal Application." (Accession No. ML071070518)
May 7, 2007	Letter to Ms. Resa Getman, Hendrick Hudson Free Library, from NRC, "Maintenance of Reference Materials at the Hendrick Hudson

Appendix C

1		Free Library Related to the Review of the Entergy Nuclear
2		Operations, Inc., License Renewal Application.” (Accession
3		No. ML071080080)
4	May 7, 2007	Letter to Ms. Susan Thaler, The Field Library, from NRC,
5		“Maintenance of Reference Materials at The Field Library Related to
6		the Review of the Entergy Nuclear Operations, Inc., License Renewal
7		Application.” (Accession No. ML071080122)
8	July 25, 2007	Letter to Entergy from NRC transmitting “Determination of
9		Acceptability and Sufficiency for Docketing, Proposed Review
10		Schedule, and Opportunity for a Hearing Regarding the Application
11		from Entergy Nuclear Operations, Inc. for Renewal of Operating
12		Licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3.”
13		(Accession No. ML071900365)
14	August 6, 2007	Letter to Entergy from NRC, “Notice of Intent to Prepare an
15		Environmental Impact Statement and Conduct Scoping Process for
16		License Renewal for Indian Pont Nuclear Generating Unit Nos. 2 and
17		3,” and forwarding <i>Federal Register</i> notice. (Accession
18		No. ML071840939)
19	August 9, 2007	Memorandum on “Forthcoming Meeting to Discuss Environmental
20		Scoping Process for Indian Point Nuclear Generating Unit Nos. 2 and
21		3 License Renewal Application.” (Accession No. ML072180296)
22	August 9, 2007	Letter to New York State Office of Parks, Recreation, and Historic
23		Preservation from NRC, “Indian Point Nuclear Generating Unit Nos. 2
24		and 3 (Indian Point) License Renewal Application Review (SHPO
25		No. 06PR06720).” (Accession No. ML072130333)
26	August 9, 2007	Letter to Advisory Council on Historic Preservation from NRC, “Indian
27		Point Nuclear Generating Unit Nos. 2 and 3 License Renewal
28		Application Review.” (Accession No. ML072130367)
29	August 16, 2007	Letter to Mr. David Stillwell, U.S. Fish and Wildlife Service (USFWS),
30		“Request for List of Protected Species Within the Area Under
31		Evaluation for the Indian Point Nuclear Generating Unit Nos. 2 and 3
32		License Renewal Application Review.” (Accession
33		No. ML072130211)
34	August 16, 2007	Letter to Mr. Peter Colosi, National Marine Fisheries Service (NMFS),
35		“Request for List of Protected Species and Essential Fish Habitat
36		Within the Area Under Evaluation for the Indian Point Nuclear
37		Generating Unit Nos. 2 and 3 License Renewal Application Review.”
38		(Accession No. ML072130388)
39	August 24, 2007	Letter to Mr. Andy Warrior, Absentee Shawnee Tribe of Oklahoma,

1 “Request for Comments Concerning the Indian Point Nuclear
2 Generating Unit Nos. 2 and 3 License Renewal Application Review.”
3 (Accession No. ML072250103)

4 August 24, 2007 Letter to The Honorable Maurice John, Cattaraugus Reservation,
5 Seneca Nation, “Request for Comments Concerning the Indian Point
6 Nuclear Generating Unit Nos. 2 and 3 License Renewal Application
7 Review.” (Accession No. ML072250171)

8 August 24, 2007 Letter to Mr. Clint Halftown, Cayuga Nation, “Request for Comments
9 Concerning the Indian Point Nuclear Generating Unit Nos. 2 and 3
10 License Renewal Application Review.” (Accession
11 No. ML072250394)

12 August 24, 2007 Letter to Ms. Nikki Owings-Crumm, Delaware Nation, “Request for
13 Comments Concerning the Indian Point Nuclear Generating Unit
14 Nos. 2 and 3 License Renewal Application Review.” (Accession
15 No. ML072250459)

16 August 24, 2007 Letter to The Honorable Jerry Douglas, Delaware Tribe of Indians,
17 “Request for Comments Concerning the Indian Point Nuclear
18 Generating Unit Nos. 2 and 3 License Renewal Application Review.”
19 (Accession No. ML072250488)

20 August 24, 2007 Letter to The Honorable C.W. Longlow, Echota Chickamauga
21 Cherokee Tribe of New Jersey, “Request for Comments Concerning
22 the Indian Point Nuclear Generating Unit Nos. 2 and 3 License
23 Renewal Application Review.” (Accession No. ML072250534)

24 August 24, 2007 Letter to The Honorable Michael Thomas, Mashantucket Pequot
25 Tribe, “Request for Comments Concerning the Indian Point Nuclear
26 Generating Unit Nos. 2 and 3 License Renewal Application Review.”
27 (Accession No. ML072260033)

28 August 24, 2007 Letter to Ms. Jeanne Schbotte, Mohegan Tribe, “Request for
29 Comments Concerning the Indian Point Nuclear Generating Unit
30 Nos. 2 and 3 License Renewal Application Review.” (Accession
31 No. ML072260047)

32 August 24, 2007 Letter to Mr. Ray Halbritter, Oneida Indian Nation of New York,
33 “Request for Comments Concerning the Indian Point Nuclear
34 Generating Unit Nos. 2 and 3 License Renewal Application Review.”
35 (Accession No. ML072260201)

36 August 24, 2007 Letter to Council of Chiefs, Onondaga Nation, “Request for Comments
37 Concerning the Indian Point Nuclear Generating Unit Nos. 2 and 3
38 License Renewal Application Review.” (Accession
39 No. ML072260245)

Appendix C

1	August 24, 2007	Letter to The Honorable Dwaine Perry, Ramapough Lenape, "Request
2		for Comments Concerning the Indian Point Nuclear Generating Unit
3		Nos. 2 and 3 License Renewal Application Review." (Accession
4		No. ML072260491)
5	August 24, 2007	Letter to Mr. Mike John, Seneca Nation of Indians, "Request for
6		Comments Concerning the Indian Point Nuclear Generating Unit
7		Nos. 2 and 3 License Renewal Application Review." (Accession
8		No. ML072260519)
9	August 24, 2007	Letter to Mr. Randy Kind, Shinnecock Tribe, "Request for Comments
10		Concerning the Indian Point Nuclear Generating Unit Nos. 2 and 3
11		License Renewal Application Review." (Accession
12		No. ML072270070)
13	August 24, 2007	Letter to The Honorable Harry B. Wallace, Unkechaug Nation,
14		"Request for Comments Concerning the Indian Point Nuclear
15		Generating Unit Nos. 2 and 3 License Renewal Application Review."
16		(Accession No. ML072270113)
17	August 24, 2007	Letter to The Honorable Leo Henry, Tuscarora Nation, "Request for
18		Comments Concerning the Indian Point Nuclear Generating Unit
19		Nos. 2 and 3 License Renewal Application Review." (Accession
20		No. ML072270548)
21	August 24, 2007	Letter to The Honorable Roger Hill, Tonawanda Band of Senecas,
22		"Request for Comments Concerning the Indian Point Nuclear
23		Generating Unit Nos. 2 and 3 License Renewal Application Review."
24		(Accession No. ML072270590)
25	August 24, 2007	Letter to Ms. Sherry White, Stockbridge-Munsee Community Band of
26		Mohican Indians, "Request for Comments Concerning the Indian Point
27		Nuclear Generating Unit Nos. 2 and 3 License Renewal Application
28		Review" (Accession No. ML072270615)
29	August 24, 2007	Letter to Mr. Ken Jock, St. Regis Mohawk Tribal Council, "Request for
30		Comments Concerning the Indian Point Nuclear Generating Unit
31		Nos. 2 and 3 License Renewal Application Review." (Accession
32		No. ML072280045)
33	August 29, 2007	Letter to NRC from USFWS, "Indian Point Nuclear Generating Unit
34		Nos. 2 and 3 Protected Species Response." (Accession
35		No. ML0732307840)
36	October 4, 2007	Letter to NRC from NMFS regarding endangered species near Indian
37		Point Nuclear Generating Unit Nos. 2 and 3. (Accession No.
38		ML073340068)

1	October 5, 2007	Letter to NRC from New York State Department of Environmental
2		Conservation (NYSDEC), "Indian Point Units 2 and 3 Relicensing
3		Extension Request for Scoping Comments on SEIS." (Accession
4		No. ML072820746)
5	October 10, 2007	Letter to NRC from NYSDEC, "Indian Point Units 2 and 3 Relicensing
6		Extension Request for Scoping Comments on SEIS." (Accession
7		No. ML072900470)
8	October 11, 2007	Letter to NYSDEC from NRC regarding extension request for scoping
9		comments. (Accession No. ML072840275)
10	October 24, 2007	"Meeting Summary of Public Environmental Scoping Meetings
11		Related to the Review of the Indian Point Nuclear Generating Unit
12		Nos. 2 and 3, License Renewal Application (TAC nos. MD5411 and
13		MD5412)." (Accession No. ML072851079)
14	November 8, 2007	Summary of Site Audit Related to the Review of the License Renewal
15		Application for Indian Point Nuclear Generating Unit Nos. 2 and 3.
16		(Accession No. ML073050267)
17	November 14, 2007	Letter to NRC from Entergy, "Supplement to License Renewal
18		Application (LRA) Environmental Report References." (Accession
19		No. ML073330590)
20	November 27, 2007	Letter to NYSDEC from NRC, "Request for List of State Protected
21		Species Within the Area Under Evaluation for the Indian Point Nuclear
22		Generating Unit Nos. 2 and 3 License Renewal Application Review."
23		(Accession No. ML073190161)
24	December 5, 2007	Letter to Entergy from NRC, "Request for Additional Information
25		Regarding Environmental Review for Indian Point Nuclear Generating
26		Unit Nos. 2 and 3 License Renewal (TAC nos. MD5411 and
27		MD5412)." (Accession No. ML073330931)
28	December 7, 2007	Letter to Entergy from NRC, "Request for Additional Information
29		Regarding Severe Accident Mitigation Alternatives for Indian Point
30		Nuclear Generating Unit Nos. 2 and 3 License Renewal (TAC
31		nos. MD5411 and MD5412)." (Accession No. ML073110447)
32	December 20, 2007	Letter to NRC from Entergy, "Supplement to License Renewal
33		Application (LRA)—Environmental Report References." (Accession
34		No. ML080080205)
35	December 28, 2007	Letter to NRC from NYSDEC regarding rare or State-listed animals
36		and plants, significant natural communities, and other habitats on or in
37		the vicinity of the Indian Point site. (Accession No. ML080070085,
38		withheld from public disclosure per request by NYSDEC)

Appendix C

1	January 4, 2008	Letter to NRC from Entergy, "Reply to Request for Additional
2		Information Regarding Environmental Review for License Renewal
3		Application." (Accession No. ML080110372)
4	January 10, 2008	Letter to NRC from Entergy, "Supplemental Response to Request for
5		Additional Information Regarding Environmental Review for License
6		Renewal Application." (Accession No. ML080220165)
7	January 30, 2008	Letter to NRC from Entergy, "Supplemental Response to Request for
8		Additional Information Regarding Environmental Review for License
9		Renewal Application." (Accession No. ML080380096)
10	February 20, 2008	Letter to NRC from Entergy, "Document Request for Additional
11		Information Regarding Environmental Review for License Renewal
12		Application—Electronic Copy of Impingement Data—Tables 4-1 and
13		4-2 of the 1990 Annual Report (EA 1991)." (Accession
14		No. ML080580408)
15	February 28, 2008	Letter to NRC from NMFS, "Essential Fish Habitat Information
16		Request for Docket Nos. 50-247 and 50-286; Indian Point Nuclear
17		Generating Unit Nos. 2 and 3 License Renewal; at the Village of
18		Buchanan, Town of Cortlandt, Westchester County, NY." (Accession
19		No. ML080990403)
20	March 7, 2008	Letter to NRC from Entergy, "Document Request for Additional
21		Information Regarding Environmental Review for License Renewal
22		Application—Hudson River Fisheries Program Data (Year Class
23		Report)." (Accession No. ML080770457)
24	April 9, 2008	Letter to Entergy from NRC, "Request for Additional Information
25		Regarding the Review of the License Renewal Application for Indian
26		Point Nuclear Generating Unit Nos. 2 and 3 (TAC nos. MD5411 and
27		MD5412)." (Accession No. ML080880104)
28	April 14, 2008	Letter to Entergy from NRC, "Request for Additional Information
29		Regarding the Review of the License Renewal Application for Indian
30		Point Nuclear Generating Unit Nos. 2 and 3 (TAC nos. MD5411 and
31		MD5412)." (Accession No. ML080940408)
32	April 23, 2008	Letter to Entergy from NRC, "Revision of Schedule for the Review of
33		the Indian Point Nuclear Generating Unit Nos. 2 and 3 License
34		Renewal Application (TAC nos. MD5411 and MD5412)." (Accession
35		No. ML081000441)
36	April 23, 2008	Letter to NRC from Entergy, "Reply to Document Request for
37		Additional Information Regarding Site Audit Review of License
38		Renewal Application for Indian Point Nuclear Generating Unit Nos. 2
39		and 3." (Accession No. ML081230243)

1	May 14, 2008	Letter to NRC from Entergy, "Reply to Request for Additional
2		Information Regarding License Renewal Application—Refurbishment."
3		(Accession No. ML081440052)
4	May 22, 2008	Letter to NRC from Entergy, "Supplemental Reply to Request for
5		Additional Information Regarding License Renewal Application—
6		Severe Accident Mitigation Alternatives Analysis." (Accession
7		No. ML081490336)

Appendix D

Organizations Contacted

Appendix D

Organizations Contacted

The U.S. Nuclear Regulatory Commission contacted the following Federal, State, regional, and local agencies, and Native American Tribes, during its independent review of the environmental impacts related to the application by Entergy Nuclear Operations, Inc., for renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3:

Absentee Shawnee Tribe of Oklahoma

Cattaraugus Reservation, Seneca Nation

Cayuga Nation

Delaware Nation

Delaware Tribe of Indians

Echota Chickamauga Cherokee Tribe of New Jersey

National Marine Fisheries Service

New York State Department of Environmental Conservation

New York State Office of Parks, Recreation and Historic Preservation, Historic Preservation Field Services Bureau

Oneida Indian Nation of New York

Onondaga Nation

Ramapough Lenape, Ramapough Tribal Office

Seneca Nation of Indians

Seneca Nation Tribal Historic Preservation

Shinnecock Tribe

St. Regis Mohawk Tribal Council

Stockbridge-Munsee Community Band of Mohican Indians, Tribal Historic Preservation Office

The Mashantucket Pequot Tribe (CT)

The Mohegan Tribe (CT)

Tonawanda Band of Senecas

Tuscarora Nation

Unkechaug Nation

U.S. Environmental Protection Agency, Region 2

U.S. Fish and Wildlife Service

Appendix E

Indian Point Nuclear Generating Unit Numbers 2 and 3 Compliance Status and Consultation Correspondence

Appendix E

Indian Point Nuclear Generating Unit Nos. 2 and 3 Compliance Status and Consultation Correspondence

Consultation correspondence related to the evaluation of the application for renewal of the operating licenses for Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3, respectively) is identified in Table E-1. Copies of the correspondence are included in this appendix.

The licenses, permits, consultations, and other approvals obtained from Federal, State, regional, and local authorities for SSES are listed in Table E-2.

Table E-1. Consultation Correspondence

Source	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission (R. Franovich)	State Historical Preservation Office (Office of Parks, Recreation, and Historic Preservation, R. L. Pierpont)	August 9, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Advisory Council on Historic Preservation (D. Klima)	August 9, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	U.S. Fish and Wildlife Service (D. Stillwell)	August 16, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	National Marine Fisheries Commission (P. Colosi)	August 16, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Absentee Shawnee Tribe of Oklahoma (A. Warrior)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Cattaraugus Reservation, Seneca Nation (The Hon. M. John)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Cayuga Nation (C. Halftown)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Delaware Nation (N. Owings-Crumm)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Delaware Tribe of Indian (The Hon. J. Douglas)	August 24, 2007

Appendix E

Source	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission (R. Franovich)	Echota Chickamauga Cherokee Tribe of New Jersey (The Hon. C.W. Longlow)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Mashantucket Pequot Tribe (The Hon. M. Thomas)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Mohegan Tribe (J. Schbotte)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Oneida Indian Nation of New York (R. Halbritter)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Onondaga Nation (Council of Chiefs)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Ramapough Lenape (The Hon. D. Perry)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Seneca Nation of Indians (M. John)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Shinnecock Tribe (R. Kind)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Unkechaug Nation (The Hon. H. B. Wallace)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Tuscarora Nation (The Hon. L. Henry)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Tonawanda Band of Senecas (The Hon. R. Hill)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	Stockbridge-Munsee Community of Mohican Indians (S. White)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	St. Regis Mohawk (K. Jock)	August 24, 2007
U.S. Nuclear Regulatory Commission (R. Franovich)	New York State Dept. of Environmental Conservation (J. Pietrusiak)	November 11, 2007
U.S. Fish and Wildlife Service (M. VanDonsell and R. Niver)	U.S. Nuclear Regulatory Commission (R. Franovich)	August 29, 2007
Delaware Nation (D. Nieto)	U.S. Nuclear Regulatory Commission	September 5, 2007
National Marine Fisheries Service (M. A. Colligan)	U.S. Nuclear Regulatory Commission (R. Franovich)	October 4, 2007

Source	Recipient	Date of Letter
New York State Department of Environmental Conservation (T. Seoane)	U.S. Nuclear Regulatory Commission (R. Franovich)	December 28, 2007
National Marine Fisheries Service (P. Colosi)	U.S. Nuclear Regulatory Commission (R. Franovich)	February 28, 2008

Table E-2. Federal, State, Local, and Regional Licenses, Permits, Consultations, and Other Approvals for the Indian Point site

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NRC	10 CFR Part 50	Possession License, Indian Point Unit 1	DPR-5		09/28/13	Authorizes SAFSTOR for Unit 1
NRC	10 CFR Part 50	Operating license, IP2	DPR-26		09/28/13	Authorizes operation of IP2
NRC	10 CFR Part 50	Operating license, IP3	DPR-64		12/10/15	Authorizes operation of IP3
DOT	49 CFR 107	IP2 Hazardous Materials Certificate of Registration	062706552061 0Q		06/30/09	Radioactive and hazardous materials shipments
DOT	49 CFR 107	IP3 Hazardous Materials Certificate of Registration	062706552069 0Q		06/30/09	Radioactive and hazardous materials shipments
EPA	40 CFR Part 264	IP2 Hazardous Solid Waste Amendment Permit	NYD991304411		10/14/02	Accumulation and temporary onsite storage of mixed waste for >90 days
EPA	40 CFR Part 264	IP3 Hazardous Solid Waste Amendment Permit	NYD085503746		10/17/01	Accumulation and temporary onsite storage of mixed waste for >90 days

Appendix E

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NYSDE C	6 NYCRR Part 325	IP2 Pesticide Application Business Registration	12696		04/30/09	Pesticide application
NYSDE C	6 NYCRR Part 325	IP3 Pesticide Application Business Registration	13163		04/30/09	Pesticide application
NYSDE C	6 NYCRR Parts 704 and 750	IP1, 2, and 3 SPDES Permit	NY 000 4472		10/01/92	Discharge of wastewaters and stormwaters to waters of the State
NYSDE C	6 NYCRR Part 704	Simulator Transformer Vault SPDES Permit	NY 025 0414		03/01/08	Discharge of wastewaters to waters of the State
NYSDE C	6 NYCRR Part 704	Tank Farm SPDES Permit	NY 025 1135		02/10/10	Discharge of wastewaters to waters of the State
NYSDE C	6 NYCRR Part 704	Buchanan Gas Turbine SPDES Permit	NY 022 4826		03/01/08	Discharge of wastewaters to waters of the State
NYSDE C	6 NYCRR Part 750	ISFSI Stormwater SPDES General Permit for Construction Activities	NYR 10H166		NA	Stormwater discharge during construction of dry cask spent fuel storage
NYSDE C	6 NYCRR Parts 200 and 201	IP2 Air Permit	3-5522-00011/00026		NA	Operation of air emission sources (boilers, turbines and generators)
NYSDE C	6 NYCRR Parts 200 and 201	IP3 Air Permit	3-5522-00105/00009		NA	Operation of air emission sources (boilers, turbines and generators)
NYSDE C	6 NYCRR Part 596	IP2 Hazardous Substance Bulk Storage Registration Certificate	3-000107		09/04/07	Onsite bulk storage of hazardous substances
NYSDE C	6 NYCRR Part 596	IP3 Hazardous Substance Bulk Storage Registration Certificate	3-000071		08/16/08	Onsite bulk storage of hazardous substances

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NYSDE C	6 NYCRR Part 610	IP2 Major Oil Storage Facility	3-2140		--	Onsite bulk storage of >400,000 gallons of petroleum products
NYSDE C	6 NYCRR Part 372	IP2 Hazardous Waste Generator Identification	NYD000765073		NA	Hazardous waste generation
NYSDE C	6 NYCRR Part 372	IP3 Hazardous Waste Generator Identification	NYD000765073		NA	Hazardous waste generation
NYSDE C	6 NYCRR Part 373	IP2 Hazardous Waste Part 373 Permit	NYD991304411		02/28/07	Accumulation and temporary onsite storage of mixed waste for >90 days
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP2 Gas Turbine 1 Air Permit	#00021	NA	12/31/06	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP2 Gas Turbine 2 Air Permit	#00022	NA	12/31/06	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP2 Gas Turbine 3 Air Permit	#00023	NA	12/31/06	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP2 Boiler Permit	52-4493		NA	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP2 Vapor Extractor Air Permit	52-5682		12/31/06	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP3 Boiler Permit	52-6497		NA	Operation of an air contamination source

Appendix E

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP3 Training Center Boiler Permit	52-6498		NA	Operation of an air contamination source
WCDO H	Chapter 873, Article XIII, Section 873.1306.1 of the Laws of Westchester County	IP3 Vapor Extractor Air Permit	--		--	Operation of an air contamination source
WCDO H	Westchester County Sanitary Code, Article XXV	IP3 Petroleum Bulk Storage Registration Certificate	3-166367		09/10/07	Onsite Bulk Storage of Petroleum Products
SCDHE C	Act No. 429 of 1980, South Carolina Radioactive Waste Transportation and Disposal Act	IP2 South Carolina Radioactive Waste Transport Permit	0019-31-07		12/31/07	Transportation of radioactive waste into the State of South Carolina.
SCDHE C	Act No. 429 of 1980, South Carolina Radioactive Waste Transportation and Disposal Act	IP3 South Carolina Radioactive Waste Transport Permit	0072-31-07		12/31/07	Transportation of radioactive waste into the State of South Carolina.
TDEC	Tennessee Department of Environment and Conservation Regulations	IP2 Tennessee Radioactive Waste-License-for-Delivery	T-NY-010-L07		12/31/07	Shipment of radioactive material into Tennessee to a disposal/processing facility.
TDEC	Tennessee Department of Environment and Conservation Regulations	IP3 Tennessee Radioactive Waste-License-for-Delivery	T-NY-005-L07		12/31/07	Shipment of radioactive material into Tennessee to a disposal/processing facility.

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
^(a) Application pending.						
CFR	=	<i>Code of Federal Regulations</i>				
DOT	=	U.S. Department of Transportation				
NA	=	not applicable				
NRC	=	U.S. Nuclear Regulatory Commission				
NYCRR	=	New York Codes, Rules, and Regulations				
NYSDEC	=	New York State Department of Environmental Conservation				
SCDHEC	=	South Carolina Department of Health and Environmental Control				
SPDES	=	State Pollutant Discharge Elimination System				
TDEC	=	Tennessee Department of Environment and Conservation				
USC	=	<i>United States Code</i>				
WCDOH	=	Westchester County Department of Health				

Appendix E

August 9, 2007

Ms. Ruth L. Pierpont, Director
New York State Office of Parks, Recreation
and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, P.O. Box 189
Waterford, NY 12188-0189

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3 (INDIAN POINT)
LICENSE RENEWAL APPLICATION REVIEW (SHPO NO. 06PR06720)

Dear Ms. Pierpont:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for Indian Point, which is located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is operated by Entergy Nuclear Operations, Inc. (Entergy). The application for renewal was submitted by Entergy by letter dated April 23, 2007, and supplemented by letters dated May 3, and June 21, 2007, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8(c), the SEIS will include analyses of potential impacts to historic and cultural resources.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land-disturbing operations or projected refurbishment activities specifically related to license renewal may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

On September 19, 2007, the NRC will conduct two public NEPA scoping meetings at the Colonial Terrace, located at 119 Oregon Road in Cortlandt Manor, NY. You and your staff are invited to attend. Your office will receive a copy of the draft SEIS along with a request for comments. The staff expects to publish the draft SEIS in July 2008.

R. Pierpont

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If you have any questions or require additional information, please contact Ms. Jill Caverly, Environmental Project Manager, by phone at 301-415-6699 or by email at jsc1@nrc.gov.

Sincerely,

/RA/

Rani Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 9, 2007

Mr. Don L. Klima, Director
Advisory Council on Historic Preservation
Office of Federal Agency Programs
1100 Pennsylvania Ave, NW, Suite 803
Washington, DC 20004

SUBJECT: INDIAN POINT GENERATING UNIT NOS. 2 & 3 LICENSE RENEWAL
APPLICATION REVIEW

Dear Mr. Klima:

The U.S. Nuclear Regulatory Commission (NRC and the staff) is reviewing an application to renew the operating licenses for Indian Point Generating Unit Nos. 2 & 3 (Indian Point) which is located in Buchanan, New York, approximately 24 miles north of the New York City boundary line. Indian Point is operated by Entergy Nuclear Operations, Inc. (Entergy). The application for renewal was submitted by Entergy by letter dated April 23, 2007, and supplemented by letters dated May 3, and June 21, 2007, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8(c), the SEIS will include analyses of potential impacts to historic and cultural resources.

The NRC staff plans to hold two public NEPA scoping meetings on September 19, 2007, at Colonial Terrace, located at 119 Oregon Road in Cortlandt Manor, New York. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 10:00 p.m., as necessary. In addition, staff will conduct a site audit September 10-14, 2007, at Indian Point. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is late July 2008.

D. Klima

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If you have any questions or require additional information, please contact the Environmental Project Manager, Ms. Jill Caverly at 301-415-6699 or via e-mail at jsc@nrc.gov.

Sincerely,

/RA/

Rani Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-268

cc: See next page

Appendix E

August 16, 2007

Mr. David Stillwell
Field Supervisor
U.S. Fish and Wildlife Service
New York Field Office
3817 Luker Road
Cortland, NY 13045

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER
EVALUATION FOR THE INDIAN POINT NUCLEAR GENERATING UNIT NOS.
2 & 3 LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. David Stillwell:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Entergy Nuclear Operations, Inc., for the renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 & 3 (Indian Point). Indian Point is located in Buchanan, New York, approximately 24 miles north of the New York City boundary line. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action is to renew the facility operating licenses for Indian Point for an additional 20 years beyond the expiration of the current operating licenses. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The Indian Point site covers approximately 239 acres. Indian Point is bordered on the north, south and east by partially wooded privately owned land and on the west by the Hudson River. Enclosures 1 and 2 provide a general overview of the site location and site layout.

Indian Point is equipped with a once-through open-cycle cooling system that withdraws cooling water from and discharges back into the Hudson River. The intake system includes seven bays for each unit located at the shore. Six 96-inch pipes discharge water beneath the water's surface within a 40-foot wide discharge canal.

The transmission lines in the scope of NRC's environmental review for license renewal are those that were originally constructed for the specific purpose of connecting the plant to the transmission system. The transmission line corridor to the Buchanan Substation (approximately 2100 feet southeast from the reactors, just across Broadway from the facility's main entrance) is located in the industrial portion of the site, except for where the lines cross Broadway. This transmission line corridor is being evaluated as part of the environmental review process.

D. Stillwell

-2-

The enclosed transmission line map shows the transmission system that is being evaluated in the SEIS. Two 345-kilovolt (kV) lines connect Indian Point to the Buchanan Substation. This corridor also includes 138-kV transmission lines that supply offsite power from the substation into Indian Point.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally-listed, proposed, and candidate species and critical habitat that may be in the vicinity of Indian Point and its associated transmission line rights-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The NRC staff plans to hold two public NEPA scoping meetings on September 19, 2007, at Colonial Terrace, located at 119 Oregon Road in Cortlandt Manor, New York. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 10:00 p.m., as necessary. In addition, the NRC staff plans to conduct a site audit at Indian Point during the week of September 10, 2007. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is late July 2008.

If you have any questions concerning the NRC staff's review of this LRA, please contact Ms. Jill Caverly, Project Manager, at 301-415-8450 or via e-mail at jsc1@nrc.gov.

Sincerely,

/RA/

Rani Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:

1. Site Location
2. Site Layout

cc w/encls: See next page

August 16, 2007

Mr. Peter Colosi
Habitat Conservation Coordinator
National Marine Fisheries Service
One Blackburn Drive
Glouster, MA 01930

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND ESSENTIAL FISH
HABITAT WITHIN THE AREA UNDER EVALUATION FOR THE INDIAN POINT
NUCLEAR GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL
APPLICATION REVIEW

Dear Mr. Colosi:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Entergy Nuclear Operations, Inc. for the renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point). Indian Point is located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to marine resources and habitat. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended; the Fish and Wildlife Coordination Act of 1934, as amended; and the Sustainable Fisheries Act of 1996.

The proposed action is to renew the facility operating licenses for Indian Point for an additional 20 years beyond the expiration of the current operating licenses. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The Indian Point site covers approximately 239 acres. Indian Point is bordered on the north, south and east by partially wooded privately owned land and on the west by the Hudson River. Enclosures 1 and 2 provide a general overview of the site location and site layout.

Indian Point is equipped with a once-through open-cycle cooling system that withdraws cooling water from and discharges back into the Hudson River. The intake system includes seven bays for each unit located at the shore. Six 96-inch pipes discharge water beneath the water's surface within a 40-foot wide discharge canal.

P. Colosi

-2-

The transmission lines in the scope of NRC's environmental review for license renewal are those that were originally constructed for the specific purpose of connecting the plant to the transmission system. The transmission line corridor to the Buchanan Substation (approximately 2100 feet southeast from the reactors, just across Broadway from the facility's main entrance) is located in the industrial portion of the site, except for where the lines cross Broadway. This transmission line corridor is being evaluated as part of the SEIS process. The enclosed transmission line map shows the transmission system that is being evaluated in the SEIS. Two 345-kilovolt (kV) lines connect Indian Point to the Buchanan Substation. This corridor also includes 138-kV transmission lines that supply offsite power from the substation into Indian Point.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally listed, proposed, and candidate species and critical habitat that may be in the vicinity of the Indian Point site. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also, in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of essential fish habitats that have been designated in the vicinity of the Indian Point site.

On September 19, 2007, the NRC staff plans to hold two public NEPA scoping meetings at the Colonial Terrace, located at 119 Oregon Rd. in Cortlandt Manor, NY. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. The NRC staff plans to conduct a site audit at the Indian Point site during the week of September 10, 2007. You and your staff are invited to attend both the public meetings and the site audit. In addition, your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is July 2008.

If you have any questions concerning the NRC staff review of this LRA, please contact Ms. Jill Caverly, Project Manager at 301-415-6699 or jsc1@nrc.gov.

Sincerely,

/RA/

Rani Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:
As stated

cc w/encls: See next page

Appendix E

August 24, 2007

Mr. Andy Warrior
Director, Cultural Preservation
Absentee Shawnee Tribe of Oklahoma
2025 S. Gordon Cooper Drive
Shawnee, OK 74801

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Mr. Warrior:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Absentee Shawnee Tribe of Oklahoma. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Absentee Shawnee Tribe of Oklahoma to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

A. Warrior

-2-

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the Indian Point license renewal supplement to the GEIS on Wednesday, September 19, 2007, at The Colonial Terrace, located at 119 Oregon Rd. in Cortlandt Manor, NY. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at <http://adamswebsearch.nrc.gov/dologin.html>. The accession number for the LRA is ML071210507. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at pdr@nrc.gov.

The Indian Point LRA is also available on the Internet at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html>. In addition, the Hendrick Hudson Free Library, located in Montrose, NY, the Field Library, located in Peekskill, NY, and the White Plains Public Library located in White Plains, NY, have agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Absentee Shawnee Tribe of Oklahoma may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

Appendix E

A. Warrior

-3-

The staff expects to publish the draft supplement to the GEIS in July 2008. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for Indian Point is planned for April 2009. If you need additional information regarding the environmental review process, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or at jsc1@nrc.gov.

Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

The Honorable Maurice John, President
Cattaraugus Reservation, Seneca Nation
140 Rt. 438
Irving, NY 14081

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear President John:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Cattaraugus Reservation, Seneca Nation. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Cattaraugus Reservation, Seneca Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Appendix E

M. John

-2-

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the Indian Point license renewal supplement to the GEIS on Wednesday, September 19, 2007, at The Colonial Terrace, located at 119 Oregon Rd. in Cortlandt Manor, NY. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at <http://adamswebsearch.nrc.gov/dologin.html>. The accession number for the LRA is ML071210507. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at pdr@nrc.gov.

The Indian Point LRA is also available on the Internet at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html>. In addition, the Hendrick Hudson Free Library, located in Montrose, NY, the Field Library, located in Peekskill, NY, and the White Plains Public Library located in White Plains, NY, have agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Cattaraugus Reservation, Seneca Nation may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

M. John

-3-

The staff expects to publish the draft supplement to the GEIS in July 2008. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for Indian Point is planned for April 2009. If you need additional information regarding the environmental review process, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or at jsc1@nrc.gov.

Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

Mr. Clint Halftown
Representative
Cayuga Nation
P.O. Box 11
Versailles, NY 14168

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Mr. Halftown:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Cayuga Nation. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Cayuga Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

C. Halftown

-2-

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Appendix E

C. Halftown

-3-

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Ms. Nikki Owings-Crumm
Environmental Director
Delaware Nation
P.O. Box 825
Andarko, OK 73005

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Ms. Owings-Crumm:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Delaware Nation. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Delaware Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

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Appendix E

N. Owings-Crumm

-2-

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N. Owings-Crumm

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

The Honorable Jerry Douglas, Chief
Delaware Tribe of Indians
Delaware Tribal Headquarters
170 North East Barbara
Bartlesville, OK 74006

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chief Douglas:

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J. Douglas

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Appendix E

J. Douglas

-3-

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

The Honorable C.W. Longlow, Chief
Echota Chickamauga Cherokee Tribe
of New Jersey
1164 Stuyvesant Avenue
Irvington, NJ 07111

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chief Longlow:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Echota Chickamauga Cherokee Tribe of New Jersey. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Echota Chickamauga Cherokee Tribe of New Jersey to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Appendix E

C.W. Longlow

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The Indian Point LRA is also available on the Internet at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html>. In addition, the Hendrick Hudson Free Library, located in Montrose, NY, the Field Library, located in Peekskill, NY, and the White Plains Public Library located in White Plains, NY, have agreed to make the LRA available for public inspection.

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Please submit any comments that the Echota Chickamauga Cherokee Tribe of New Jersey may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

C.W. Longlow

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

The Honorable Michael Thomas, Chairman
Mashantucket Pequot Tribe
110 Pequot Trail
P.O. Box 3180
Mashantucket, CT 06339

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chairman Thomas:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Mashantucket Pequot Tribe. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Mashantucket Pequot Tribe to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

M. Thomas

-2-

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The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Mashantucket Pequot Tribe may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

Appendix E

M. Thomas

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Ms. Jeanne Schbotte
Mohegan Tribe
5 Crow Hill Road
Uncasville, CT 06382

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Ms. Schbotte:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Mohegan Tribe. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Mohegan Tribe to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

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Appendix E

J. Schbotte

-2-

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

Mr. Ray Halbritter, Nation Representative
Oneida Indian Nation of New York
Genessee Street, Ames Plaza
Oneida, NY 13421

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Mr. Halbritter:

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R. Halbritter

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Appendix E

R. Halbritter

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/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Council of Chiefs
Onondaga Nation
258 C Route 11a
Onondaga Nation
Nedrow, NY 13120

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Council Members:

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Council of Chiefs

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Council of Chiefs

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/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

The Honorable Dwaine Perry, Chief
Ramapough Lenape
Ramapough Tribal Office
189 Stag Hill Road
Mahwah, NJ 07430

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

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Appendix E

D. Perry

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Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Mr. Mike John
Conservationist
Seneca Nation of Indians
P.O. Box 231
Salamanca, NY 14479

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Mr. John:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Seneca Nation of Indians. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Seneca Nation of Indians to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Appendix E

M. John

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To accommodate interested members of the public, the NRC will hold two public scoping meetings for the Indian Point license renewal supplement to the GEIS on Wednesday, September 19, 2007, at The Colonial Terrace, located at 119 Oregon Rd. in Cortlandt Manor, NY. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at <http://adamswebsearch.nrc.gov/dologin.html>. The accession number for the LRA is ML071210507. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at pdr@nrc.gov.

The Indian Point LRA is also available on the Internet at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html>. In addition, the Hendrick Hudson Free Library, located in Montrose, NY, the Field Library, located in Peekskill, NY, and the White Plains Public Library located in White Plains, NY, have agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Seneca Nation of Indians may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

M. John

-3-

The staff expects to publish the draft supplement to the GEIS in July 2008. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for Indian Point is planned for April 2009. If you need additional information regarding the environmental review process, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or at isc1@nrc.gov.

Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Mr. Randy Kind, Chairman
Shinnecock Tribe
Rte 27-A, Montauk Hwy
Southampton, NY 11968

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chairman Kind:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Shinnecock Tribe. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Shinnecock Tribe to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

R. Kind

-2-

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Please submit any comments that the Shinnecock Tribe may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

Appendix E

R. Kind

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

The Honorable Harry B. Wallace, Chief
Unkechaug Nation
P.O. Box 86
Mastic, New York 11950

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chief Wallace:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Unkechaug Nation. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Unkechaug Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

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Appendix E

H. Wallace

-2-

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H. Wallace

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Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

The Honorable Leo Henry, Chief
Tuscarora Nation
5616 Walmore Road
Lewiston, New York 14092

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chief Henry:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Units No. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Tuscarora Nation. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Tuscarora Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

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L. Henry

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Appendix E

L. Henry

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/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

DISTRIBUTION: See next page

August 24, 2007

The Honorable Roger Hill, Chief
Tonawanda Band of Senecas
7027 Meadville Road
Bason, New York 14013

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Chief Hill:

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R. Hill

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R. Hill

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/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Appendix E

August 24, 2007

Ms. Sherry White
Tribal Historic Preservation Officer
Stockbridge-Munsee Community Band of
Mohican Indians
W13447 Camp 14 Road
Bowler, WI 54416

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Ms. White:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the Stockbridge-Munsee Community Band of Mohican Indians. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the Stockbridge-Munsee Community Band of Mohican Indians to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

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S. White

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Appendix E

S. White

-3-

The staff expects to publish the draft supplement to the GEIS in July 2008. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for Indian Point is planned for April 2009. If you need additional information regarding the environmental review process, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or at jsc1@nrc.gov.

Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

August 24, 2007

Mr. Ken Jock
Council Member
St. Regis Mohawk Tribal Council
412 State Route 37
Akwesasne, NY 13655

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE INDIAN POINT NUCLEAR
GENERATING UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION
REVIEW

Dear Mr. Jock:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Entergy Nuclear Operations (Entergy) for the renewal of the operating licenses for the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point), located in Buchanan, NY, approximately 24 miles north of the New York City boundary line. Indian Point is in close proximity to lands that may be of interest to the St. Regis Mohawk Tribal Council. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, Section 51.28(b), the NRC invites the St. Regis Mohawk Tribal Council to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for Indian Point will expire in September, 2013, and December, 2015. Entergy submitted its application for renewal of the Indian Point operating licenses in a letter dated April 23, 2007, as supplemented by letters dated May 3 and June 21, 2007.

The NRC is gathering information for an Indian Point site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the Indian Point site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Appendix E

K. Jock

-2-

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the Indian Point license renewal supplement to the GEIS on Wednesday, September 19, 2007, at The Colonial Terrace, located at 119 Oregon Road in Cortlandt Manor, NY. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at <http://adamswebsearch.nrc.gov/dologin.htm>. The accession number for the LRA is ML071210507. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at pdrr@nrc.gov.

The Indian Point LRA is also available on the Internet at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html>. In addition, the Hendrick Hudson Free Library, located in Montrose, NY, the Field Library, located in Peekskill, NY, and the White Plains Public Library located in White Plains, NY, have agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the St. Regis Mohawk Tribal Council may have to offer on the scope of the environmental review by October 12, 2007. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at IndianPointEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

K. Jock

-3-

The staff expects to publish the draft supplement to the GEIS in July 2008. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for Indian Point is planned for April 2009. If you need additional information regarding the environmental review process, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or at isc1@nrc.gov.

Sincerely,

/RA Christian Jacobs for/

Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

cc: See next page

Delaware Nation
Environmental Programs

P.O. Box 825
Anadarko, OK 73005
405 / 247-2448 x 137
Fax: 405 / 247-9393

RECEIVED

2007 SEP 12 AM 9:57

RULES AND DIRECTIVES
BRANCH
15730

September 5, 2007

5/11/07
70 FR 26850
(2)

U.S. Nuclear Regulatory Commission
Chief of Rules and Directives Branch
Division of Administrative Services
Mail Stop T-6D59
Washington, D.C. 20555-0001

Re: Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal Application Review

Dear Sir:

I am writing in regard to your letter dated August 24, 2007 requesting comments concerning the Indian Point Nuclear Generating Unit Nos. 2 and 3 license renewal application review. As mentioned in the environmental report, the Delaware people were one of the aboriginal entities located in the Hudson-Mohawk Basin in the early 17th century and should have been one of the initial consulting parties. As one of the aboriginal entities, we are very interested in being a part of the review process not only for cultural preservation but for environmental protection as well.

In order for Delaware Nation personnel to be thoroughly informed about this project and to provide comments we would like to request status as a consulting party. With this status, we are confident that you would be able to forward a copy of all formal documents sent to all consulting parties prior to the August 24, 2007 letter we received. It is important to the Delaware Nation that all cultural sites are properly maintained and the environmental impacts be reviewed before further action is taken.

Thank you for contacting the Delaware Nation to be included in the review of this application renewal. We look forward to your quick response and receipt of the documents requested to continue a productive relationship with your organization. If you have any questions or require additional information, you may contact Mrs. Danieala Nieto, Acting Director of Environmental Programs and/or Ms. Tamara Francis, Cultural Preservation Director by telephone at (405) 247-2448 or by fax at (405) 247-9393.

Sincerely,

Danieala Nieto

Danieala Nieto, Air Program Coordinator and Acting Director
Delaware Nation of Oklahoma Environmental Programs

cc: Tamara Francis, Cultural Preservation Director
Orvel Gibson, Tribal Administrator

SONSI Review Complete
Template = ADM-013

FRIDS = ADM-03
Cell = No Phone (bump)

Jill Caverly - Indian Point Nuclear Generating Unit Nos. 2 and 3 Protected Species Response

From: <MaryEllen_VanDonsel@fws.gov>
To: <jsc1@nrc.gov>
Date: 08/29/2007 11:06 AM
Subject: Indian Point Nuclear Generating Unit Nos. 2 and 3 Protected Species Response

Please see the attached file for our response from the U.S. Fish and Wildlife Service.

MaryEllen VanDonsel
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045
Phone: 607-753-9334
Fax: 607-753-9699



United States Department of the Interior

FISH AND WILDLIFE SERVICE

New York Field Office

3817 Laker Road

Cortland, NY 13045

Phone: (607) 753-9334 Fax: (607) 753-9699

<http://www.fws.gov/northeast/nyfo>Project Number: 70193To: Rani FranovichDate: 8-29-07Regarding: Indian Point Nuclear Generating Units 2 and 3Town/County: Buchanan / Westchester

We have received your request for information regarding occurrences of Federally-listed threatened and endangered species within the vicinity of the above-referenced project/property. Due to increasing workload and reduction of staff, we are no longer able to reply to endangered species list requests in a timely manner. In an effort to streamline project reviews, we are shifting the majority of species list requests to our website at <http://www.fws.gov/northeast/nyfo/es/section7.htm>. Please go to our website and print the appropriate portions of our county list of endangered, threatened, proposed, and candidate species, and the official list request response. Step-by-step instructions are found on our website.

As a reminder, Section 9 of the Endangered Species Act (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) prohibits unauthorized taking* of listed species and applies to Federal and non-Federal activities. Additionally, endangered species and their habitats are protected by Section 7(a)(2) of the ESA, which requires Federal agencies, in consultation with the U.S. Fish and Wildlife Service (Service), to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. An assessment of the potential direct, indirect, and cumulative impacts is required for all Federal actions that may affect listed species. For projects not authorized, funded, or carried out by a Federal agency, consultation with the Service pursuant to Section 7(a)(2) of the ESA is not required. However, no person is authorized to "take"* any listed species without appropriate authorizations from the Service. Therefore, we provide technical assistance to individuals and agencies to assist with project planning to avoid the potential for "take," or when appropriate, to provide assistance with their application for an incidental take permit pursuant to Section 10(a)(1)(B) of the ESA.

Project construction or implementation should not commence until all requirements of the ESA have been fulfilled. If you have any questions or require further assistance regarding threatened or endangered species, please contact the Endangered Species Program at (607) 753-9334. Please refer to the above document control number in any future correspondence.

Endangered Species Biologist: Robyn A. Niver RAN

*Under the Act and regulations, it is illegal for any person subject to the jurisdiction of the United States to *take* (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import or export, ship in interstate or foreign commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any endangered fish or wildlife species and most threatened fish and wildlife species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. "Harm" includes any act which actually kills or injures fish or wildlife, and case law has clarified that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife.

New York State Department of Environmental Conservation

Office of General Counsel, 14th Floor
625 Broadway, Albany, New York 12233-1500
FAX: (518) 402-9018 or (518) 402-9019
Website: www.dec.ny.gov



October 5, 2007

Via e-mail and Regular First Class Mail

Mr. Bo Pham
Senior Project Manager - Indian Point Relicensing Application
Division of License Renewal
Mail Stop 0-7B1
United States Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

**Re: Indian Point Units 2 and 3 Relicensing
Extension Request for Scoping Comments on SEIS**

Dear Mr. Pham:

The State of New York respectfully requests an extension until October 31, 2007, in which to file written Scoping Comments on the draft Supplemental Environmental Impact Statement (SEIS) that the Nuclear Regulatory Commission (NRC) is preparing in conjunction with the relicensing application filed by Entergy Nuclear Operations, Inc., for the Indian Point nuclear power plants (Indian Point 2 and Indian Point 3) in Buchanan, New York.

The State has been working diligently to prepare its comments. As you know, the Department of Environmental Conservation has assumed the role of coordinating with other State Executive Agencies on the relicensing application. The Executive Agencies are also working closely with the State Attorney General's Office on the relicensing application. The additional time will allow for more efficient coordination on the scoping comments.

Moreover, the NRC has extended the deadline until November 30, 2007, in which to file a Request for a Hearing/Petition for Leave to Intervene on the relicensing application. The State is thus in the process of identifying environmental issues to raise as contentions. Without question, that process is related to the drafting of comments on the SEIS. Extending the deadline to file Scoping Comments will more closely coordinate with the State's efforts on the Request for a Hearing/Petition for Leave to Intervene.

Appendix E

Finally, Joan Matthews, the lead counsel for the State Executive Agencies, has had a significant family medical emergency since Labor Day, which only this week appears to be resolving, allowing her to once again devote her full attention to this matter.

Please feel to contact either one of us if you have any questions about this request.

Respectfully submitted,


JOAN LEARY MATTHEWS
Senior Attorney for Special Projects
New York State Department of
Environmental Conservation
518-402-9190
jlmathe@gw.dec.state.ny.us


JOHN SIPOS
Assistant Attorney General
New York State Department of Law
Environmental Protection Bureau
The Capitol
Albany, NY 12224
518-402-2251
john.sipos@oag.state.ny.us

New York State Department of Environmental Conservation

Office of General Counsel, 14th Floor
625 Broadway, Albany, New York 12233-1500
FAX: (518) 402-9018 or (518) 402-9019
Website: www.dec.ny.gov



Alexander B. Grannis
Commissioner

October 10, 2007

Via e-mail and Regular First Class Mail

Mr. Bo Pham
Senior Project Manager - Indian Point Relicensing Application
Division of License Renewal
Mail Stop 0-7B1
United States Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

**Re: Indian Point Units 2 and 3 Relicensing
Extension Request for Scoping Comments on SEIS**

Dear Mr. Pham:

Thank you for your telephone call yesterday in response to the State of New York's request to submit scoping comments by October 31, 2007, on the above matter. This letter is to confirm that the State will submit its scoping comments by October 31, 2007, and that the NRC will consider these comments. These written comments will be in addition to the oral comments that the New York Department of Environmental Conservation and the New York Department of Law provided at the scoping session on September 19, 2007. We very much appreciate this accommodation.

Respectfully submitted,

JOAN LEARY MATTHEWS
Senior Attorney for Special Projects
New York State Department of
Environmental Conservation
518-402-9190
jlmатhe@gw.dec.state.ny.us

JOHN SIPOS
Assistant Attorney General
New York State Department of Law
Environmental Protection Bureau
The Capitol
Albany, NY 12224
518-402-2251
john.sipos@oag.state.ny.us

EDMS #280184

Appendix E

October 11, 2007

Joan Leary Matthews
Senior Attorney for Special Projects
New York State Department of Environmental Conservation
Office of General Counsel, 14th Floor
625 Broadway
Albany, NY 12233-1500

Dear Ms. Matthews:

I am responding to your letter of October 5, 2007, in which you requested an extension until October 31, 2007, to file written scoping comments for the environmental impact statement that the U.S. Nuclear Regulatory Commission (NRC) will be preparing as part of its review of the Indian Point Nuclear Generating, Unit Nos. 2 and 3, license renewal application.

The NRC staff has considered your request, but has determined that an extension of the comment period is not warranted. As you know, a Notice was published in the *Federal Register* on August 10, 2007, inviting members of the public to attend the environmental scoping meeting scheduled for September 19, 2007, and providing an opportunity for interested persons to submit written scoping comments during a two-month period following publication of the Notice (72 FR 45075). As stated in the *Federal Register*, written scoping comments should be submitted no later than October 12, 2007, to be considered in the scoping process. Numerous comments have been submitted to the NRC, during the scoping meeting and in writing, and we anticipate further written comments before the end of the comment period. Nonetheless, the NRC will consider comments received after such date, to the extent that it is practicable to do so. We encourage you to submit your written scoping comments at your earliest opportunity.

Thank you for your interest and participation in the license renewal process.

Sincerely,

/RA by Jill Caverly for/
Bo M. Pham, Senior Project Manager
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

cc: See next page



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

OCT -4 2007

Chief, Rules and Directives Branch
Division of Administrative Services
Office of Administration
Mailstop T-6D59
US Nuclear Regulatory Commission
Washington, DC 20555-0001

Docket 50-247
50-286

Re: 72 FR45075-6 (August 10, 2007)

To Whom It May Concern:

These comments are submitted by the Protected Resources Division (PRD) of NOAA's National Marine Fisheries Service (NMFS) regarding the application for renewal of Facility Operating Licenses DPR-26 and DPR-64 for an additional 20 years of operation at Indian Point Nuclear Generating Unit Nos. 2 and 3. A request for comments related to the Nuclear Regulatory Commission's (NRC) intent to prepare an Environmental Impact Statement (EIS) and conduct the scoping process pursuant to the National Environmental Policy Act (NEPA) was published in the Federal Register on August 10, 2007.

A population of federally endangered shortnose sturgeon (*Acipenser brevirostrum*) occurs in the Hudson River. Additionally, Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are also present in the Hudson River. Atlantic sturgeon are considered a Candidate Species as NMFS has initiated a status review for this species to determine if listing as threatened or endangered under the ESA is warranted. A status review report was completed by the status review team in February 2007. NMFS is currently reviewing the report and other available information to determine if listing under the ESA is warranted. A listing determination, and, if listing is warranted, any accompanying proposed rule(s), is expected to be published by NMFS in 2008. If it is determined that listing is warranted, a listing determination and final rule listing the species could be published within a year from the date of publication of the listing determination or proposed rule. The Status Review report is available at:
http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/AtlSturgeonStatusReviewReport.pdf.

NMFS has several concerns regarding the potential for the continued operation of the Indian Point facility to affect sturgeon. NMFS' primary concern is the likelihood of impingement of



Appendix E

sturgeon on screens or racks at plant intakes. Information provided in the application by Dynegy for an Endangered Species Act (ESA) Section 10(a)(1)(B) permit for their Roseton and Danskammer plants indicated that from 1972-1998, 37 shortnose sturgeon were impinged at Indian Point Unit 2 and from 1976-1998, 26 shortnose sturgeon were impinged at Indian Point Unit 3. It is NMFS understanding that no monitoring of the intakes has occurred since screening and a fish return system were installed in 1998. While the screening and fish return system were designed to minimize entrainment and reduce the levels of injury and mortality associated with impingement, no studies have been conducted to demonstrate the effectiveness of these systems for sturgeon. While NMFS has no information on likely impingement rates since 1998, we also have no information that suggests it no longer occurs. Shortnose sturgeon impinged on intake screens or racks experience high levels of injury and/or mortality.

Sturgeon yolk sac larvae (YSL) and post yolk sac larvae (PYSL) have been documented in the vicinity of Indian Point. Given that two distinct distributions of YSL and PYSL have been identified in the river (above RM 120 and RM 48 to 110), it is assumed that the larvae in the lower river grouping are Atlantic sturgeon. As such, entrainment is a significant concern for Atlantic sturgeon in this area of the river.

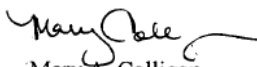
The best available information suggests that unauthorized take (as defined in Section 9 of the ESA) has occurred in the past at the Indian Point facility and may continue to occur. Additionally, Atlantic sturgeon eggs and/or larvae are likely to be present in this region of the river and may be subject to entrainment in the facility's intakes. Both shortnose and Atlantic sturgeon may also be affected by the discharge of heated effluent, chlorine, and other pollutants or antifouling agents.

Section 7(a)(2) of the ESA states that each Federal agency shall, in consultation with the Secretary, insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species must undergo section 7 consultation. The relicensing of Indian Point by the NRC is a federal action that will require section 7 consultation. If it is determined through consultation between the NRC and NMFS that the action is likely to adversely affect any listed species (i.e., if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effects are not: discountable, insignificant, or beneficial) then a formal consultation, resulting in the issuance of a Biological Opinion and accompanying Incidental Take Statement would be required.

Any NEPA documentation prepared by NRC relating to the relicensing of this facility should contain an assessment of the facility's impact on shortnose and Atlantic sturgeon. Additionally, NMFS expects the NRC to initiate section 7 consultation with NMFS on the effects of the proposed action on listed species. In order to conduct a consultation, NMFS will need a complete project description and a complete assessment of the facility's impacts on listed species. NMFS expects that this assessment will include an estimate of the number of shortnose sturgeon likely to be impinged and/or entrained at the facility's intakes over the life of the proposed 20 year license. This information should be submitted to NMFS along with a request for concurrence with NRC's determination of effects and justification for that determination.

My staff looks forward to working cooperatively with the NRC during the relicensing process. Should you have any questions regarding shortnose sturgeon or the section 7 process in general, please contact Pat Scida, Endangered Species Coordinator (978-281-9208 or Pasquale.Scida@noaa.gov). For questions specific to Atlantic sturgeon, please contact Kim Damon-Randall, Proactive Conservation Program Coordinator (978-281-9300 x6535).

Sincerely,



Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

Cc: Nash, NRC
Crocker, Damon-Randall - F/NER4
Rusanowsky, Colosi - F/NER3
Lindow, F

File Code: Sec 7 NRC Indian Point Relicensing
PCTS: T/NER/2006/07100

Appendix E

November 27, 2007

Ms. Jean Pietrusiak
New York State Department of the Environment
NYDEC-DFWMR
NY Natural Heritage Program – Information Services
625 Broadway, 5th Floor
Albany, NY 12233-4757

SUBJECT: REQUEST FOR LIST OF STATE PROTECTED SPECIES WITHIN THE AREA
UNDER EVALUATION FOR THE INDIAN POINT NUCLEAR GENERATING
UNIT NOS. 2 AND 3 LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Pietrusiak:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Entergy Nuclear Operations, Inc. (Entergy), for the renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point). Indian Point is located in Buchanan, New York, approximately 24 miles north of the New York City boundary line. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action is to renew the facility operating licenses for Indian Point for an additional 20 years beyond the expiration of the current operating licenses. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The Indian Point site covers approximately 239 acres. Indian Point is bordered on the north, south and east by partially wooded, privately owned land and on the west by the Hudson River. Enclosures 1 and 2 provide a general overview of the site location and site layout.

Indian Point is equipped with a once-through open-cycle cooling system that withdraws cooling water from, and discharges water back into, the Hudson River. The intake system includes seven bays for each unit located at the shore. Six 96-inch pipes discharge water beneath the river's surface within a 40-foot wide discharge canal.

The transmission lines in the scope of NRC's environmental review for license renewal are those that were originally constructed for the specific purpose of connecting the plant to the transmission system. The transmission line corridor to the Buchanan Substation (approximately 2100 feet southeast from the reactors, just across Broadway from the facility's main entrance) is located in the industrial portion of the site, except for where the lines cross Broadway. This transmission line corridor is being evaluated as part of the SEIS process.

The enclosed transmission line map shows the transmission system that is being evaluated in the SEIS. Two 345-kilovolt (kV) lines connect Indian Point to the Buchanan Substation. This

J. Pietrusiak

- 2 -

corridor also includes 138-kV transmission lines that supply offsite power from the substation into Indian Point.

To support the SEIS preparation process, the NRC requests information on state-listed, proposed, and candidate species and critical habitat that may be in the vicinity of Indian Point. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

If you have any questions concerning the NRC staff's review of this license renewal application, please contact Ms. Jill Caverly, Environmental Project Manager, at 301-415-6699 or by e-mail at jsc1@nrc.gov.

Sincerely,

/RA Bo Pham for/

Rani Franovich, Branch Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:

1. Site location map
2. Site layout map

cc w/encls: See next page

Appendix E

New York State Department of Environmental Conservation Division of Fish, Wildlife & Marine Resources

New York Natural Heritage Program

625 Broadway, Albany, New York 12233-4757

Phone: (518) 402-8935 • FAX: (518) 402-8925

Website: www.dec.state.ny.us



Alexander B. Grannis
Commissioner

December 28, 2007

Rani Franovich
U. S. Nuclear Regulatory Commission
Projects Branch 2, Division License Renewal
Washington, DC 20555-0001

Dear Ms. Franovich:

In response to your recent request, we have reviewed the New York Natural Heritage Program databases with respect to an Environmental Assessment for the proposed License Renewal Application - Indian Point Nuclear Generating Units 2 and 3, area as indicated on the map you provided, located in Town of Buchanan.

Enclosed is a report of rare or state-listed animals and plants, significant natural communities, and other significant habitats, which our databases indicate occur, or may occur, on your site or in the immediate vicinity of your site. The information contained in this report is considered sensitive and should not be released to the public without permission from the New York Natural Heritage Program.

This project location is adjacent to a designated Significant Coastal Fish and Wildlife Habitat. This habitat is part of New York State's Coastal Management Program (CMP), which is administered by the NYS Department of State (DOS). Projects which may impact the habitat are reviewed by DOS for consistency with the CMP. For more information regarding this designated habitat and applicable consistency review requirements, please contact:

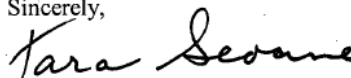
Jeff Zappieri or Vance Barr - (518) 474-6000
NYS Department of State
Division of Coastal Resources and Waterfront Revitalization
41 State Street, Albany, NY 12231

The presence of rare species may result in your project requiring additional permits, permit conditions, or review. For further guidance, and for information regarding other permits that may be required under state law for regulated areas or activities (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the enclosed address.

For most sites, comprehensive field surveys have not been conducted; the enclosed report only includes records from our databases. We cannot provide a definitive statement on the presence or absence of all rare or state-listed species or significant natural communities. This information should NOT be substituted for on-site surveys that may be required for environmental impact assessment.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

Sincerely,

A handwritten signature in black ink, appearing to read "Tara Seoane".

Tara Seoane
Information Services
NY Natural Heritage Program

cc: Reg. 3, Fisheries Mgr.
Peter Nye, Endangered Species Unit, Albany
Shaun Keeler, Bureau of Fisheries, Albany
Chris Hogan, Environmental Permits, 4th floor, Albany

Enclosure (report containing a list of rare or State-listed plants and animals) withheld by NRC as sensitive information per New York Natural Heritage Program request.



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

FEB 28 2008

Ms. Rani Franovich
Branch Chief, Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: Essential Fish Habitat Information Request for Docket Nos. 50-247 and 50-286; Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal; at the Village of Buchanan, Town of Cortlandt, Westchester County, NY

Dear Ms. Franovich:

Reference is made to your information request regarding essential fish habitat (EFH) designated in the vicinity of the Indian Point Nuclear Generating Station (Indian Point). Your letter indicates that the Nuclear Regulatory Commission is in the process of preparing a supplemental environmental impact statement (SEIS) under the provisions of Title 10 of the Code of Federal Regulations Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS is being prepared in conjunction with a request by Entergy Nuclear Operations, Inc. for the renewal of the operating licenses for the two operating units at Indian Point. This proposed renewal would extend the current operating licenses 20 years beyond their current expiration dates, and would cover the use and continued maintenance of Units Two and Three and appurtenant transmission lines that connect Indian Point to the nearby Buchanan Substation.

The facilities lie on the eastern shore of the Hudson River in Westchester County, approximately 24 miles north of the New York City limits. The industrial portions of the site occupy approximately 239 acres bounded to the north, east, and south by private property and by the Hudson River on the west. Entergy Nuclear Northeast owns all three units at the site. At this time, only Units Two and Three are operational, and Unit One is intact but has been decommissioned. The operating units feature Westinghouse pressurized water reactors that are cooled by water drawn from the Hudson River via a once-through, open-cycle cooling system. The intake system includes seven bays for each unit. Thermally-enriched water subsequently is returned back into the river through six, 96" pipes that empty into the plant's 40' wide discharge canal.

The Buchanan reach of the Hudson River is tidally-dominated and tends to exhibit mesohaline or oligohaline salinity ranges that vary seasonally. Salinity influences the distribution and function of aquatic communities, which comprise a wide variety of diadromous and resident fishes, a diverse forage species including a wide array of insects, crustaceans, and other invertebrates. While not intended to be an exhaustive list, it should be noted that the fish community includes American eel (*Anguilla rostrata*), striped bass (*Morone saxatilis*), white perch (*Morone americana*), blue crab (*Callinectes sapidus*), bay anchovy (*Anchoa mitchilli*), Atlantic silversides (*Menidia menidia*), hogchoker (*Trinectes maculatus*), American shad (*Alosa sapidissima*), tomcod (*Microgadus tomcod*), blueback herring (*Alosa aestivalis*), and alewife (*Alosa*



psuedoharengus) which use the general project reach for a variety of habitat functions, notably spawning and nursery habitat, resting and seasonal concentration areas.

Atlantic sturgeon (*Acipenser oxyrinchus*), a candidate species for listing under the Endangered Species Act (ESA) as announced in the Federal Register on October 16, 2006 (71 FRN 61002), also occur in the Hudson River. The term "candidate species" refers to (a) species that are the subject of a petition to list as threatened or endangered; (b) species for which NMFS has determined that listing pursuant to section 4 (b)(3)(A) of the ESA may be warranted; and (c) those species are not the subject of a petition but for which NMFS has announced the initiation of a status review in the Federal Register. The notice of availability of the status review for the Atlantic sturgeon was published in the Federal Register on April 3, 2007 (72 FRN 15865). A copy of the report can be downloaded from the following website:
www.nero.noaa.gov/prot_res/candidatespeciesprogram/csr.htm.

The Atlantic Sturgeon Status Review Team (SRT) has determined that the Hudson River and Delaware River Atlantic sturgeon stock constitute a distinct population segment (DPS) called the New York Bight DPS. The SRT has also concluded that the New York Bight DPS was likely (>50 % chance) to become endangered within the next 20 years. NMFS is currently considering the information in the status report to determine if action under the ESA is warranted. The SRT also identifies several different stressors that may impact the Atlantic sturgeon populations including dams for flood control and hydropower generation, water quality degradation, dredging, and blasting.

Federally endangered shortnose sturgeon (*Acipenser brevirostrum*) may be found in the Hudson River in the vicinity of Indian Point. Any federal action, such as the approval, funding, or implementation of a project by a federal agency that may affect a listed species must undergo consultation pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended. Once specific projects are identified and project plans are developed, the NRC should submit its determination of effects, along with justification for the determination and a request for concurrence, to the attention of the Endangered Species Coordinator, NMFS, Northeast Regional Office, Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930.

In addition, EFH has been designated in the Hudson River mixing zone for a variety of federally managed fishery resources. These include certain life stages of the red hake (*Urophycis chuss*), winter flounder (*Pseudopleuronectes americanus*), windowpane (*Scopthalmus aquosus*), bluefish (*Pomatomus saltatrix*), Atlantic butter fish (*Peprilus triacanthus*), summer flounder (*Paralichthys dentatus*), Atlantic sea herring (*Clupea harengus*), and the black sea bass (*Centropristus striata*). Information regarding these designations may be found at our regional website (<http://www.nero.noaa.gov/hcd/index.html#efh>). This information is intended as a generic guide that lists the EFH species within an area and is not intended for use on its own. The actual EFH descriptions, the species habitat preferences, and life history parameters are provided in Guide to EFH Descriptions. The Councils' Fishery Management Plans (FMPs) also should be referred to for more extensive information regarding EFH.

Section 305(b)(2) of the MSA requires all federal agencies to consult with NMFS on any action authorized, funded, or undertaken by that agency that may adversely affect EFH. Included in this consultation process is the preparation of an EFH assessment to provide necessary information on which to consult. Our EFH regulation at 50 CFR 600.905 mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation procedure. The level of detail in the EFH assessment should be commensurate with the potential impacts of the

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proposed project. It should also evaluate all of the direct, indirect, individual, and cumulative impacts on EFH.

The required contents of an EFH assessment include: 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the NRC's conclusions regarding the effects of the action on EFH; 4) proposed mitigation, if applicable. Other information that should be contained in the EFH assessment, if appropriate, includes: 1) the results of on-site inspections to evaluate the habitat and site-specific effects; 2) the views of recognized experts on the habitat or the species that may be affected; 3) a review of pertinent literature and related information; and 5) an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH.

In order to allow us to evaluate fully the project's impacts on EFH and federally managed species, additional information on the impacts of continued plant operation, especially with regard to the once-through cooling water intake from the river and water release back to the river. This information will allow us to develop EFH conservation recommendations to further minimize impacts on EFH and federally managed species. Depending upon the expected impacts and the construction schedule, additional best management practices or seasonal work restrictions may be appropriate EFH conservation recommendations

Thank you for your inquiry regarding habitat uses by resources of concern in the Indian Point area. We appreciate the opportunity to provide you with this preliminary coordination information. Should you wish to discuss these comments further, please contact Diane Rusanowsky at (203) 882-6504.

Sincerely,



Peter D. Colosi, Jr.
Assistant Regional Administrator
for Habitat Conservation

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cc: F/NER4 – Milford
F/NER3 – Protected Resources
USACE – NAN
USFWS – Cortland

Biological Assessment

**Indian Point Nuclear Generating Plant Unit Nos. 2 and 3
License Renewal**

December 2008

Docket Nos. 50-247 and 50-286

**U.S. Nuclear Regulatory Commission
Rockville, Maryland**

Biological Assessment of the Potential Effects on Federally Listed Endangered or Threatened Species from the Proposed Renewal of Indian Point Nuclear Generating Plant, Unit Nos. 2 and 3

1.1 Introduction and Purpose

The U.S. Nuclear Regulatory Commission (NRC) prepared this biological assessment (BA) to support the draft supplemental environmental impact statement (SEIS) for the renewal of the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), located on the shore of the Hudson River in the Village of Buchanan, in upper Westchester County, NY. The current 40-year licenses expire in 2013 (IP2) and 2015 (IP3). The proposed license renewal for which this BA has been prepared would extend the operating licenses to 2033 and 2035 for IP2 and IP3, respectively.

The NRC is required to prepare the draft SEIS as part of its review of a license renewal application. The draft SEIS supplements NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)," (NRC 1996, 1999)^a for the license renewal of commercial nuclear power plants. The draft SEIS covers specific issues, such as the potential impact on endangered and threatened species, that are of concern at IP2 and IP3 and that could not be addressed on a generic basis in the GEIS.

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, the NRC staff requested, in a letter dated August 16, 2007 (NRC 2007), that the National Marine Fisheries Service (NMFS) provide information on federally listed endangered or threatened species, as well as on proposed or candidate species, and on any designated critical habitats that may occur in the vicinity of IP2 and IP3. In its response, dated October 4, 2007 (NMFS 2007), NMFS expressed concern that the continued operation of IP2 and IP3 could have an impact on the shortnose sturgeon (*Acipenser brevirostrum*), an endangered species that occurs in the Hudson River. NMFS also noted that a related species that also occurs in the Hudson River, the Atlantic sturgeon (*Acipenser oxyrinchus*), is a candidate species for which NMFS has initiated a status review to determine if it should be listed as threatened or endangered.

Under Section 7, the NRC is responsible for providing information on the potential impact that the continued operation of IP2 and IP3 could have on the federally listed species, the shortnose sturgeon. In addition, the NRC has prepared information regarding the potential impact on important species, including the Atlantic sturgeon; this information can be found in Chapters 2 and 4 of the draft SEIS.

a The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

2.0 Proposed Action

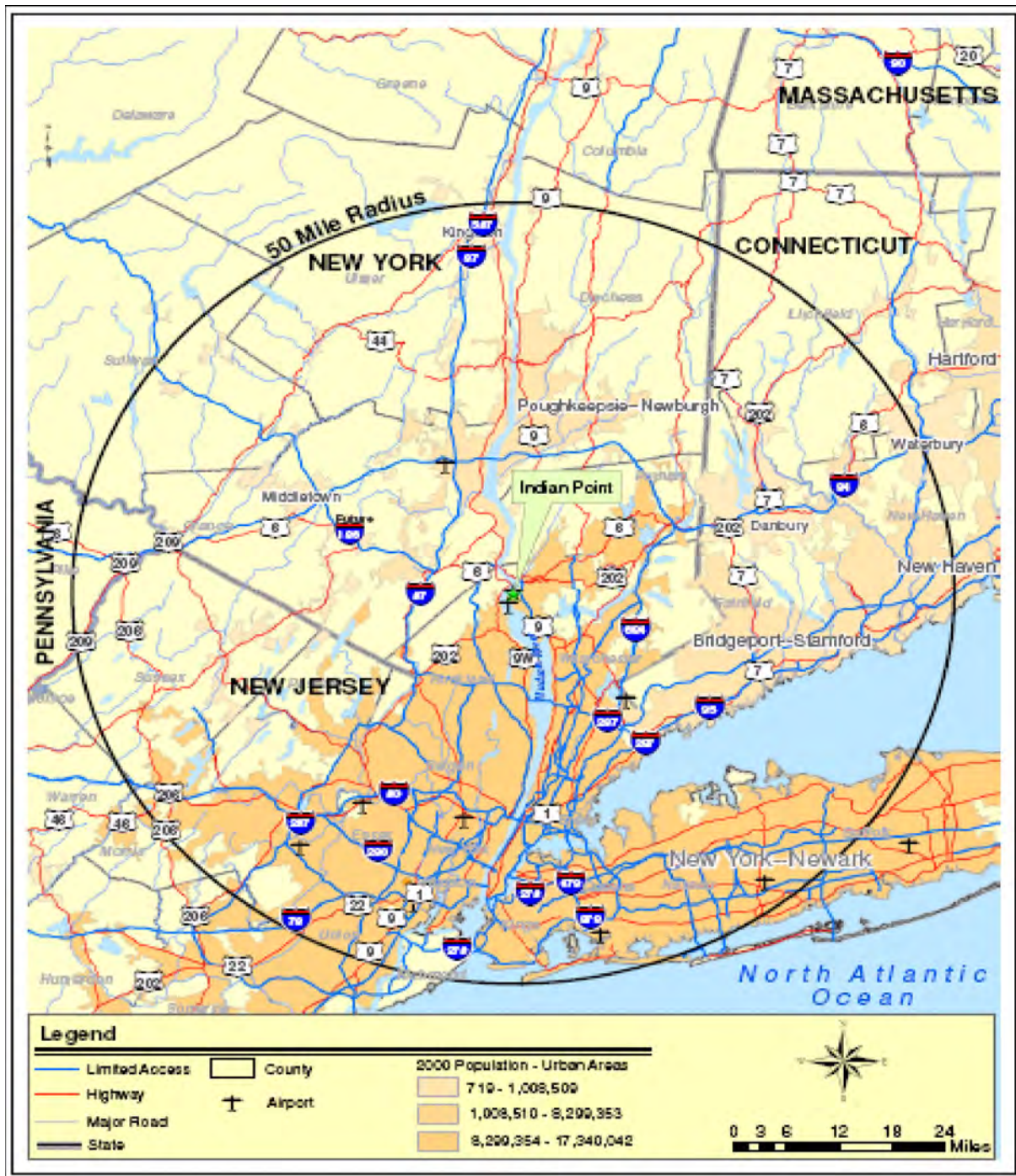
The current proposed action considered in the SEIS is the renewal of the operating licenses for IP2 and IP3 for an additional 20-year term beyond the period of the existing licenses. The applicant has indicated that it may replace reactor vessel heads and control rod drive mechanisms during the period of extended operation. (For a description of these activities and potential environmental effects, see Chapter 3 of the draft SEIS.) If the NRC grants the operating license renewals, the applicant can operate and maintain the nuclear units, the cooling systems, and the transmission lines and corridors as they are now until 2033 and 2035.

3.0 Site Description

IP2 and IP3 are located on a 239-acre (97-hectare) site on the eastern bank of the Hudson River in the Village of Buchanan, Westchester County, NY, about 24 miles (mi) (39 kilometers [km]) north of New York City, NY (Figures 1 and 2). Privately owned land bounds the north, south, and east sides of the property (Figure 3). The area is generally described as an eastern deciduous forest, dominated by oak (*Quercus*), maple (*Acer*), and beech (*Fagus*) species. The lower Hudson River is a tidal estuary, flowing 152 miles (244 km) from the Federal Dam at Troy, NY, to the Battery in New York City. IP2 and IP3 are located at River Mile (RM) 43 (RKM 69), where the average depth is 40 feet (ft) (12 meters [m]), and the average width of the river is 4500 ft (1370 m). The Hudson River is tidal all the way to the Federal Dam, and the salinity zone in the vicinity of the facility is described as oligohaline (low salinity, ranging from 0.5 to 5 parts per thousand (ppt)), with the salinity changing with the level of freshwater flow. Water temperature ranges from a winter minimum of 34 degrees F (1 degree Celsius (C)) to a summer maximum of 77 degrees F (25 degrees C) (Entergy 2007a).

The mid-Hudson River provides the cooling water for four other power plants: Roseton Generating Station, Danskammer Point Generating Station, Bowline Point Generating Station, and Lovett Generating Station; all four stations are fossil-fueled steam electric stations, located on the western shore of the river, and all use once-through cooling. Roseton consists of two units and is located at RM 66 (RKM 106), 23 mi (37 km) north of IP2 and IP3. Just 0.5 mi (0.9 km) north of Roseton is Danskammer, with four units. Bowline lies about 5 mi (8 km) south of IP2 and IP3 and consists of two units (Entergy 2007a; CHGEC 1999). Lovett, almost directly across the river from IP2 and IP3, is no longer operating.

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1 Source: Entergy 2007a

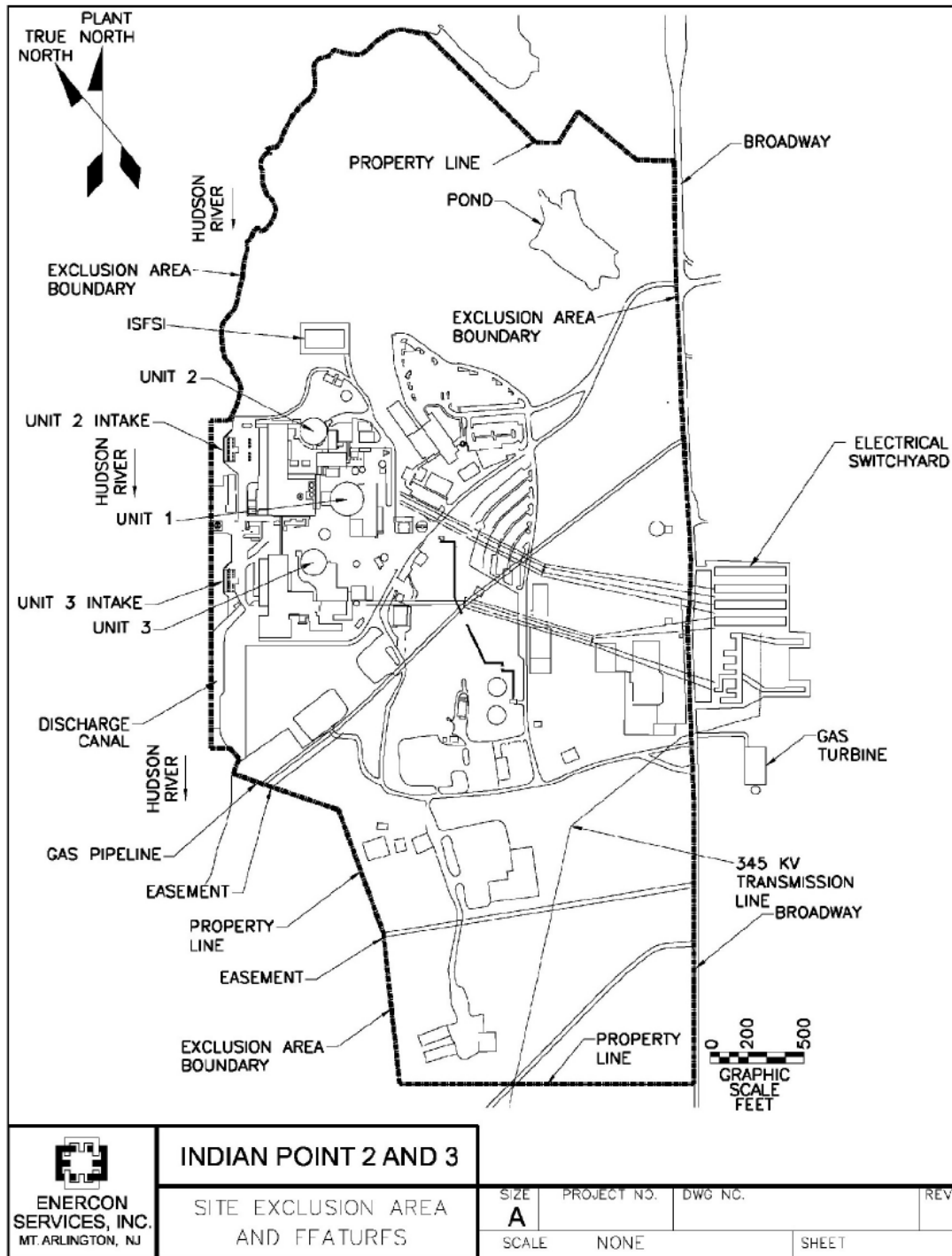
2 **Figure 1. Location of IP2 and IP3, 50-mile (80-km) radius**



Source: Entergy 2007a

Figure 2. Location of IP2 and IP3, 6-mile (10-km) radius

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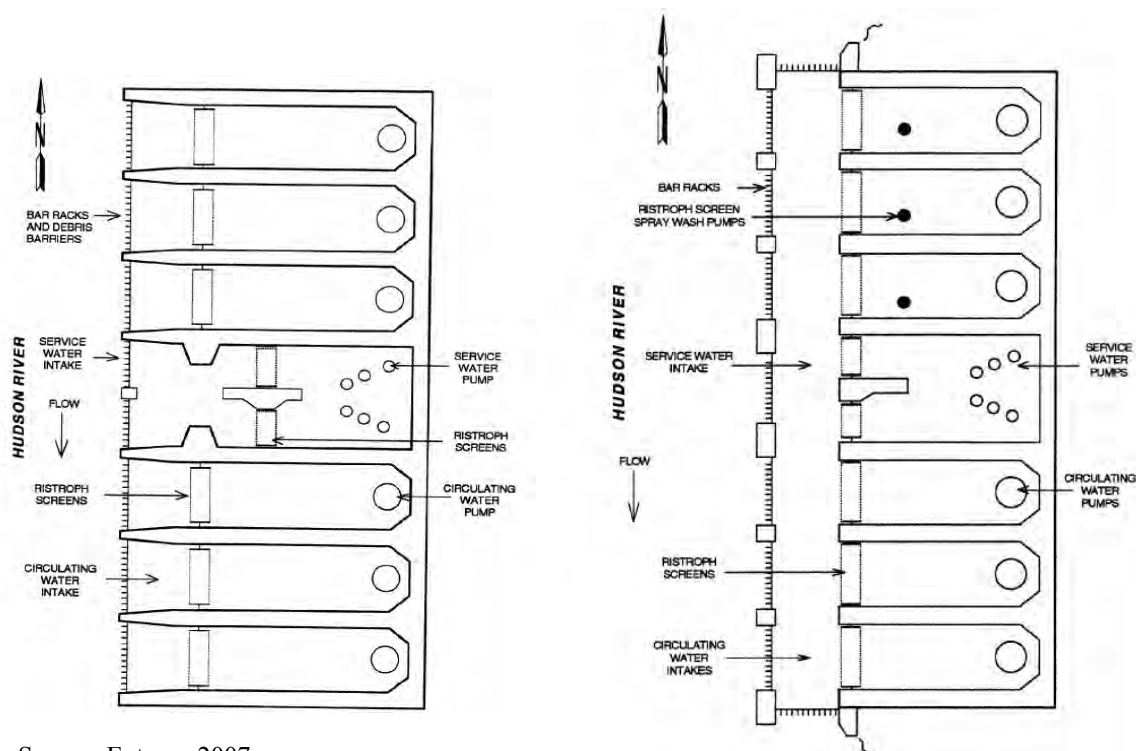


1 Source: Entergy 2007a

2 **Figure 3. IP2 and IP3 property boundaries and environs**

3.1.1 Description of Plants and Cooling Systems

IP2 and IP3 are pressurized-water reactors with turbine generators that produce a net output of 6432 megawatts-thermal and approximately 2158 megawatts-electrical. Both IP2 and IP3 use water from the Hudson River for their once-through condensers and auxiliary cooling systems. Each unit has seven intake bays (Figure 4), into which the river water flows, passing under the floating debris skimmer wall and through Ristroph traveling screens (Figure 5). IP2 has six dual-speed circulating water pumps that can each pump 140,000 gallons per minute (gpm) (8.83 cubic meters per second [m^3/s]) at full speed and 84,000 gpm (5.30 m^3/s) at reduced speed; at full speed, the approach velocity is approximately 1 foot per second (fps) (0.30 meters per second [m/s]) and at reduced speed, the approach velocity is 0.6 fps (0.2 m/s). IP3 also has six dual-speed circulating water pumps. The full speed flow rate of each of these pumps is 140,000 gpm (8.83 m^3/s), with a 1 fps (0.30 m/s) approach velocity; the reduced speed is 64,000 gpm (4.04 m^3/s), with a 0.6 fps (0.2 m/s) approach velocity (Entergy 2007a).



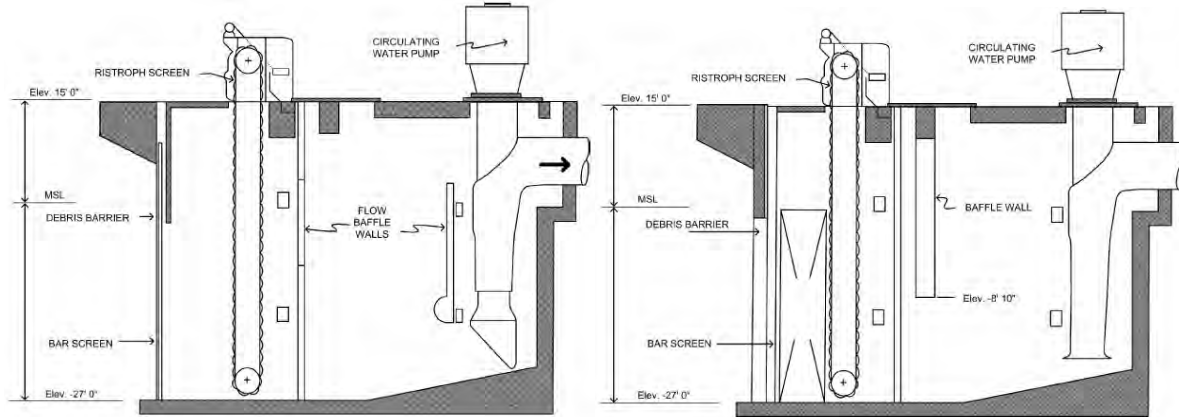
Source: Entergy 2007a

Figure 4. IP2 intake structure (left) and IP3 intake structure (right)

The traveling screens employed by IP2 and IP3 are modified vertical Ristroph-type traveling screens installed in 1990 and 1991 at IP3 and IP2, respectively. The screens were designed in concert with the Hudson River Fishermen's Association, with screen basket lip troughs to retain water and minimize vortex stress (CHGEC 1999). Studies indicated that, assuming the screens continued to operate as they had during laboratory and field testing, the screens were "the screening device most likely to impose the least mortalities in the rescue of entrapped fish by

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mechanical means” (Fletcher 1990). The same study concluded that refinements to the screens would be unlikely to greatly reduce fish kills.



Source: Entergy 2007a

Figure 5. IP2 intake system (left) and IP3 intake system (right)

There are two spray-wash systems—the high-pressure spray wash removes debris from the front of the traveling screen mechanism; the low-pressure spray washes fish from the rear of the mechanism into a fish sluice system to return them to the river. A 0.25 x 0.5-inch (in.) (0.635 x 1.27-centimeter [cm]) clear opening slot mesh on the screen basket panels was included to minimize abrasion as the fish were washed into the collection sluice. The sluice system is a 12-in.-diameter (30.5-cm-diameter) pipe that discharges fish into the river at a depth of 35 ft (10.7 m), 200 ft (61 m) from shore (CHGEC 1999).

4.0 Status Review of Shortnose Sturgeon

4.1 Life History

The shortnose sturgeon (*Acipenser brevirostrum*, family Acipenseridae) is amphidromous, with a range extending from the St. Johns River, FL, to the St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater and move into salt water periodically without relation to spawning (Collette and Klein-MacPhee, 2002). From colonial times, shortnose sturgeons have rarely been the target of commercial fisheries but have frequently been taken as incidental bycatch in Atlantic sturgeon and shad gillnet fisheries (NEFSC 2006; Dadswell et al. 1984). The shortnose sturgeon was listed on March 11, 1967, as endangered under the ESA. In 1998, NMFS completed a recovery plan for the shortnose sturgeon (NMFS 1998).

Shortnose sturgeons can grow up to 143 cm (56 in.) in total length and can weigh up to 23 kilograms (kg) (51 pounds [lb]). Females are known to live up to 67 years, while males typically do not live beyond 30 years. As young adults, the sex ratio is 1:1; however, among fish larger than 90 cm (35 in.), measured from nose to the fork of the tail, the ratio of females to males increases to 4:1. Throughout the range of the shortnose sturgeon, males and females mature at 45 to 55 cm (18 to 22 in.) fork length, but the age at which this length is achieved varies by geography. At the southern extent of the sturgeon's range, in Florida, males reach maturity at age 2, and females reach maturity at 6 years or younger; in Canada, males can reach maturity as late as 11 years, and females, 13 years. In 1 to 2 years after reaching maturity, males begin to spawn at 2-year intervals, while females may not spawn for the first time until 5 years after maturing and, thereafter, spawn at 3- to 5-year intervals (Dadswell et al. 1984).

Shortnose sturgeons migrate into freshwater to spawn during late winter or early summer. Eggs sink and adhere to the hard surfaces on the river bottom, hatching after 4 to 6 days. Larvae consume their yolk sac and begin feeding in 8 to 12 days, as they migrate downstream away from the spawning site, remaining close to the river bottom (Kynard 1997; Collette and Klein-MacPhee 2002). The juveniles, which feed on benthic insects and crustaceans, do not migrate to the estuaries until the following winter, where they remain for 3 to 5 years. As adults, they migrate to the near-shore marine environment, where their diet consists of mollusks and large crustaceans (Dadswell 1984).

4.2 Status of Shortnose Sturgeon in Hudson River

Shortnose sturgeons inhabit the lower Hudson; the Federal Dam creates a physical barrier preventing the species from swimming farther north. They are found dispersed throughout the river-estuary from late spring to early fall and then congregate to winter near Sturgeon Point (RM 86). Spawning occurs in the spring, just downstream of the Federal Dam at Troy, between RM 118 and 148 (between Cocksackie and Troy) (Bain et al. 2007; NMFS 2000). According to the NMFS environmental assessment (2000) for a permit for the incidental take of shortnose sturgeons at the nearby power plants, Roseton and Danskammer, larvae are typically found upstream of the intakes of all five power plants along the mid-Hudson.

The Hudson River population of the shortnose sturgeon was estimated to be approximately 13,000 adults in 1979–1980. Based on population studies done in the mid-1990s, the population has apparently increased 400 percent since then, up to almost 57,000 adult fish. Additional data suggest that the total population of the shortnose sturgeon in the Hudson River is approximately 61,000, including juveniles and nonspawning adults (Bain et al. 2007). The population growth has been ascribed to several strong year-classes, as well as 2 decades of sustained annual recruitment (Woodland and Secor 2007). Bain et al. (2007) maintains that the annual trawl surveys conducted by the electric utilities (CHGEC 1999) show an increase in abundance between the mid-1980s and mid-1990s, supporting the finding that the Hudson River population has increased. Staff assessed the population trend for yearling and older shortnose sturgeons in the fall juvenile survey data provided by the applicant and found an overall increase in the catch-per-unit-effort from 1975 to 2005.

4.3 Impact Assessment of Indian Point on the Shortnose Sturgeon Population

4.3.1 Entrainment

The southern extent of the shortnose sturgeon spawning area in the Hudson River is approximately RM 118 (RKM 190), about 75 RM (121 RKM) upstream of the intake of IP2 and IP3 (NMFS 2000). The eggs of shortnose sturgeons are demersal, sinking and adhering to the bottom of the river, and, upon hatching, the larvae in both yolk-sac and post-yolk-sac stages remain on the bottom of the river, primarily upstream of RM 110 (RKM 177) (NMFS 2000). Shortnose sturgeon larvae grow rapidly, and, after a few weeks, they are too large to be entrained by the cooling intake (Dadswell 1979). Because the egg and larval life stages of the shortnose sturgeon (the life stages susceptible to entrainment) are not found near the intake for IP2 and IP3, the probability of their entrainment at IP2 and IP3 is low.

IP2 and IP3 monitored entrainment from 1972 through 1987. Entrainment monitoring became more intensive at Indian Point from 1981 through 1987, and sampling was conducted for nearly 24 hours per day, 4 to 7 days per week, during the spawning season in the spring (NMFS 2000). Entrainment monitoring reports list no shortnose sturgeon eggs or larvae at IP2 and IP3. NMFS (2000) lists only eight sturgeon larvae collected at any of the mid-Hudson power plants (all eight were collected at Danskammer, and four of the eight may have been Atlantic sturgeons). Entrainment sampling data supplied by the applicant (Entergy 2007b) include large numbers of larvae for which the species could not be determined, and, therefore, one cannot conclude that there was no entrainment of shortnose sturgeons at IP2 and IP3. Entergy Nuclear Operations, Inc. (Entergy) currently conducts no monitoring program to record entrainment at IP2 and IP3, and any entrainable life stages of the shortnose sturgeon taken in recent years would go unrecorded.

Based on the life history of the shortnose sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, the number of shortnose sturgeons in early life stages entrained at IP2 and IP3 is probably low or zero. The available data from past entrainment monitoring do not indicate that entrainment was occurring. Therefore, the staff concludes that the continued operation of Indian Point for an additional 20 years is not likely to adversely affect the population of shortnose sturgeons in the Hudson River through entrainment.

4.3.2 Impingement

IP2 and IP3 monitored impingement daily until 1981, reduced collections to a randomly selected schedule of 110 days per year until 1991, and then ceased monitoring in 1991 with the installation of the modified Ristroph traveling screens. As described in Section 2.1, these screens were designed in a collaborative effort with the Hudson River Fishermen's Association to minimize the mortality of impinged fish.

In 2000, NMFS prepared an environmental assessment (EA) for the incidental take of shortnose sturgeons at Roseton and Danskammer (NMFS 2000). The EA included the estimated total number (Table 1) of shortnose sturgeons impinged at Roseton, Danskammer, Bowline Point,

Lovett, and IP2 and IP3, with adjustments to include the periods when sampling was not conducted.

Table 1. Estimated Total and Average Shortnose Sturgeon Impinged by Mid-Hudson River Power Plants, Adjusted for Periods Without Sampling

Power Plant	1972–1998		1989–1998	
	Total	Average No. Impinged/Year	Total	Average No. Impinged/Year
Bowline Point	23	0.9	0	0
Lovett	0	0	0	0
IP2	37	1.4	8	0.8
IP3	26	1.0	8	0.8
Roseton	49	1.8	15	1.5
Danskammer Point	140	5.2	44	4.4
Total	275	10.2	75	7.5

Source: Adapted from NMFS 2000.

Impingement data provided by Entergy (2007b), which are available through the NRC's online Agencywide Documents Access and Management System (ADAMS), include the raw number of shortnose sturgeons collected at IP2 and IP3 during impingement monitoring (Table 2). Some blank entries in historical results do not differentiate between "no samples analyzed" and "samples analyzed but no individuals found." Since it is unknown if there were any impinged shortnose sturgeons for those time periods, counts must be considered minimal. The NRC staff notes, however, that data submitted by Entergy indicate that a larger number of shortnose sturgeons were impinged at IP2 and IP3 in the 7 years with reported data (1974–1979, 1984, and 1987 for IP2; 1977–1980, 1984, 1987, and 1988 for IP3) than NMFS data indicate were impinged by all mid-Hudson power plants from 1972 through 1998. The NRC staff finds that the numbers provided by NMFS (2000) in its EA for IP2 and IP3 cannot be accurate. In this case, the applicant-supplied data indicate a greater effect than the NMFS-supplied data.

An increase in the population of shortnose sturgeons in the Hudson River would most likely result in an increase in impinged shortnose sturgeons at IP2 and IP3. If the population data presented by Bain et al. (2007) and Woodland and Secor (2007) are accurate, then a four-fold increase in population between the mid-1980s and mid-1990s could result in a similar increase in impingement rates. However, this population increase would also mean that the impact of taking an individual shortnose sturgeon would decrease. Without current impingement data, the NRC staff cannot determine how changes in the shortnose sturgeon population have affected impingement rates.

When considering the effects of impingement, it is important to consider the affected species' impingement mortality rate. For IP2 and IP3, however, there are few data regarding the survival of the shortnose sturgeon after impingement. In 1979, NMFS issued a biological opinion (BO) relating to the take of shortnose sturgeons at Indian Point (Dadswell 1979). At the time, there was only 1 year in which records describing the status of impinged shortnose sturgeons were kept. In that year, 60 percent of collected impinged shortnose sturgeons were dead when

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collected. The BO assumes both that all dead sturgeons died as a result of the impingement and that no impingement-related mortality occurred after the impinged sturgeons were released.

Table 2. Numbers of Shortnose Sturgeons Collected During Impingement Monitoring at Indian Point Units 2 and 3

Year	Unit 2	Unit 3
1975	3	-
1976	2	-
1977	11	2
1978	5	5
1979	4	3
1980	-	2
1981	-	-
1982	-	-
1983	-	-
1984	176	154
1985	-	-
1986	-	-
1987	116	55
1988	-	186
1989	-	-
1990	-	-
Total	317	407

Source: Enclosure 3 to NL-07-156

The BO estimated that, in a worst-case scenario, 35 shortnose sturgeons would be impinged at IP2 and IP3 per year, and that 60 percent (21 individuals) would die on the impingement screens. At the time, the population of adult shortnose sturgeons in the Hudson River was estimated to be 6,000, and this level of mortality would result in a 0.3 to 0.4 percent death rate caused by impingement at IP2 and IP3 (Dadswell 1979).

Because all monitoring of impingement ceased after the Ristroph screens were installed in 1991, no updated mortality rate estimates for impinged shortnose sturgeons exist at IP2 and IP3. The NRC staff does not know the current level of impingement or the level of mortality. Although the laboratory and field tests (Fletcher 1990) performed on the modified Ristroph screens were not conducted using the shortnose sturgeon, the tests did show that injury and death were reduced for most species when compared to the first version of screens that were proposed (and rejected, based on their "unexceptional performance") (Fletcher 1990). If the NRC staff assumes that the modified Ristroph screens performed as well as the Fletcher's 1990 results indicated, then mortality and injury from impingement would be lower than reported by the NMFS in its BO (Dadswell 1979), and the impact to the species would be less. Without current monitoring, however, the NRC staff cannot confirm this.

Based on the limited amount of data from the years before the installation of modified Ristroph screens at IP2 and IP3, and the lack of data from the years following screen installation, including any potential changes in rates of mortality caused by impingement, the NRC staff

concludes that the continued operation of IP2 and IP3 for an additional 20 years could adversely affect the population of shortnose sturgeons in the Hudson River through impingement but cannot assess the extent to which the installation of modified Ristroph screens might reduce the impact.

4.3.3 Thermal Impacts

The discharge of heated water into the Hudson River can cause lethal or sublethal effects on resident fish, influence food web characteristics and structure, and create barriers to migratory fish moving from marine to freshwater environments.

State Pollution Discharge Elimination System (SPDES) permit NY-0004472 regulates thermal discharges associated with the operation of IP2 and IP3. This permit imposes effluent limitations, monitoring requirements, and other conditions to ensure that all discharges are in compliance with Article 17 of the Environmental Conservation Law of New York State, Part 704 of the Official Compilation of the Rules and Regulations of the State of New York, and the Clean Water Act. Specific conditions of the SPDES permit related to thermal discharges from IP2 and IP3 are specified in NYSDEC (2003) and include the following:

- The maximum discharge temperature is not to exceed 110 degrees F (43 degrees C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2 degrees F (34 degrees C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2 degrees F (34 degrees C) on more than 15 days during that period in any year.

The final environmental impact statement (FEIS) associated with the SPDES permit for IP2 and IP3 (NYSDEC 2003) concludes that "Thermal modeling indicates that the thermal discharge from Indian Point causes water temperatures to rise more than allowed." The thermal modeling referred to in the FEIS appears to represent a worst-case scenario. Available modeling indicates the potential for the discharges from IP2 and IP3 to violate the conditions of the IP2 and IP3 SPDES permit, which could result in a negative impact on the shortnose sturgeon. IP2 and IP3 have not performed any triaxial thermal studies to completely assess the size and nature of the thermal plume created by the discharge from IP2 and IP3 and the possible impact on the sturgeon.

According to the NMFS Final Recovery Plan for the Shortnose Sturgeon (NMFS 1998), "During summer months, especially in southern rivers, shortnose sturgeons must cope with the physiological stress of water temperatures that often exceed 82 degrees F (28 degrees C)." Although the area closest to the discharge from IP2 and IP3 can exceed these temperatures, the summer maximum temperature of the Hudson River in the area of IP2 and IP3 is 77 degrees F (25 degrees C) (Entergy 2007a). The combined discharge from both Indian Point units is about 1.75 million gpm (110 m³/s), including the service water (Entergy 2007a). Table 3 presents the net downstream flows caused by freshwater inflow. From these data, it can be seen that 20 percent of the time, the discharge from IP2 and IP3 would be, at most, 15 percent of the net flow; however, 98 percent of the time, the discharge would be, at most, 97 percent of the net flow. This means that, at given times, the discharge from IP2 and IP3 would not necessarily be well mixed into the Hudson River.

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Table 3. Cumulative Frequency Distribution of Net Downstream Flows of Hudson River

Million gallons per minute (gpm)	Cumulative percentile
11.7	20
6.8	40
4.71	60
3.1	80
1.8	98

Adapted from Entergy 2007a

The NRC staff cannot determine—based on available information—whether a shortnose sturgeon in the Hudson River would experience any prolonged physiological stress from the thermal plume caused by the discharge from IP2 and IP3. Shortnose sturgeons could be forced to seek refuge from elevated water temperatures as they are forced to do in southern rivers, and this could limit their available habitat. If studies reveal that the plume is buoyant, shortnose sturgeons could pass underneath the plume on their passage past the facility, but there are no data to indicate that this is the case.

As noted earlier, the NYSDEC thermal modeling of the Hudson River suggests that the discharge from IP2 and IP3 could exceed the limits specified in the SPDES permit, but without a triaxial thermal study, the exact size and nature of the thermal plume is unknown. Information about the species, based on the NMFS recovery plan, suggests to the NRC staff that increased temperatures can have a significant effect on the shortnose sturgeon. Therefore, the NRC staff concludes that the continued operation of IP2 and IP3 for an additional 20 years could adversely affect the population of shortnose sturgeons in the Hudson River through thermal discharge, but the staff is unable to determine the extent to which the population would be affected.

5.0 Conclusion

Renewal of the operating licenses of IP2 and IP3 to include another 20 years of operation could adversely affect the population of shortnose sturgeon in the Hudson River through impingement and thermal impacts. At this time, the NRC staff cannot quantify the extent to which the population could be affected.

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Appendix F

GEIS Environmental Issues Not Applicable to Indian Point Nuclear Generating Station Unit Nos. 2 and 3

Appendix F

GEIS Environmental Issues Not Applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3

Table F-1 lists those environmental issues identified in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS), issued 1996 and 1999,⁽⁴⁾ and in Table B-1 of Appendix B to Subpart A of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51), that are not applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) because of plant or site characteristics.

Table F-1. GEIS Environmental Issues Not Applicable to IP2 and IP3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)			
Altered thermal stratification of lakes	1	4.2.1.2.3, 4.4.2.2	IP2 and IP3 do not discharge into a lake.
Water use conflicts (plants with cooling pond or cooling towers using makeup water from a small river with low flow)	1	4.3.2.1, 4.4.2.1	IP2 and IP3 have a once-through cooling system.
Water use conflicts (plants with cooling towers and cooling ponds using make-up water from a small river with low flow)	2	4.3.2.1 4.4.2.1	This issue is related to heat-dissipation systems that are not installed at IP2 and IP3.
AQUATIC ECOLOGY (FOR ALL PLANTS)			
AQUATIC ECOLOGY (FOR PLANTS WITH COOLING TOWER-BASED HEAT DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	1	4.2.2.1.2, 4.4.3	This issue is related to heat-dissipation systems that are not installed at IP2 and IP3.

(4) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include both the GEIS and its Addendum 1.

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ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
Impingement of fish and shellfish	1	4.2.2.1.3, 4.4.3	This issue is related to heat-dissipation systems that are not installed at IP2 and IP3.
Heat shock	1	4.2.2.1.4, 4.4.4	This issue is related to heat-dissipation systems that are not installed at IP2 and IP3.
GROUND WATER USE AND QUALITY			
Ground water use conflicts (potable and service water, and dewatering; plants that use <100 gpm)	1	4.8.1.1, 4.8.1.2	IP2 and IP3 do not use ground water for any purpose.
Ground water use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	2	4.8.1.1, 4.8.1.2	IP2 and IP3 do not use ground water for any purpose.
Ground water use conflicts (plants using cooling towers withdrawing makeup water from a small river)	2	4.8.1.3	This issue is related to heat-dissipation systems that are not installed at IP2 and IP3.
Ground water use conflicts (Ranney wells)	2	4.8.1.4	IP2 and IP3 do not have or use Ranney wells.
Ground water quality degradation (Ranney wells)	1	4.8.2.2	IP2 and IP3 do not have or use Ranney wells.
Ground water quality degradation (saltwater intrusion)	1	4.8.2.1	IP2 and IP3 do not use for any purpose.
Ground water quality degradation (cooling ponds in salt marshes)	1	4.8.3	IP2 and IP3 do not use cooling ponds.
Ground water quality degradation (cooling ponds at inland sites)	2	4.8.3	IP2 and IP3 do not use cooling ponds.

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
HUMAN HEALTH			
Microbial organisms (occupational Health)	1	4.3.6	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.
Microbiological organisms (public health; plants lakes or canals, cooling towers, or cooling ponds that discharge to a small river)	2	4.3.6	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.
TERRESTRIAL RESOURCES			
Cooling tower impacts on crops and ornamental vegetation	1	4.3.4	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.
Cooling tower impacts on native plants	1	4.3.5.1	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.
Bird collisions with cooling towers	1	4.3.5.2	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.
Cooling pond impacts on terrestrial resources	1	4.4.4	This issue is related to a heat-dissipation system that is not installed at IP2 and IP3.

References

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Appendix G

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Indian Point Nuclear Generating Unit Nos. 2 and 3 in Support of License Renewal Application Review

Appendix G

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Indian Point Nuclear Generating Unit Nos. 2 and 3 in Support of License Renewal Application Review

G.1 Introduction

Entergy Nuclear Operations, Inc. (Entergy) submitted an assessment of severe accident mitigation alternatives (SAMAs) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) as part of the environmental report (ER) (Entergy 2007). Entergy based its assessment on the most recent probabilistic safety assessment (PSA) for IP2 and IP3 (a site-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code), and on insights from the Individual Plant Examination (IPE) (Con Ed 1992 and NYPA 1994) and the Individual Plant Examination of External Events (IPEEE) (Con Ed 1995 and NYPA 1997) for each unit. In identifying and evaluating potential SAMAs, Entergy considered SAMAs that addressed the major contributors to core damage frequency (CDF) and large early release frequency (LERF) at IP2 and IP3, as well as SAMA candidates for other operating plants that have submitted license renewal applications. Entergy identified 231 candidate SAMAs for IP2 and 237 SAMAs for IP3. This list was reduced to 68 (IP2) and 62 (IP3) unique SAMAs by eliminating SAMAs that are not applicable at IP2 and IP3 because they have design differences, they have already been implemented at IP2 and IP3, or they are similar in nature and could be combined with another SAMA candidate. Entergy assessed the costs and benefits associated with each of the potential SAMAs and concluded in the ER that several of these were potentially cost beneficial.

Based on a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) issued requests for additional information (RAIs) to Entergy by letters dated December 7, 2007 (NRC 2007), and April 2, 2008 (NRC 2008). Key questions concerned major changes to the internal flood model in each of the PSA updates; PSA peer review comments and their resolution; MACCS2 input data and assumptions (including core inventory, evacuation modeling, and offsite economic costs); assumptions used to quantify the benefits for certain SAMAs; reasons for unit-to-unit differences for certain risk contributors and estimated SAMA benefits; and further information on several specific candidate SAMAs and low-cost alternatives, including SAMAs related to steam generator tube rupture (SGTR) events. Entergy submitted additional information by letters dated February 5, 2008 (Entergy 2008a), and May 22, 2008 (Entergy 2008b). In response to the RAIs, Entergy provided clarification of the internal flooding analysis changes in each PSA model version; additional information regarding the peer review process and comment resolution; details regarding the MACCS2 input data, including results of a sensitivity analysis addressing loss of tourism and business; additional explanation and justification for the assumptions in each analysis case; descriptions of plant-specific features

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that account for differences in risk and SAMA benefits between units; and additional information regarding several specific SAMAs, including SGTR-related SAMAs. Entergy's responses addressed the NRC staff's concerns and resulted in the identification of several additional potentially cost-beneficial SAMAs and the elimination of one previously identified cost-beneficial SAMA.

An assessment of SAMAs for IP2 and IP3 is presented below.

G.2 Estimate of Risk for IP2 and IP3

Entergy's estimates of offsite risk at IP2 and IP3 are summarized in Section G.2.1. The summary is followed by the NRC staff's review of Entergy's risk estimates in Section G.2.2.

G.2.1. Entergy's Risk Estimates

The two distinct analyses that are combined to form the basis for the risk estimates used in the SAMA analysis are (1) the IP2 and IP3 Level 1 and Level 2 PSA models, which are updated versions of the IPE (Con Ed 1992 and NYPA 1994) and IPEEE (Con Ed 1995 and NYPA 1997) for each unit, and (2) supplemental analyses of offsite consequences and economic impacts (essentially a Level 3 PSA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent IP2 and IP3 Level 1 and Level 2 PSA models available at the time of the ER, referred to as the IP2 Revision 1 PSA model (April 2007) for IP2 and the IP3 Revision 2 PSA model (April 2007) for IP3. The scope of the PSA models does not include external events.

The baseline CDF for the purpose of the SAMA evaluation is approximately 1.79×10^{-5} per year for IP2 and 1.15×10^{-5} per year for IP3. The CDF is based on the risk assessment for internally initiated events, including internal flooding. Entergy did not include the contributions from external events within the IP2 and IP3 risk estimates; however, it did perform separate assessments of the CDF from external events and did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of approximately 3.8 for IP2 and 5.5 for IP3. This is discussed further in Sections G.2.2 and G.6.2.

The breakdown of CDF by initiating event is provided in Table G-1 for IP2 and IP3. For IP2, loss of offsite power sequences, including station blackout (SBO) events, and internal flooding initiators are the dominant contributors to CDF. For IP3, internal flooding initiators, loss-of-coolant accidents (LOCAs), SGTR events, and anticipated transient without scram (ATWS) events are the dominant contributors to CDF.

There are several significant differences between the two Indian Point units that account for differences in the risk contributions shown in Table G-1. These differences include:

The pressurizer PORV block valves are normally closed in Unit 2, and normally open in Unit 3. Thus, the ability to use the PORVs for feed and bleed cooling in LOOP and partial power loss events is greater at Unit 3, resulting in a lower CDF for LOOP events in Unit 3.

There are differences in the internal flooding sources and building configurations (e.g., ingress and egress paths). These physical differences together with differences in the method for calculating failure frequencies result in higher flood CDF frequencies in Unit 2.

In Unit 2, DC control power for EDGs and other loads on emergency 480 VAC busses is supplied from either normal or emergency backup supplies, with automatic switching between supplies. Unit 3 does not have this backup capability. This results in a lower CDF contribution from loss of DC power events in Unit 2.

Table G-1. IP2 and IP3 Core Damage Frequency

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
loss of offsite power ¹	6.7×10^{-6}	38	1.2×10^{-7}	1
internal flooding	4.7×10^{-6}	26	2.2×10^{-6}	20
LOCA	1.5×10^{-6}	8	2.2×10^{-6}	19
transients ¹	1.2×10^{-6}	7	8.5×10^{-7}	7
ATWS	9.9×10^{-7}	6	1.5×10^{-6}	13
SBO				
SGTR	8.5×10^{-7}	5	7.2×10^{-7}	6
loss of component cooling water (CCW)	7.2×10^{-7}	4	1.6×10^{-6}	14
loss of nonessential service water	5.8×10^{-7}	3	1.1×10^{-7}	<1
interfacing systems LOCA (ISLOCA)	3.0×10^{-7}	2	2.8×10^{-7}	2
reactor vessel rupture				
loss of 125 volts (V) direct current (dc) power	1.5×10^{-7}	<1	1.5×10^{-7}	1
total loss of service water system	1.0×10^{-7}	<1	1.0×10^{-7}	<1
loss of essential service water	5.8×10^{-8}	<1	1.0×10^{-6}	9
	4.4×10^{-8}	<1	5.4×10^{-7}	5
	1.9×10^{-10}	<1	1.9×10^{-8}	<1
Total CDF (internal events)	1.79×10^{-5}	100	1.15×10^{-5}	100

¹ Contributions from SBO and ATWS events are noted separately and are not included in the reported values for loss of offsite power or transients.

The current Level 2 PSA models are based on the IPE models, with updates to reflect changes to the plant and modeling techniques, including a 3.3 percent and 4.8 percent power uprate for IP2 and IP3, respectively; inclusion of additional plant damage states (PDSs) to improve the Level 1–Level 2 PSA interface; and updated accident progression and source term analyses using a later version of the Modular Accident Analysis Program (MAAP) computer code. The Level 1 core damage sequences are placed into one of 57 PDS bins that provide the interface between the Level 1 and Level 2 analyses. The Level 2 models use a single containment event tree (CET) with functional nodes representing both systemic and phenomenological events. CET nodes are evaluated using supporting fault trees and logic rules.

The result of the Level 2 PSA is a set of nine release categories with their respective frequency and release characteristics. The results of this analysis for IP2 and IP3 are provided in Tables

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E.1-9 (IP2) and E.3-9 (IP3) of the ER. The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for each of the nine release categories using the results of MAAP 4.04 computer code calculations. The release characteristics for each release category were obtained by frequency-weighting the release characteristics for each CET endpoint contributing to the release category (Entergy 2007).

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within an 80-kilometer (50-mile) radius) for the year 2035, emergency response evacuation modeling, and economic data. The magnitude of the onsite impacts (in terms of cleanup and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997a).

In the ER, Entergy estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.22 person-sievert (Sv; 22 person-rem) per year for IP2, and 0.24 Sv (24 person-rem) per year for IP3. The breakdown of the total population dose by containment failure mode is summarized in Table G-2, based on information provided in response to an RAI (Entergy 2008a). SGTR events and late containment failures caused by gradual overpressurization by steam and noncondensable gases dominate the population dose risk at both units.

Table G-2. Breakdown of Population Dose by Containment Failure Mode

Containment Failure Mode	IP2		IP3	
	Population Dose (Person-Rem ¹ Per Year)	Percent Contribution	Population Dose (Person-Rem ¹ Per Year)	Percent Contribution
intact containment	<0.1	<1	<0.1	<1
basemat meltthrough	1.1	5	0.6	3
gradual overpressure	7.4	34	4.4	18
late hydrogen burns	0.9	4	0.6	2
early hydrogen burns	2.1	10	0.8	3
in-vessel steam explosion	0.1	1	0.1	0
reactor vessel rupture	1.0	5	0.4	2
ISLOCA	1.6	7	1.1	4
SGTR	7.7	35	16.6	68
Total	22.0	100	24.3	100

¹One person-rem = 0.01 Sv.

1
2 Review of Entergy's Risk Estimates

3 Entergy's determination of offsite risk at IP2 and IP3 is based on the following four major
4 elements of analysis:

- 5 (1) the Level 1 and Level 2 risk models that form the bases for the IPE submittals (Con Ed
6 1992 and NYPA 1994) and the IPEEE submittals (Con Ed 1995 and NYPA 1997)
- 7 (2) the major modifications to the IPE models that have been incorporated in the IP2 and
8 IP3 2007 PSA updates
- 9 (3) adjustments to the IPEEE seismic and fire risk results to represent recent plant changes,
10 updated failure probabilities, and more realistic assumptions
- 11 (4) the MACCS2 analyses performed to translate fission product source terms and release
12 frequencies from the Level 2 PSA model into offsite consequence measures

13 Each of these analyses was reviewed to determine the acceptability of Entergy's risk estimates
14 for the SAMA analysis, as summarized below.

15 The NRC staff's reviews of the IP2 and IP3 IPE submittals are described in the NRC reports
16 dated August 14, 1996 (NRC 1996) and October 20, 1995 (NRC 1995), for IP2 and IP3,
17 respectively. Based on its review of the IPE submittals and responses to RAIs, the NRC staff
18 concluded that the IPE submittals met the intent of Generic Letter (GL) 88-20; that is, the
19 licensee's IPE process is capable of identifying the most likely severe accidents and severe
20 accident vulnerabilities. Although no vulnerabilities were identified in the IPE, several plant
21 improvements were identified. These improvements have either been implemented at the site
22 or addressed by a SAMA in the current evaluation (Entergy 2007). These improvements are
23 discussed in Section G.3.2.

24 There have been three revisions to the IP2 PSA model and two revisions to the IP3 PSA model
25 since the respective IPE submittals. A comparison of the internal events CDF between the IPE
26 submittals and the current PSA models indicates a decrease of approximately 45 and 75
27 percent for IP2 and IP3, respectively (from 3.13×10^{-5} per year to 1.79×10^{-5} per year for IP2 and
28 from 4.40×10^{-5} per year to 1.15×10^{-5} per year for IP3). A description of those changes that
29 resulted in the greatest impact on the internal-event CDF is provided in Sections E.1.4 and
30 E.3.4 of the ER (Entergy 2007) and in response to a staff RAI (Entergy 2008a) and is
31 summarized in Tables G-3a and G-3b for IP2 and IP3, respectively.

Table G-3a. IP2 PSA Historical Summary

PSA Version	Summary of Changes from Prior Model	CDF (per year)
1992	IPE submittal (excluding internal flooding) (RISKMAN)	3.13×10^{-5}
Update	5/2003 PSA Update (RISKMAN) - credited recovery of feedwater and condensate - added treatment of cross-header common-cause failure (CCF) for essential and nonessential service water headers - updated equipment performance and unavailability data - revised human error probabilities based on thermal-hydraulic calculations - updated reactor coolant pump (RCP) seal LOCA model - added treatment of internal flooding events	2.19×10^{-5}
Rev. 0	3/2005 PSA update (Computer-Aided Fault-Tree Analysis code (CAFTA)) - updated initiating event, component failure, and unavailability databases - updated offsite power recovery data per EPRI 1009889 - revised internal flooding analysis, including pipe-break frequencies and human error probabilities - changed CCF model from multiple Greek letter to Alpha method - updated human reliability analysis (HRA) method to the EPRI HRA method - updated RCP seal LOCA model to WCAP-16141 (WOG2000) - updated ISLOCA model to address ISLOCAs inside containment, to credit mitigation only for small LOCAs outside containment, and to remove credit for makeup to the refueling water storage tank (RWST)	1.71×10^{-5}
Rev. 1	2/2007 PSA update - updated selected initiating event frequencies - updated offsite power recovery model per NUREG/CR-6890 - included CCF for plugging service water pump strainers - revised model to reflect that normal offsite power feeds to the 480-V ac safeguards buses do not trip on a safety injection (SI) signal without a concurrent loss of offsite power - added credit for Indian Point Unit 1 (IP1) station air compressors for scenarios that do not involve loss of offsite power - revised auxiliary feedwater (AFW) success criterion to require flow to two (rather than one) steam generators for normal (non-ATWS) response	1.79×10^{-5}

1

Table G-3b IP3 PSA Historical Summary

PSA Version	Summary of Changes from Prior Model	CDF (per year)
1994	IPE submittal (including internal flooding CDF of 6.5×10^{-6})	4.40×10^{-5}
Rev. 1	6/2001 PSA Update - updated initiating event, component failure, and unavailability databases - updated offsite power recovery model per NUREG/CR-5496 - revised and added CCF component groups consistent with the most recent probabilistic risk assessment (PRA) practices, and updated CCF data - revised HRA to reflect EOP changes - updated RCP seal LOCA model per Brookhaven model, including credit for qualified high-temperature RCP seals	1.35×10^{-5}
	- incorporated major plant design changes, including: • replacement of power-operated relief valves (PORVs) to eliminate leakage and allow operation with the block valve open • reassignment of power supplies to emergency diesel generator (EDG) room exhaust fans to eliminate dependencies • modification of backup battery charger 35 to be able to be powered from 480-V MCC 36C, 36D, or 36E • installation of a diesel-driven station air compressor. • installation of temperature detectors to provide control room alarm if high temperature on the 15 and 33 feet (ft) elevation of the control building • installation of a waterproof door to the deluge valve station	
Rev. 2	2/2007 PSA Update - added a total loss of service water initiating event - updated offsite power recovery model per NUREG/CR-6890 - changed CCF model from modified Beta method to Alpha method - updated RCP seal LOCA model to WCAP-16141 (WOG2000) - revised AFW success criterion to require flow to two (rather than one) steam generators for normal (non-ATWS) response - modified success criteria for cooling of internal recirculation pumps to remove credit for cooling by redundant systems - removed the credit for an offsite gas turbine (which is no longer maintained)	1.15×10^{-5}

Appendix G

1 The CDF values from the IP2 and IP3 IPE submittals (3.13×10^{-5} per year and 4.40×10^{-5} per
2 year, respectively) are near the average of the CDF values reported in the IPEs for pressurized-
3 water reactors (PWRs) with dry containments. Figure 11.2 of NUREG-1560 shows that the IPE-
4 based total internal events for these plants range from 9×10^{-8} to 8×10^{-5} per year, with an
5 average CDF for the group of 2×10^{-5} per year (NRC 1997b). The NRC staff recognizes that
6 other plants have updated the values for CDF subsequent to the IPE submittals to reflect
7 modeling and hardware changes. The current internal event CDF results for IP2 and IP3
8 (1.79×10^{-5} per year and 1.15×10^{-5} per year, respectively) are comparable to those for other
9 plants of similar vintage and characteristics.

10 The NRC staff considered the peer reviews performed for the IP2 and IP3 PSAs and the
11 potential impact of the review findings on the SAMA evaluation in order to reach a conclusion
12 regarding adequacy of the PRA to support SAMA evaluation. In the ER, Entergy described the
13 peer review by the (former) Westinghouse Owner's Group (WOG) of the IP2 PSA model,
14 conducted in May 2002, and of the IP3 PSA model, conducted in January 2001. The IP2 model
15 reviewed was an updated version of the IPE that predated the May 2003 version described in
16 Table G-3a. Similarly, the IP3 model reviewed was an updated version of the IPE that predated
17 the June 2001 version described in Table G-3b.

18 For both IP2 and IP3, the ER states that all of the technical elements were graded as sufficient
19 to support applications requiring the capabilities defined for grade 2 (e.g., risk-ranking
20 applications). In addition, most of the elements were further graded as sufficient to support
21 applications requiring the capabilities defined for grade 3 (e.g., risk-informed applications
22 supported by deterministic insights).

23 For IP2, the ER states that there were no Level A findings (for which immediate model changes
24 would have been appropriate) from the peer review. Although a number of minor model
25 corrections were made following the peer review, no significant changes were made to the
26 model structure or underlying assumptions in the May 2003 PSA update. The IP2 model was
27 subsequently converted from the support-state RISKMAN model to a linked-fault-tree CAFTA
28 model. Entergy indicates that the conversion effort included a number of modeling changes for
29 consistency with other Entergy models and addressed the remaining findings and observations
30 (F&Os) from the IP2 Peer Review (i.e., Level B, C, and D F&Os), where appropriate. In
31 addition, the issues raised during the peer review of the IP3 model were also examined for
32 applicability to IP2; all applicable issues were addressed consistent with the treatment used for
33 IP3. For IP3, the ER states that all Level A and B F&Os from the IP3 peer review were
34 addressed in the final version of the Revision 1 PSA model for IP3, which was issued in
35 June 2001, and that less significant (Level C & D) F&Os were addressed, where appropriate.

36 Entergy indicates that the model changes incorporated in the IP2 Revision 1 and the IP3
37 Revision 2 PSA models also underwent an internal independent review by Entergy PSA staff
38 and plant personnel and were subjected to a focused self-assessment to demonstrate technical
39 quality in preparation for the NRC Mitigating Systems Performance Indicator (MSPI) program in
40 2006. In addition, the IP2 model was also subjected to a weeklong review by a team of industry
41 peers from outside the Entergy staff in July 2005. Finally, the ER indicates that the model
42 changes in the IP2 Revision 1 and the IP3 Revision 2 PSA models were peer reviewed for
43 accuracy and consistency by members of the Entergy Nuclear Systems Analysis Group not
44 directly involved in their implementation (Entergy 2007).

1 Given that the IP2 and IP3 internal events PSA models have been peer reviewed and the peer
2 review findings were either addressed or judged to have no adverse impact on the SAMA
3 evaluation, and that Entergy has satisfactorily addressed the NRC questions regarding the PSA
4 (NRC 2007, NRC 2008, Entergy 2008a, Entergy 2008b), the NRC staff concludes that the
5 internal events Level 1 PSA model for the plants is of sufficient quality to support the SAMA
6 evaluation.

7 Section E.1.4 of the ER states that, for IP2, internal flooding was examined as part of the
8 IPEEE, while Section E.3.4 indicates that internal flooding was included in the IP3 IPE. Internal
9 flooding was later incorporated into the IP2 May 2003 PSA update, resulting in the consistent
10 treatment of internal flooding for the two units.

11 The IP2 IPEEE analysis of internal flooding yielded a CDF of 6.6×10^{-6} per year while the IP3 IPE
12 internal flooding analysis yielded a CDF of 6.5×10^{-6} per year. For each plant, three scenarios
13 accounted for more than 80 percent of the flood CDF. All these scenarios result in a reactor trip
14 and the nonrecoverable loss of safety-related switchgear from flooding sources located in or
15 adjacent to the each unit's 480-V switchgear room.

16 The internal flooding analysis was included in the WOG peer review. In response to an RAI,
17 Entergy provided a detailed discussion on the incorporation of peer review comments for IP2
18 and IP3. For IP2, the licensee indicated that there were only two WOG peer review findings
19 associated with the internal flooding analysis.

20 The first finding related to use of a flooding event screening criterion of 1×10^{-6} per year in the
21 analysis. That criterion, however, was only applied to a scenario involving the potential for
22 intercompartmental flooding from the EDG building to the electrical tunnel and involved leakage
23 that could be accommodated by existing plant drains rather than catastrophic failure. Therefore,
24 it was determined that screening of this scenario was appropriate and a model change was not
25 needed.

26 The second finding was a general concern that the flooding study had not been updated since
27 1993. The IP2 internal flooding analysis was subsequently updated in 2005 (Entergy 2008a).
28 For IP3, the licensee indicated that the IP3 WOG peer review concluded that the internal
29 flooding analysis demonstrated a superior combination of industry data and models to obtain
30 plant-specific piping rupture frequencies. The peer review identified four F&Os related to the
31 internal flooding analysis. One F&O was a strength that warranted no change to the model.
32 The other findings related to incorporation of historical data, assembly of walkdown records, and
33 consideration of applicable draft American Society of Mechanical Engineers (ASME) standards
34 to enhance the flooding analysis. The findings related to the incorporation of historical data and
35 to the assembly of walkdown records were resolved during preparation of the final version of
36 Revision 1 of the IP3 PSA model. The draft ASME standards identified by the review team were
37 reviewed, and no modeling changes were warranted. Therefore, all internal flooding review
38 comments that affect the model were addressed in the model used for the SAMA analysis
39 (Entergy 2008a).

40 As indicated above, the current IP2 and IP3 PSA models do not include external events. In the
41 absence of such an analysis, Entergy used the IP2 and IP3 IPEEEs, in conjunction with minor
42 adjustments in fire and seismic scenarios, to identify the highest risk accident sequences and
43 the potential means of reducing the risk posed by those sequences, as discussed below.

Appendix G

The IP2 and IP3 IPEEEs were submitted in December 1995 (Con Ed 1995) and September 1997 (NYPA 1997), in response to Supplement 4 of GL 88-20 (NRC 1991). These submittals included a seismic PRA analysis, a fire PRA, a high-wind risk model, and a screening analysis for other external events. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified, several opportunities for risk reduction were identified and implemented, as discussed below. In letters dated August 13, 1999, and February 15, 2001, the NRC staff concluded that the submittals for IP2 and IP3 generally met the intent of Supplement 4 to GL 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC 1999 and 2001). For IP3, the NRC staff identified an issue related to misdirection of manual fire suppression, which can fail equipment, but decided to resolve that issue separately from the IPEEE.

The IPEEE seismic analyses employed a seismic PSA following the guidance of NUREG-1407. The IPEEE estimated a seismic CDF of 1.46×10^{-5} and 4.4×10^{-5} per year for IP2 and IP3, respectively. Components related to decay heat removal were modeled in the seismic PSA for both units. No unique decay-heat removal vulnerabilities were found for either unit based on the quantitative risk results. Seismic-induced flooding and fires were examined as part of the IPEEE process for both units. Specific seismic-fire interactions were identified by Entergy, as listed in Table 2.12 of NUREG-1742 (NRC 2002). However, upon further consideration, the NRC staff concluded that the contribution to the CDF is small because the conditional probability of a fire, given an earthquake, is small (NRC 2001). For IP2 and IP3, the IPEEEs also addressed the issue of relay chattering through a detailed examination of the relays used in IP2 against the low-capacity relay list found in Appendix D of Electric Power Research Institute (EPRI) NP-7148-SL. A list of the dominant contributors to the seismic CDF for IP2 and IP3 is provided in Tables G-4a and G-4b, based on the information provided in response to an RAI (Entergy 2008a).

In Section 4.21.5.4 of the ER, Entergy noted that conservative assumptions were used in the seismic analyses, including the use of a single, conservative surrogate element to model the most seismically rugged components, the assumption that redundant components are completely correlated in determining the probability of seismic-induced failure, and the assumption that seismic-induced ATWS events are not recoverable. For purposes of the SAMA evaluation, Entergy performed a reevaluation of the seismic CDF, as discussed below. For IP2, as a result of an IPEEE recommendation, the CCW surge tank hold-down bolts were upgraded. This effectively eliminated the contribution from the failure of the CCW surge tank, reducing the seismic CDF for IP2 from 1.46×10^{-5} per year to approximately 1.06×10^{-5} per year. For IP3, no seismic improvements were recommended. However, Entergy reevaluated the seismic PSA to reflect updated random component failure probabilities and to model recovery of onsite power and local operation of the turbine-driven AFW pump. This reduced the seismic CDF for IP3 from 4.4×10^{-5} per year to 2.65×10^{-5} per year. These reduced CDF values were used in developing the external events multipliers in the SAMA benefit analysis, as discussed later.

1 **Table G-4a. IP2 Seismic Scenarios and Their Contribution to Seismic CDF**

Seismic Scenario Description	CDF (per year)	
	Frequency	Percent Contribution
failure of CCW, primarily caused by failure of surge tank hold-down bolts	4.2×10^{-6}	29
failure of the turbine building frame and consequential failure of control building	3.5×10^{-6}	24
collapse of IP1 super heater stack onto control building	3.0×10^{-6}	21
loss of 480 V emergency power	1.3×10^{-6}	9
loss of service water (seismic failure of service water pumps)	1.3×10^{-6}	9
seismic-induced loss of offsite power	4.4×10^{-7}	3
Other	7.4×10^{-7}	5
Total Seismic CDF from Dominant Scenarios	1.46×10^{-5}	100

2 **Table G-4b IP3 Seismic Scenarios and Their Contribution to Seismic CDF**

Seismic Scenario Description	CDF (per year)	
	Frequency	Percent Contribution
loss of 480-V ac electric power with consequential RCP seal LOCA	1.9×10^{-5}	43
loss of CCW with consequential RCP seal LOCA	1.0×10^{-5}	23
loss of offsite power with seismic failures of the RHR heat exchangers, the condensate stage tank, containment instrument racks, and AFW	9.2×10^{-6}	21
surrogate element (represents screened out, rugged components and structures, where failure leads to core damage)	3.5×10^{-6}	8
seismic-induced ATWS	2.2×10^{-6}	5
Total Seismic CDF from Dominant Scenarios	4.4×10^{-5}	100

Appendix G

The IPEEE fire analyses employed a combination of PRA with the EPRI's fire-induced vulnerability evaluation methodology. The evaluation was performed in four phases:

- (1) qualitative screening
- (2) quantitative screening
- (3) fire damage evaluation screening
- (4) fire scenario evaluation and quantification

Each phase focused on those fire areas that did not screen out in the prior phases. The final phase involved using the IPE model for internal events to quantify the CDF resulting from a fire-initiating event. Each fire area that remained after screening was then treated as a separate initiating event and was propagated through the model with the appropriate model modifications, as necessary. The CDF for each area was obtained by accounting for the frequency of a fire in a given fire area; the conditional core damage probability associated with that fire scenario in the fire area, including, where appropriate, the impact of fire suppression; and fire propagation. The potential impact on containment performance and isolation was evaluated following the core damage evaluation. The total fire CDF from the IPEEE was estimated to be 1.8×10^{-5} per year for IP2 (Con Ed 1995) and 5.6×10^{-5} per year for IP3 (NYPA 1997).

In Section 4.21.5.4 of the ER, Entergy noted that conservative assumptions were used in the IPEEE fire analyses, including overestimation of the frequency and severity of fires; conservative treatment of open, hot short, and short-to-ground circuits; and assumption of a plant trip for all fires. For purposes of the SAMA evaluation, Entergy performed a reevaluation of the fire CDF, as discussed below.

- For IP2, Section E.1.3.2 of the ER notes that the IP2 IPEEE fire model had the following known conservatisms:
 - The main feedwater and condensate systems were assumed to be unavailable in all scenarios, even when their power source was not affected by the fire scenario.
 - The pressurizer PORV block valves were assumed to be in the limiting position (open or closed) to maximize the impact of the fire.
 - All sequences involving RCP seal LOCAs were assumed to lead to complete seal failure.

For the purpose of the SAMA evaluation, Entergy reevaluated the dominant IPEEE fire sequences (sequences with CDF contributions greater than 1×10^{-7} per year) to reduce the conservatisms associated with main feedwater and condensate unavailability and PORV block valve assumptions and to reflect updated modeling associated with RCP-seal LOCAs. In response to a RAI, Entergy explained that other portions of the fire analysis methodology and modeling were not revised as part of the SAMA update. Entergy also noted that preliminary fire analysis results were inadvertently included in the ER and provided a corrected, revised IP2 fire CDF value of 8.4×10^{-6} per reactor year (Entergy 2008a). These revised results are included in Table G-5a and were used in developing the external events multiplier in the SAMA benefit analysis.

Similarly, for IP3, Section E.3.3.2 of the ER notes that the IP3 IPEEE fire model had known conservatisms in estimating the fire ignition frequency (e.g., an air compressor ignition

frequency did not take into account that the compressor would operate only for a total of about 5 days per year). Also, at the time of IPEEE, the automatic suppression systems in some plant areas were placed in “manual” mode because of concerns with seismic interactions. Subsequently, some fire suppression systems were extensively modified so that the suppression mode could have been returned to “automatic.” As part of the update for the purpose of SAMA evaluations, Entergy performed a reanalysis of the fire CDF and provided a revised IP3 fire CDF value of 2.55×10^{-5} per year (Entergy 2007). These revised results are included in Table G-5b and were used to develop the external events multiplier in the SAMA benefit analysis.

Table G-5a. IP2 Fire Areas and Their Contribution to Fire CDF

Fire Area	Area Description	CDF (per year)	
		IPEEE	Fire Reanalysis
1A	electrical tunnel/pipe penetration area	9.2×10^{-7}	6.6×10^{-7}
2A	primary water makeup area	1.1×10^{-6}	5.1×10^{-7}
11	cable spreading room	4.3×10^{-6}	2.0×10^{-6}
14	switchgear room	3.8×10^{-6}	1.4×10^{-6}
15	Control room	7.1×10^{-6}	3.0×10^{-6}
74A	electrical penetration area	1.1×10^{-6}	7.3×10^{-7}
6A	Drumming and storage station	1.5×10^{-9}	1.5×10^{-9}
32A	cable tunnel	9.6×10^{-8}	9.6×10^{-8}
1	CCW pump room	2.2×10^{-9}	2.2×10^{-9}
22/63A	Service water intake	7.5×10^{-9}	7.5×10^{-9}
23	AFW pump room	6.2×10^{-9}	6.2×10^{-9}
Total Fire CDF from Major Fire Areas		1.8×10^{-5}	8.4×10^{-6}

Table G-5b. IP3 Fire Areas and Their Contribution to Fire CDF

Fire Area	Area Description	CDF (per year)	
		IPEEE	Fire Reanalysis
14	480-V switchgear room	3.5×10^{-5}	1.3×10^{-5}
11	cable spreading room	6.8×10^{-6}	5.3×10^{-6}
15	Control room	3.7×10^{-6}	3.7×10^{-6}
14/37A	480-V switchgear room/south turbine building	4.5×10^{-6}	1.8×10^{-7}
10	diesel generator 31	2.1×10^{-6}	2.0×10^{-6}
102A	diesel generator 33	1.9×10^{-6}	4.7×10^{-9}
60A	upper electrical tunnel	7.1×10^{-7}	7.1×10^{-7}
101A	diesel generator 32	3.4×10^{-7}	5.2×10^{-9}
7A	lower electrical tunnel	2.8×10^{-7}	2.8×10^{-7}

Appendix G

1

Table G-5b (continued)

Fire Area	Area Description	CDF (per year)	
		IPEEE	Fire Reanalysis
23	AFW pump room	2.3×10^{-7}	2.3×10^{-7}
37A	south turbine building elevation 15 ft	3.8×10^{-8}	3.8×10^{-8}
17A	primary auxiliary building (PAB) corridor	3.2×10^{-8}	3.2×10^{-8}
Total Fire CDF from Major Fire Areas		5.6×10^{-5}	2.6×10^{-5}

2 For high-wind and tornado events, the ER noted that IP2 structures and systems predate the
3 1975 Standard Review Plan (SRP) criteria. Therefore, a detailed PRA was developed as part of
4 the IPEEE analysis to address the impact of high-wind events at IP2. The equipment of
5 concern includes that located within sheet metal clad structures (e.g., the gas turbine and AFW
6 components) and equipment in the yard, including the condensate storage tank (CST) and
7 service water pumps. The CDF for high-wind events was estimated in the IPEEE to be
8 3.03×10^{-5} per year. In Section E.1.3.3.1 and E.1.4.3 of the ER, Entergy noted that its planned
9 removal of the gas turbines from service would reduce the probability of recovering power from
10 the offsite gas turbine location (as modeled in the PRA), but as shown by a sensitivity analysis
11 this impact would be offset by the increased reliability and ruggedness of the new IP2
12 SBO/Appendix R diesel generator relative to that of the gas turbines. Accordingly, Entergy used
13 the IPEEE high-wind CDF of 3.03×10^{-5} per year in determining the external event multiplier for
14 IP2, as discussed later.

15 The IP3 structures and systems also predate the SRP criteria, but the IPEEE found the
16 estimated CDF for high-wind events to be below the 10^{-6} per year screening criterion (from
17 NUREG-1407). This conclusion is based in part on the assumption that high water levels are
18 maintained in the condensate storage and city water storage tank, thus preventing significant
19 wind load and pressure differential damage to the tanks that provide water to the AFW system
20 (NYPA 1997). Because of the low CDF value, the IP3 external-event multiplier does not
21 explicitly account for risks associated with high-wind and tornado events.

22 The IP2 and IP3 IPEEE submittals examined a number of other external hazards, including
23 external flooding, ice formation, and accidents involving hazardous chemicals, transportation
24 (e.g., accidental aircraft impacts), or nearby industrial facilities. These evaluations followed the
25 screening and evaluation approaches specified in Supplement 4 to GL 88-20 (NRC 1991). No
26 risks to the plant from external floods, ice formation, or accidents involving hazardous
27 chemicals, transportation, or nearby facilities, were identified that might lead to core damage
28 with a predicted frequency in excess of 10^{-6} per year (Con Ed 1995 and NYPA 1997). For IP3,
29 scenarios involving hydrogen explosions within the turbine building, the pipe trench between the
30 PAB and containment, the hydrogen shed area in the containment access facility, and the pipe
31 chase on the 73-ft elevation of the northeast corner of the PAB were identified that, in total,
32 could result in core damage with an estimated frequency slightly above 10^{-6} per year. As a
33 result, Phase II SAMA 53 was identified to evaluate the change in plant risk from plant
34 modifications to install an excess flow valve to reduce the risk associated with hydrogen
35 explosions inside the turbine building or PAB. Entergy noted that the risks from deliberate
36 aircraft impacts were explicitly excluded, since this was being considered in other forums, along
37 with other sources of sabotage.

1 Based on the aforementioned results, Entergy estimated that the external event CDF is
2 approximately 2.8 and 4.52 times that of the internal-event CDF for IP2 and IP3, respectively.
3 For IP2, this factor was based on an internal event CDF of 1.79×10^{-5} per year, a seismic CDF of
4 1.06×10^{-5} per year, a fire CDF of 8.4×10^{-6} per year, and a high-wind CDF contribution of
5 3.03×10^{-5} per year. For IP3, this factor was based on an internal-event CDF of 1.15×10^{-5} per
6 year, a seismic CDF of 2.65×10^{-5} per year, and a fire CDF of 2.55×10^{-5} per year. Accordingly,
7 the total CDF from internal and external events would be approximately 3.8 times the internal-
8 event CDF for IP2 and 5.5 times the internal event CDF for IP3.

9 In the SAMA analysis submitted in the ER, Entergy increased the benefit that was derived from
10 the internal-event model by a factor 3.8 and 5.5 to account for the combined contribution from
11 internal and external events for IP2 and IP3, respectively. For SAMA candidates that address
12 only a specific external event and have no bearing on internal-event risk (e.g., IP2 SAMA 66—
13 Harden EDG Building Against High Winds), Entergy derived the benefit directly from the
14 external-event risk model and then increased the benefit by the multipliers identified earlier.
15 This resulted in a bounding benefit for the SAMA candidates addressing a specific external
16 event. The NRC staff agrees with the licensee's overall conclusion concerning the impact of
17 external events and concludes that the licensee's use of a multiplier of 3.8 and 5.5 for IP2 and
18 IP3, respectively, to account for external events is reasonable for the purposes of the SAMA
19 evaluation. This is discussed further in Section G.6.2.

20 The NRC staff reviewed both the general process used by Entergy to translate the results of the
21 Level 1 PSA into containment releases and the results of the Level 2 analysis, as described in
22 the ER and in response to the NRC staff RAIs (Entergy 2007 and 2008a). The containment
23 designs and the Level 2 analyses are similar for IP2 and IP3. The NRC staff notes that, after
24 reviewing information provided by Entergy, the current Level 2 PSA models are based on the
25 IPE models, with updates to reflect changes to the plant and modeling techniques, including a
26 3.3 percent and 4.8 percent power uprate for IP2 and IP3, respectively; inclusion of additional
27 PDSs to improve the Level 1–Level 2 PSA interface; and updated accident progression and
28 source term analyses using a later version of the MAAP computer code.

29 The Level 1 core damage sequences are placed into one of 57 PDS bins that provide the
30 interface between the Level 1 and Level 2 analyses. The PDSs are defined by a set of
31 functional characteristics for system operation that are important to accident progression,
32 containment failure, and source-term definition. The Level 2 models use a single CET with
33 functional nodes representing both systemic and phenomenological events. The CET is used to
34 determine the appropriate release category for each Level 2 sequence. CET nodes are
35 evaluated using supporting fault trees and logic rules.

36 Entergy characterized the releases for the spectrum of possible radionuclide release scenarios
37 using a set of nine release categories, defined based on the timing and magnitude of the
38 release and whether the containment remains intact, fails, or is bypassed. The frequency of
39 each release category was obtained by summing the frequency of the individual accident
40 progression CET endpoints binned into the release category. The release characteristics for
41 each category were obtained by frequency weighting the release characteristics for each CET
42 endstate contributing to the release category. The source-term release fractions for the CET
43 endstates were estimated based on the results of plant-specific analyses of the dominant CET
44 scenarios using the MAAP (Version 4.04) computer program. The release categories and their
45 frequencies and release characteristics are presented in Tables E.1-10 and E.3-10 of the ER.

Appendix G

During the review of the Level 2 analysis, the NRC staff could not determine the modeling approach used to assess the likelihood of a thermally induced SGTR (TI-SGTR) following core damage in the current IP2 and IP3 PSAs. Entergy explained that TI-SGTR events are considered in the Level 2 analyses for two conditions:

- (1) high reactor cooling system (RCS) pressure and steam generators dry (no secondary-side cooling)
- (2) high RCS pressure and steam generators initially dry, with recovery of secondary-side cooling before challenging the steam generator tubes

The first condition applies to transient event sequences in which RCS pressure is at the pressurizer PORV setpoint at the time of core damage. No credit is taken for recovery of secondary-side cooling in these sequences. Entergy states that a TI-SGTR probability of 0.01 is used for this case, based on Table 2-1 of NUREG/CR-4551, Volume 2, Revision 1, Part 1, which shows a distribution that ranges from 10^{-5} to 0.1208 and a mean value of 0.018. The second condition applies to SBO sequences in which RCS pressure is at the pressurizer PORV setpoint at the time of core damage. Entergy states that a TI-SGTR probability of 5×10^{-4} is used for this SBO case, based on the expectation that the steam generators will not dry out until after battery depletion and that secondary-side cooling and other mitigating system functions could be recovered before that time. The value is stated as being derived from the transient case value of 0.01 combined with the human error probability of 5.2×10^{-2} for failure to align AFW following ac power recovery. Entergy explained that a stuck-open main steam safety valve or other secondary-side depressurization event is required to create the large differential pressure needed for the conditional TI-SGTR probabilities assumed above and that the Level 2 analyses conservatively did not account for the probability that these additional failures do not occur (Entergy 2008b). A sensitivity analysis that increases the probability of the TI-SGTR was developed at the staff's request and is described in Section G.6.2.

The NRC staff's reviews of the Level 2 IPEs for IP2 and IP3 concluded that the analyses addressed the most important severe accident phenomena normally associated with large dry containments and identified no significant problems or errors (NRC 1995 and 1996). It should be noted, however, that the current Level 2 models are revisions to those of the IPE. The Level 2 PSA models were included in the WOG peer reviews mentioned previously. The changes to the Level 2 models to update the methodology and to address the peer review recommendations are described in Sections E.1.4 and E.3.4 of the ER (Entergy 2007) and in response to an RAI concerning peer review findings related to the Level 2 PSA model (Entergy 2008a).

In the RAI response, Entergy provided a detailed discussion of all the changes that resulted from the incorporation of the WOG peer review of the Level 2 PRA. For IP2, the licensee indicated that there were two Level C F&Os related to the Level 2 analysis. One issue dealt with treatment of containment failure from energetic events (e.g., direct containment heating, hydrogen combustion, in-vessel steam explosions, and ex-vessel steam explosions). The other issue related to treatment of a stuck-open main steam safety valve following an SGTR core damage event. Entergy indicated that all peer review recommendations associated with the WOG review were incorporated in Revision 0 of the IP2 PSA (3/2005).

For IP3, Entergy indicated that there were six F&Os from the WOG peer review team related to the Level 2 analysis:

- One F&O was related to the containment strength that was considered for a plant-specific containment structural analysis.
- One Level A F&O recommended that the LERF definition include the release of iodine as well as cesium and tellurium.
- Two Level B F&Os were related to justification for the value used for ex-vessel explosions, and an overestimation of the “Alpha mode”-induced containment failure probability.
- One Level C F&O recommended crediting repair and recovery of systems that affect containment performance.
- One Level D F&O was related to documentation.

Entergy indicated that all Level A and B F&Os were resolved and that changes were incorporated as necessary in Revision 1 of the IP3 PSA (6/2001). Entergy also stated that the Level C and D F&Os were addressed, as appropriate, in the next revision of the model (Revision 2, 2/2007).

Based on the NRC staff’s review of the Level 2 methodology, the fact that the Level 2 model was reviewed in more detail as part of the WOG peer review and updated to address peer review findings, and Entergy’s responses to the RAIs, the NRC staff concludes that the Level 2 PSAs for IP2 and IP3 are technically sound and provide an acceptable basis for evaluating the benefits associated with various SAMAs.

As indicated in the ER, the estimated IP2 and IP3 reactor core radionuclide inventories used in the MACCS2 input are based on the current core configuration and a power level of 3216 megawatt thermal (MWt). The information was derived from Westinghouse Electric Company, Core Radiation Sources to Support IP2 and IP3 2 Power Uprate Project, and Westinghouse Electric Company, Core Radiation Sources to Support IP2 and IP3 3 Stretch Power Uprate (SPU) Project, CN-REA-03-40 (3/7/2005). In response to an RAI, Entergy confirmed that the current core design and operational practice are consistent with this analysis and that there are no planned future changes to reactor power level or fuel management strategies that would affect the reactor core radionuclide inventory used in the MACCS2 analysis (Entergy 2008a).

The NRC staff reviewed the process used by Entergy to extend the containment performance (Level 2) portion of the PSA to an assessment of offsite consequences (essentially a Level 3 PSA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was used to estimate offsite consequences. Plant-specific input to the code includes the source terms for each release category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within an 80-kilometer (50-mile) radius for the year 2035, emergency evacuation modeling, and economic data. This information is provided in Sections E.1.5 and E.3.5 of the ER for IP2 and IP3, respectively (Entergy 2007).

Entergy used site-specific meteorological data for the 5 years, 2000 through 2004, as input to the MACCS2 code. Entergy averaged the data over this interval for this study. The 5-year data included 43,848 consecutive hourly values of windspeed, wind direction, precipitation, and temperature recorded at the IP2 and IP3 meteorological tower from January 2000 to

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December 2004. Missing data were estimated using data substitution methods. These methods include substitution of missing data with valid data from the previous hour and substitution of valid data collected from other elevations on the meteorological tower. The NRC staff notes that previous SAMA analyses have shown little sensitivity to year-to-year differences in meteorological data and concludes that the approach taken for collecting and applying the meteorological data in the SAMA analysis is reasonable.

The population distribution the licensee used as input to the MACCS2 analysis was estimated for the year 2035 based on information from the New York Statistical Information System from 2000 to 2030, the New Jersey Department of Labor and Workforce Development from 2000 to 2025, the Connecticut State Data Center from 2000 to 2020, and the Pennsylvania State Data Center from 2000 to 2020. These data were used to project county-level resident populations to the year 2035 using regression analysis. The 2035 transient population was assumed to be the 2004 transient-to-permanent population ratio multiplied by the extrapolated permanent population. The 2004 transient data were obtained from State tourism agencies. The NRC staff notes that Entergy's projected 2035 population within a 50-mile radius of IP2 and IP3 reported in Tables E.1-12 and E.3-12 of the Entergy ER (19.2 million people) is approximately 15 percent greater than the 50-mile population obtained from NRC SECPOP2000 code (16.8 million) for the year 2003 (NRC 2003). This represents an average annual growth rate of 0.4 percent, which comports with Entergy's estimated growth rates reported in section 2.6.1 of the Entergy ER. The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for the purposes of the SAMA evaluation.

Entergy did not credit evacuation either as part of the base-case analysis or for estimating the benefit from SAMA cases. Entergy assumed a "no evacuation scenario" to conservatively estimate the population dose. In response to a RAI, Entergy clarified that the "no evacuation scenario" assumes that individuals within the 10-mile evacuation zone continue normal activity following a postulated accident without taking emergency response actions such as evacuation or sheltering. Relocation actions within a 50-mile radius of the plant are still modeled in the "no evacuation scenario." As such, individuals within hot spots or high-radiation areas anywhere within the 50-mile zone are assumed to be relocated outside the 50-mile zone until long-term protective actions reduce radiation levels (Entergy 2008a). As used in the MACCS2 code, "evacuation" refers to the prompt movement of the population out of an affected region (e.g., certain sectors of the EPZ) during the emergency-phase time period immediately following an accident, in accordance with the emergency evacuation plan. "Relocation" refers to the movement of the population out of an affected region (e.g., within hot spots or high radiation areas) during the intermediate phase or long term phase based on longer-term dose considerations. The NRC staff concludes that the evacuation and relocation assumptions and analysis are generally conservative and acceptable for the purposes of the SAMA evaluation.

Much of the site-specific economic data was obtained from the 2002 Census of Agriculture (USDA 2002). These include the value of farm and nonfarm wealth. Other data, such as population relocation cost, daily cost for a person who is relocated, and cost of farm and nonfarm decontamination were obtained from the Code Manual for MACCS2 (NRC 1997c). The data from the MACCS2 Code Manual were inflation-adjusted using the consumer price index corresponding to the year 2005. Information on regional crops was obtained from the 2002 Census of Agriculture. Crops for each county were mapped into the seven MACCS2 crop categories.

MACCS2 requires an average value of nonfarm wealth (identified as VALWNF in MACCS2). The county-level nonfarm property value was used as a basis for deriving VALWNF and resulted in a value of \$163,631 per person. This does not explicitly account for the economic value associated with tourism and business. In the ER, Entergy assessed the impact of including tourism and business losses using a sensitivity case. This sensitivity case assumed a loss of \$208,838 per person in the affected region, as opposed to \$163,631 per person in the base case. The NRC staff questioned the basis for the modified VALWNF value (\$208,838 per person) and the rationale for treating the loss of tourism and business in a sensitivity case rather than in the baseline analysis (NRC 2007). In response, Entergy described the basis for the modified VALWNF value and explained that the impact of lost tourism and business was not modeled in the baseline analysis because the level of tourism and business activity can be reestablished in time. Nevertheless, Entergy provided the results of a revised uncertainty analysis using the modified VALWNF value (Entergy 2008a). As a result, three additional potentially cost-beneficial SAMAs were identified (SAMAs 9 and 53 for IP2 and SAMA 53 for IP3). In response to an RAI, Entergy indicated that these SAMAs have been submitted for engineering project cost-benefit analysis to obtain a more detailed examination of their viability and implementation costs (Entergy 2008b). As described in Section G.6.2, the NRC staff has adopted the case incorporating lost tourism and business as its base case, given that it may take years to re-establish the level of tourism and business activity following a severe accident.

The NRC staff concludes that the methodology used by Entergy to estimate the offsite consequences for IP2 and IP3 provides an acceptable basis from which to proceed with an assessment of the risk reduction potential for candidate SAMAs because the key elements of the methodology are consistent with standard practice. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by Entergy.

G.3 Potential Plant Improvements

This section discusses the process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by Entergy.

G.3.1. Process for Identifying Potential Plant Improvements

Entergy's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the most significant basic events from the current, plant-specific PSA
- review of potential plant improvements identified in the IP2 and IP3 IPE and IPEEE
- review of Phase II SAMAs from license renewal applications for nine other pressurized water reactors
- review of dominant contributors to seismic and fire events in the current seismic and fire analyses
- review of other NRC and industry documentation discussing potential plant improvements

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Based on this process, an initial set of 231 candidate SAMAs for IP2 and 237 candidate SAMAs for IP3, referred to as Phase I SAMAs, was identified. In Phase I of the evaluation, Entergy performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using one of the following criteria:

- The SAMA is not applicable at IP2 and IP3 because of design differences.
- The SAMA has already been implemented at IP2 and IP3.
- The SAMA is similar in nature and could be combined with another SAMA candidate.

Based on this screening, 163 IP2 SAMAs and 175 IP3 SAMAs were eliminated, leaving 68 unique SAMAs for IP2 and 62 unique SAMAs for IP3. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Tables E.2-2 and E.4-2 of the ER (Entergy 2007). In Phase II, a detailed evaluation was performed for each of the remaining SAMA candidates, as discussed in Sections G.4 and G.6 below. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 3.8 for IP2 and 5.5 for IP3, as previously discussed.

G.3.2. Review of Entergy's Process

Entergy's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events but also included explicit consideration of potential SAMAs for seismic and fire. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from functional, initiating event, and risk-reduction worth (RRW) perspectives at IP2 and IP3 and included selected SAMAs from prior SAMA analyses for other plants.

Entergy provided a tabular listing of the PSA basic events, sorted according to their RRW for CDF (Entergy 2007). SAMAs affecting these basic events would have the greatest potential for reducing risk. Entergy used an RRW cutoff of 1.005, which corresponds to about a 0.5-percent change in CDF, given the 100 -percent reliability of the SAMA. This equates to a benefit of approximately \$7,000 for IP2 and IP3 (based on a total benefit of about \$1.3 million for each unit for eliminating all severe accidents caused by internal events). Entergy also provided and reviewed the LERF-based RRW events down to an RRW of 1.005. Entergy correlated the top CDF and LERF events with the SAMAs evaluated in Phase I or Phase II and showed that, with a few exceptions, all of the significant basic events are addressed by one or more SAMAs (Entergy 2007). Of the basic events of high-risk importance that are not addressed by SAMAs, each is closely tied to other basic events that had been addressed by one or more SAMAs.

Entergy considered the potential plant improvements described in the IPE and IPEEE in the identification of plant-specific candidate SAMAs for internal and external events. As a result of the IPE, four major procedural/hardware improvements were identified for each unit. The IP2 enhancements are to (1) upgrade IP2 gas turbine black-start capability, (2) install an additional EDG building fan, (3) monitor changes in the operating position of PORV block valves, and (4) implement periodic testing of all the EDG building fans. The IP3 enhancements are to (1) revise emergency operating procedures (EOPs) to instruct operators to align the backup city water supply to the AFW pumps, should the CST outlet valve fail as indicated by a low-suction-flow alarm, (2) revise the alarm response procedure for a high AFW pump room temperature, to direct operators to open the rollup door to the AFW pump room for ventilation, (3) install a switchgear room high-temperature alarm and implement an associated procedure to direct

1 operators to block open doors to the 480-V ac switchgear room, and (4) revise EOPs to
2 emphasize the need to align the safe-shutdown equipment to MCC 312A during events
3 involving the loss of all 480-V ac safeguard buses while offsite power is available, as well as
4 during fire-related events. These improvements have all been implemented and therefore were
5 not considered further in the SAMA analysis.

6 As a result of the IPEEEs, several improvements were identified for external events. The IP2
7 enhancements are to (1) replace the hold-down bolts for the CCW surge tank with higher tensile
8 strength bolts, (2) add surveillance of the control building drain flapper valve flow, (3) add
9 weather stripping to doors between the transformer area and the switchgear room, and (4) add
10 screens on the 480-V switchgear room equipment. The IP3 enhancements are to (1) restore
11 the carbon dioxide (CO₂) suppression system to automatic mode within the switchgear room,
12 (2) reroute the EDG exhaust fans and the auxiliary cables so that a fire in a single EDG cell
13 would not affect multiple EDGs, and (3) install an excess flow valve to reduce the risk
14 associated with hydrogen explosions inside the turbine building or PAB. With the exception of
15 the last item, all of these improvements have been implemented and therefore were not
16 considered further in the SAMA analysis. As noted in Section E.3.3.3 of the ER, IP3 SAMA 53
17 (install an excess flow valve to reduce the risk associated with hydrogen explosions) was
18 proposed as a result of the IPEEE analysis and retained for the Phase II evaluation.

19 Several concerns were raised in the IPEEE regarding the seismic-induced failures of fire
20 protection equipment (primarily for IP3). As mentioned above, these seismic-fire interactions
21 were judged to be of little risk significance (NRC 2001). One plant improvement identified in
22 Table 2.4 of NUREG-1742 (NRC 2002) addressed the potential spurious operation of the EDG
23 room's CO₂ system and subsequent shutdown of the EDG ventilation system during a seismic
24 event. Entergy subsequently installed a quality assurance Category I, seismic class I actuation
25 permission auxiliary control panel for CO₂ discharge into the EDG building. Since shutdown of
26 EDG ventilation caused by spurious operation of the CO₂ system during a seismic event is not
27 considered in the seismic PSA model, the seismic CDF was not affected by this modification.

28 As noted in Section E.1.3.3.1 of the ER, the IP2 CDF for SBO events with gas turbines
29 unavailable could be reduced by (1) aligning the IP3 Appendix R diesel to IP2, (2) installing an
30 IP2 Appendix R diesel, (3) upgrading the EDG building for high winds, and (4) protecting the
31 alternate power source from tornadoes and high winds. However, with the exception of the third
32 item, these modifications were not evaluated as candidate SAMAs because a modification to
33 replace the existing gas turbines with an IP2 SBO/Appendix R diesel generator capable of being
34 used to recover power to the vital buses following an SBO is planned for the near future. The
35 planned modification includes provisions for aligning the IP3 Appendix R generator to IP2 and
36 for protecting the new alternate power source from tornadoes and high winds.

37 For a number of the Phase II SAMAs listed in the ER, the NRC staff found that information
38 provided did not sufficiently describe the proposed modifications or other considerations that
39 might have been taken into account in estimating the benefit and implementation cost.

40 Therefore, the NRC staff requested, and the licensee provided, more information on certain
41 proposed modifications listed for the Phase II SAMA candidates (NRC 2007, Entergy 2008a).

42 For several SAMA candidates, the staff questioned if lower cost alternatives could have been
43 considered, including:

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- the implementation of improved instrumentation and procedures to help cool down and depressurize the RCS before RWST depletion
- the implementation of a procedure for recovery of steam dump to condenser from the unaffected steam generator
- the implementation of a procedure for recovery of the main feedwater valve/condensate post-SI actuation
- the purchase or manufacture of a “gagging device” that could be used to close a stuck-open steam generator safety valve on an SGTR before core damage occurred
- The reactivation of the IP3 postaccident containment venting system (a system that is still active on IP2 but was deactivated on IP3)

In response, Entergy indicated that most of the low-cost alternatives to aid in the mitigation of an SGTR (4 out of the 5 alternatives dismissed above) have been already implemented and provided specific reasons why the cost of these alternative SAMA candidates would be high enough that the decision on the final SAMA selection would not have been affected. However, the alternative associated with the gagging device was found to be potentially cost beneficial (Entergy 2008a and 2008b). The evaluation of these SAMAs is discussed further in Section G.6.2.

The NRC staff notes that the set of SAMAs submitted is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The NRC staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for IP2 and IP3 and that the set of SAMAs evaluated in the ER, together with those identified in response to the NRC staff inquiries, is reasonably comprehensive and therefore acceptable. The search included reviewing insights from the plant-specific risk studies and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, the NRC staff recognizes that the prior implementation of plant modifications for seismic and fire events, and the absence of external-event vulnerabilities, reasonably justifies examining primarily the internal-event risk results for this purpose.

G.4 Risk-Reduction Potential of Plant Improvements

Entergy evaluated the risk-reduction potential of the remaining 68 IP2 and 62 IP3 SAMAs. The SAMA evaluations were performed using realistic assumptions with some conservatism. On balance, such calculations overestimate the benefits and are conservative.

For all of the SAMAs, Entergy used model requantification to determine the potential benefits. The CDF and population-dose reductions were estimated using the latest version of the IP2 and IP3 PSA models. The changes made to the models to quantify the impact of the SAMAs are detailed in Tables E.2-2 and E.4-2 of the ER (Entergy 2007). Table G-6 lists the assumptions

1 considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk
2 reduction in terms of the percentage of reduction in CDF and population dose, and the
3 estimated total benefit (present value) of the averted risk. The estimated benefits reported in
4 Table G-6 reflect the combined benefit for both internal and external events. The determination
5 of the benefits for the various SAMAs is further discussed in Section G.6.

6 The NRC staff questioned the assumptions used in evaluating the benefits or risk-reduction
7 estimates of a number of SAMAs provided in the ER (NRC 2007). For example, the NRC staff
8 requested information regarding the plant features or modeling assumptions that result in the
9 CCW pumps having limited risk importance. In response, Entergy stated that both units are
10 unique in that the capability exists to initiate backup cooling to key components in the event the
11 primary CCW cooling function is lost. The use of backup city water cooling to the charging
12 pumps enables continued seal injection and therefore reduces the likelihood of an RCP seal
13 LOCA. In IP2, city water backup or primary water can be used to cool the safety injection and
14 residual heat removal (RHR) pumps. In IP3, city water backup is available to cool RHR
15 Pump 31. Also, CCW is not required in either plant during the injection phase of the response
16 to a LOCA. The NRC staff considers the explanation of the plant features, as clarified, to be
17 reasonable and therefore acceptable for the purposes of the SAMA evaluation.

18 For a number of the Phase II SAMAs listed in the ER, the description of the improvement and
19 the associated analyses appeared either inconsistent between the two units or were unclear.
20 Therefore, the NRC staff asked the applicant to provide more detailed descriptions of the
21 modifications for several of the Phase II SAMA candidates (NRC 2007). In response, Entergy
22 provided additional information on those SAMA candidates that further explained the SAMA
23 modifications and the differences between units that account for the different analysis
24 assumptions for each unit (Entergy 2008a). Entergy also provided further clarifications and
25 discussion regarding the analysis assumptions and their bases. As an example, the licensee
26 clarified a major difference in operation of a turbine-driven AFW pump between the two units
27 that affects the disposition of several SAMA candidates. In its response, Entergy indicated that
28 the units respond differently upon depletion of the station batteries. IP2 has pneumatic level
29 and pressure instruments that allow operators to monitor key parameters and effectively control
30 AFW flow after the batteries are depleted, whereas IP3 does not have this instrumentation.
31 Although it is still possible for the operators to manipulate AFW flow, the current IP3 model does
32 not credit this manual operation.

33 In the SAMA analysis submitted in the ER, Entergy increased the benefit that was derived from
34 the internal-event model by factors of 3.8 and 5.5 to account for the combined contribution from
35 internal and external events for IP2 and IP3, respectively. The NRC staff agrees with the
36 licensee's overall conclusion concerning the impact of external events and concludes that the
37 licensee's use of a multiplier of 3.8 and 5.5 for IP2 and IP3, respectively, to account for external
38 events is reasonable for the purposes of the SAMA evaluation. This is discussed further in
39 Section G.6.2.

40 For SAMA candidates that only address a specific external event and have no bearing on
41 internal-event risk (e.g., IP2 SAMA 66—Harden EDG Building Against High Winds), Entergy
42 derived the benefit directly from the external-event risk model and then increased the benefit by
43 the multipliers identified earlier. The NRC staff notes that the use of multipliers for these
44 SAMAs (conceptually, to account for additional benefits in internal events) is unnecessary, since

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these SAMAs have no bearing on internal events. However, use of the multipliers adds conservatism to the benefit estimate for these SAMA candidates.

IP3 SAMA 53 (install an excess-flow valve to reduce the risk associated with hydrogen explosions) was identified to reduce the risk associated with hydrogen explosions inside the turbine building or PAB. The proposed plant modification involves the installation of a nonelectric excess-flow valve. The benefit of this SAMA is also calculated in a bounding manner. As discussed in Section G.6.2, this SAMA was found to be potentially cost beneficial, based on revised analyses submitted in response to an NRC request.

The NRC staff has reviewed Entergy's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on Entergy's risk reduction estimates.

G.5 Cost Impacts of Candidate Plant Improvements

Entergy estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and use of other licensees' estimates for similar improvements. The ER stated that the cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles. The cost estimates provided in the ER also did not account for inflation, which is considered another conservatism.

The NRC staff reviewed the bases for the licensee's cost estimates. For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The NRC staff reviewed the costs and found them to be reasonable and generally consistent with estimates provided in support of other licensees' analyses.

Table G-6. Final Potentially Cost-Beneficial SAMAs for IP2 and IP3 ¹

SAMA	Assumptions	% Risk Reduction		Total Benefit (\$)		Cost (\$)
		CDF	Population Dose	Baseline ² (Int + Ext Events)	Baseline With Uncertainty	
IP2 SAMAs						
9 - Create a reactor cavity flooding system.	Eliminate containment failure caused by concrete-core interaction.	0	48	1.8M	3.8M	3.7M
28 - Provide a portable diesel-driven battery charger.	Eliminate failure of local operation of the turbine-driven AFW pump during SBO scenarios.	5	10	441K	928K	494K
44 - Use fire water system as backup for steam generator inventory.	Eliminate failure of the turbine-driven AFW pump and local operation of AFW during SBO.	33	15	1.0M	2.1M	1.7M
53 - Keep both pressurizer PORV block valves open.	Eliminate failure of PORV block valves to open.	18	4	386K	812K	800K
54 - Install flood alarm in the 480-V ac switchgear room	Reduce control folding initiator frequencies by a factor of 3.	20	40	1.8M	3.8M	200K
56 - Keep RHR heat exchanger discharge MOVs normally open.	Eliminate failure of RHR heat exchanger discharge MOVs to open.	2	18	45K	94K	82K
60 - Provide added protection against flood propagation from stairwell 4 into the 480-V ac switchgear room.	Eliminate flood initiated by a break in fire protection piping in stairwell 4.	5	9	408K	860K	216K
61 - Provide added protection against flood propagation from the deluge room into the 480-V ac switchgear room.	Eliminate flood initiated by a break in the 10" fire protection piping in the deluge room at elevation 15'.	10	20	898K	1.8M	192K
65 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	Eliminate control building flooding initiators.	20	20	1.8M	3.8M	560K

Table G-6 (continued)

SAMA	Assumptions	% Risk Reduction		Total Benefit (\$)		Cost (\$)
		CDF	Population Dose	Baseline ² (Int + Ext Events)	Baseline With Uncertainty	
IP3 SAMAS						
30 - Provide a portable diesel-driven battery charger.	Reduce internal switchgear room floods 5% and increase the time available to recover offsite power before local operation of AFW is required from 2 hours to 24 hours during SBO scenarios.	4 ³	1 ³	100K ³	145K ³	494K
52 - Open city water supply valve for alternative AFW pump suction.	Eliminate loss of the normal suction path to the AFW system.	1	1	71K	103K	50K
53 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	Eliminate hydrogen ruptures inside the turbine building.	2	2	160K	232K	228K
55 – Provide the capability of powering one SI pump or RHR pump using the Appendix R bus (MCC 312A).	Eliminate operator failure to align MCC 312A.	16	18	1.3M	2.0M	1.3M
61 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	Eliminate control building flooding initiators.	17	20	1.4M	2.1M	560K
62 - Install flood alarm in the 480-V ac switchgear room.	Eliminate control building flooding initiators.	17	20	1.4M	2.1M	197K

² The information reproduced by combining the information from ER Tables E.2-2 and E.4-2 and Entergy's response to RAI 4e (Entergy 2008a).

³ Reported benefit values account for risk reduction in both internal and external events and include the economic impact of lost tourism and business following a severe accident. The values do not account for analysis uncertainties.

⁴ SAMA 30 was identified as cost beneficial in the ER. However, an error in the original benefit calculation was discovered subsequent to the ER, as described in Entergy's response to RAI 5g (Entergy 2008a). Reported values in Table G-6 reflect correction of the calculational error. SAMA 30 is no longer cost beneficial after corrections.

The NRC staff questioned the high cost estimate (\$800,000) for changing the pressurizer PORV block valves from normally closed to normally open in conjunction with IP2 SAMA 53 (NRC 2008a). In response, Entergy clarified that a modification had been previously implemented allowing closure of the block valves when operating pressure is less than 2235 pounds per square inch gauge (psig). If the reactor coolant pressure increases to 2300 psig, the current circuitry alarms and sends a signal to open the block valves. The SAMA would reverse this operating approach and may require adding or changing the auto-open feature to a lower value. Entergy provided a breakdown of the estimated cost, which included a \$236,000 contingency cost. As Section 4.21 of the ER states that contingency costs are excluded, the staff requested clarification of this apparent inconsistency. In response, Entergy stated that the site-specific implementation cost estimates include some contingency costs to account for the high degree of uncertainty associated with the preliminary cost estimates and that, given the bounding nature of the benefit analysis, it is reasonable to include contingency costs in these estimates. To eliminate the confusion between Section 4.21 of the ER and the stated practice above, Entergy revised Section 4.21, eliminating the contingency exclusion clause (Entergy 2008b). Considering that this SAMA has been added to the list of potentially cost-beneficial SAMAs (see Section G.6), the staff finds the cost estimate for SAMA 53 to be acceptable. In addition, no other improvement cost estimates were identified as outliers. Therefore, the impact of including contingency costs does not appear to be consequential.

The NRC staff concludes that the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

G.6 Cost-Benefit Comparison

Entergy's cost-benefit analysis and the NRC staff's review are described in the following sections.

G.6.1. Entergy's Evaluation

The methodology used by Entergy was based primarily on the NRC's guidance for performing a cost-benefit analysis (i.e., NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (NRC 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) - COE, where

APE = present value of averted public exposure (\$)

AOC = present value of averted offsite property damage costs (\$)

AOE = present value of averted occupational exposure costs (\$)

AOSC = present value of averted onsite costs (\$)

COE = cost of enhancement (\$)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA, and it is not considered cost beneficial. Entergy's derivation of each of the associated costs is summarized below.

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NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed—one at 3 percent and one at 7 percent (NRC 2004). Entergy performed the SAMA analysis using 7 percent and provided a sensitivity analysis using the 3 percent discount rate in order to capture SAMAs that may be cost-effective using the lower discount rate, as well as the higher, baseline rate (Entergy 2007). This analysis is sufficient to satisfy NRC policy in Revision 4 of NUREG/BR-0058.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

$$\begin{aligned} \text{APE} = & \text{Annual reduction in public exposure } (\Delta \text{person-rem/year}) \\ & \times \text{monetary equivalent of unit dose } (\$2000 \text{ per person-rem}) \\ & \times \text{present value conversion factor } (10.76 \text{ based on a 20-year period with} \\ & \text{a 7 percent discount rate}) \end{aligned}$$

As stated in NUREG/BR-0184 (NRC 1997a), the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk caused by a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss caused by a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, Entergy calculated an APE of approximately \$474,000 for IP2 and \$527,000 for IP3 for the 20-year license renewal period.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

$$\begin{aligned} \text{AOC} = & \text{Annual CDF reduction} \\ & \times \text{offsite economic costs associated with a severe accident (on a per-} \\ & \text{event basis)} \\ & \times \text{present value conversion factor} \end{aligned}$$

For the purposes of initial screening, which assumes all severe accidents caused by internal events are eliminated, Entergy calculated an annual offsite economic cost of about \$45,000 for IP2 and \$53,000 for IP3 based on the Level 3 risk analysis. This results in a discounted value of approximately \$483,000 for IP2 and \$568,000 for IP3 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

$$\begin{aligned} \text{AOE} = & \text{Annual CDF reduction} \\ & \times \text{occupational exposure per core damage event} \\ & \times \text{monetary equivalent of unit dose} \\ & \times \text{present value conversion factor} \end{aligned}$$

Entergy derived the values for AOE from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values that provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook, in conjunction with a monetary equivalent of unit dose of \$2000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents caused by internal events are eliminated, Entergy calculated an AOE of approximately \$7,000 for IP2 and \$4,000 for IP3 for the 20-year license renewal period.

Averted Onsite Costs

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. Entergy derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook (NRC 1997a).

Entergy divided this cost element into two parts—the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs (ACC), and the replacement power cost (RPC).

ACCs were calculated using the following formula:

$$\begin{aligned} \text{ACC} = & \text{Annual CDF reduction} \\ & \times \text{present value of cleanup costs per core damage event} \\ & \times \text{present value conversion factor} \end{aligned}$$

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes all severe accidents caused by internal events are eliminated, Entergy calculated an ACC of approximately \$208,000 for IP2 and \$133,000 for IP3 for the 20-year license renewal period.

Long-term RPCs were calculated using the following formula:

$$\begin{aligned} \text{RPC} = & \text{Annual CDF reduction} \\ & \times \text{present value of replacement power for a single event} \\ & \times \text{factor to account for remaining service years for which replacement} \\ & \text{power is required} \\ & \times \text{reactor power scaling factor} \end{aligned}$$

Entergy based its calculations on the value of 1071 megawatt electric (MWe) and scaled up from the 910 MWe reference plant in NUREG/BR-0184 (NRC 1997b). Therefore, Entergy applied a power-scaling factor of 1071/910 to determine the RPCs. For the purposes of initial screening, which assumes all severe accidents caused by internal events are eliminated, Entergy calculated an RPC of approximately \$166,000 for IP2 and \$107,000 for IP3, and an

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1 AOSC of approximately \$374,000 for IP2 and \$240,000 for IP3 for the 20-year license renewal
2 period.

3 Using the above equations, Entergy estimated the total present dollar-value equivalent
4 associated with completely eliminating severe accidents caused by internal events at IP2 and
5 IP3 to be about \$1.3 million for each unit. Use of a multiplier of 3.8 for IP2 and 5.5 for IP3 to
6 account for external events increases the value to \$5.1 million for IP2 and \$7.4 million for IP3
7 and represents the dollar value associated with completely eliminating the risk of severe
8 accidents caused by all internal and external events at IP2 and IP3, respectively.

9 Entergy's Results

10 If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA
11 was considered by Entergy not to be cost beneficial. In the baseline analysis (using a 7 percent
12 discount rate) and the sensitivity analysis (using a 3 percent discount rate) contained in the ER,
13 Entergy identified 10 potentially cost-beneficial SAMAs (five for IP2 and five for IP3). Based on
14 consideration of analysis uncertainties, Entergy identified two additional potentially cost-
15 beneficial SAMAs for IP2 in the ER (IP2 SAMAs 44 and 56).

16 In response to an NRC staff request, Entergy provided the results of a revised uncertainty
17 analysis in which the impact of lost tourism and business was accounted for in the baseline
18 analysis (rather than as a separate sensitivity case). The revised uncertainty analysis resulted
19 in the identification of two additional potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9
20 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3 SAMA 53).

21 The potentially cost-beneficial SAMAs for IP2 are the following:

- 22 • SAMA 9—Create a reactor cavity flooding system to reduce the impact of core-concrete
23 interaction from molten core debris following core damage and vessel failure (cost
24 beneficial in revised analysis, with uncertainties).
- 25 • SAMA 28—Provide a portable diesel-driven battery charger to improve dc power
26 reliability. A safety-related disconnect would be used to charge a selected battery. This
27 modification would enhance the long-term operation of the turbine-driven AFW pump on
28 battery depletion.
- 29 • SAMA 44—Use fire water as a backup for steam generator inventory to increase the
30 availability of the steam generator water supply to ensure adequate inventory for the
31 operation of the turbine-driven AFW pump during SBO events (cost beneficial with
32 uncertainties).
- 33 • SAMA 53—Keep both pressurizer PORV block valves open. This modification would
34 reduce the CDF contribution from loss of secondary heat sink by improving the
35 availability of feed and bleed (cost beneficial in revised analysis, with uncertainties).
- 36 • SAMA 54—Install a flood alarm in the 480-V ac switchgear room to mitigate the
37 occurrence of internal floods inside the 480-V ac switchgear room.
- 38 • SAMA 56—Keep RHR heat exchanger discharge valves, motor-operated valves 746
39 and 747, normally open. This procedure change would reduce the CDF contribution from
40 transients and LOCAs (cost beneficial with uncertainties).

- 1 • SAMA 60—Provide added protection against flood propagation from stairwell 4 into the
- 2 480-V ac switchgear room to reduce the CDF contribution from flood sources within
- 3 stairwell 4 adjacent to the 480-V ac switchgear room.
- 4 • SAMA 61—Provide added protection against flood propagation from the deluge room
- 5 into the 480-V ac switchgear room to reduce the CDF contribution from flood sources
- 6 within the deluge room adjacent to the 480-V ac switchgear room.
- 7 • SAMA 65—Upgrade the alternate safe shutdown system (ASSS) to allow timely
- 8 restoration of RCP-seal injection and cooling from events that cause a loss of power
- 9 from the 480-V ac vital buses.

10 The potentially cost-beneficial SAMAs for IP3 are the following:

- 11 • SAMA 30—Provide a portable diesel-driven battery charger to improve dc power
- 12 reliability. A safety-related disconnect would be used to charge a selected battery. This
- 13 modification would enhance the long-term operation of the turbine-driven AFW pump on
- 14 battery depletion.
- 15 • SAMA 52—Institute a procedure for opening the city water supply valve for alternative
- 16 AFW system pump suction to enhance the availability of the AFW system.
- 17 • SAMA 53—Install an excess flow valve to reduce the risk associated with hydrogen
- 18 explosions inside the turbine building or PAB (cost beneficial in revised analysis, with
- 19 uncertainties).
- 20 • SAMA 55—Provide the capability of powering one safety injection pump or RHR pump
- 21 using the Appendix R diesel (MCC 312A) to enhance RCS injection capability during
- 22 events that cause a loss of power from the 480-V ac vital buses.
- 23 • SAMA 61—Upgrade the ASSS to allow timely restoration of RCP-seal injection and
- 24 cooling from events that cause a loss of power from the 480-V ac vital buses.
- 25 • SAMA 62—Install a flood alarm in the 480-V ac switchgear room to mitigate the
- 26 occurrence of internal floods inside the 480-V ac switchgear room.

27 In response to an NRC staff inquiry regarding estimated benefits for certain SAMAs and lower
 28 cost alternatives, one additional potentially cost-beneficial SAMA was identified (applicable to
 29 SGTR events in both units), and one SAMA that was previously identified as potentially cost
 30 beneficial was found no longer cost beneficial based on correction of an error in the ER (IP3
 31 SAMA 30). The potentially cost-beneficial SAMAs and Entergy's plans for further evaluation of
 32 these SAMAs are discussed in more detail in Section G.6.2.

33 **6.1.1 Review of Entergy's Cost-Benefit Evaluation**

34 The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184 (NRC
 35 1997a) and was implemented consistent with this guidance.

36 SAMAs identified primarily on the basis of the internal events analysis could provide benefits in
 37 certain external events, in addition to their benefits in internal events. To account for the
 38 additional benefits in external events, Entergy multiplied the internal event benefits for each
 39 internal event SAMA by an amount equal to the ratio of the sum of the internal and external

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event CDF to the internal event CDF. This ratio is approximately 3.8 for IP2 and 5.5 for IP3. Potential benefits in external events were estimated in this manner, since the external-event models are generally less detailed than the internal-event models and do not lend themselves to quantifying the benefits of the specific plant changes associated with internal-event SAMAs. For example, the benefits of a procedural change associated with an important internal event sequence cannot be readily assessed using the seismic-risk model if that operator action or system is not represented in the seismic-risk model. The use of a multiplier on the benefits obtained from the internal events PSA to incorporate the impact of external events implicitly assumes that each SAMA would offer the same percentage reduction in external-event CDF and population dose as it offers in internal events. While this provides only a rough approximation of the potential benefits, such an adjustment was considered appropriate, given the large risk contribution from external events relative to internal events and the lack of information on which to base a more precise risk reduction estimate for external events. In view of the remaining conservatism in the external events CDF, and the licensee's further evaluation of the impacts of the use of a multiplier on the SAMA screening (as part of the uncertainty assessment discussed below), the NRC staff agrees that the use of these multipliers for external events is reasonable.

For SAMA candidates that only address a specific external event and have no bearing on internal-event risk, Entergy derived the benefit directly from the external-event risk model and then increased the benefit by the multipliers identified earlier. The NRC staff notes that the use of multipliers for these SAMAs (conceptually, to account for additional benefits in internal events) is unnecessary, since these SAMAs have no bearing on internal events. However, use of the multipliers adds conservatism to the benefit estimate for these SAMA candidates.

Entergy considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, Entergy presents the results of an uncertainty analysis of the internal-event CDF for IP2 and IP3, which indicates that the 95th percentile value is a factor of 2.1 times the mean CDF for IP2 and 1.4 times the mean CDF for IP3. Entergy assessed the impact on the SAMA screening if the estimated benefits for each SAMA were further increased by these uncertainty factors. For purposes of this assessment, Entergy applied a multiplier of 8 to the internal-event benefits for each unit to account for both internal and external events, with analysis uncertainty. The multiplier of 8 slightly exceeds the product of the external-event multiplier and the uncertainty factor for each unit (i.e., $3.8 \times 2.1 = 8.0$ for IP2, and $5.5 \times 1.4 = 7.7$ for IP3) and adds a small amount of additional conservatism. Although not cost beneficial in the baseline analysis, Entergy included any additional SAMAs identified as potentially cost beneficial in the uncertainty analysis within the set of potentially cost-beneficial SAMAs that it intends to examine further for implementation.

Entergy also provided the results of additional sensitivity analyses in the ER, including use of a 3 percent discount rate, use of a longer plant life, and the consideration of economic losses by tourism and business (which were not included in the baseline analysis). These analyses did not identify any additional potentially cost-beneficial SAMAs beyond those already identified through the uncertainty analysis.

The NRC staff questioned the rationale for treating the loss of tourism and business in a sensitivity case rather than in the baseline analysis (NRC 2007). Incorporation of tourism and business losses within the baseline analysis could result in identification of additional cost-beneficial SAMAs, particularly when the baseline benefits are multiplied to account for

1 uncertainties. In response, Entergy explained that the impact of lost tourism and business was
2 not modeled in the baseline analysis because the level of tourism and business activity can be
3 reestablished in time. Nevertheless, Entergy provided the results of an additional uncertainty
4 case showing the impact of lost tourism and business combined with analysis uncertainty. This
5 uncertainty case resulted in the identification of two additional potentially cost-beneficial SAMAs
6 for IP2 (IP2 SAMAs 9 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3
7 SAMA 53). Given that it may take years to reestablish the level of tourism and business activity
8 following a severe accident, the NRC staff has conservatively adopted the case incorporating
9 lost tourism and business as its base case and has reflected the results of that case in
10 Table G-6.

11 In responding to an NRC RAI, Entergy identified and corrected an error in the benefit analysis
12 for IP3 SAMA 30 (provide a portable battery charger for monitoring instrumentation necessary to
13 allow manual operation of the turbine-driven AFW pump), which results in this SAMA no longer
14 being potentially cost beneficial. As indicated in ER Section E.4.3, the benefit of this SAMA was
15 estimated based on the assumption that the SAMA would increase the time available to recover
16 offsite power before local operation of AFW is required from 2 hours to 24 hours, and would also
17 reduce internal switchgear room floods by 5 percent (which bounds the benefit of using a
18 portable diesel-driven battery charger in switchgear flood events). According to Entergy, the
19 original analysis inadvertently reduced the contribution from internal switchgear room floods by
20 more than 5 percent (Entergy 2008a). Entergy's reevaluation of the benefits for this SAMA,
21 consistent with the intended bounding case, resulted in a reduction in the baseline benefit to
22 about \$146,000, including the impacts of lost tourism and business and analysis uncertainties.
23 As such, this SAMA is no longer cost beneficial. The revised benefit estimate is reflected in
24 Table G-6. The NRC staff notes that the benefit associated with several other SAMA
25 candidates that could increase the time available to recover offsite power before local operation
26 of AFW is required from 2 hours to 24 hours (e.g., IP3 SAMA 24 (provide additional dc battery
27 capacity) was estimated at about \$51,000, including the impacts of lost tourism and business
28 and analysis uncertainties. Therefore, a revised benefit estimate of \$145,000 for IP3 SAMA 30,
29 which also includes the additional benefit from reducing the contribution of internal switchgear
30 room floods by 5 percent, appears reasonable. Entergy indicates that the implementation cost
31 associated with IP3 SAMA 30 (i.e., \$494,000) was specifically estimated for IP3. The proposed
32 plant modification involves purchasing, installing, and maintaining a diesel-driven generator to
33 charge the 125-V dc batteries. Safety-related quick-disconnects would be used to charge the
34 selected battery. The diesel generator would be installed in a weather enclosure outside the
35 turbine or control building, requiring fire barrier penetration sealing. Calculation of cable size, as
36 well as procedure development and training, would be required (Entergy 2007). In view of the
37 scope of these modifications and the fact that the modifications involve a safety-related dc
38 system, the estimated costs appear reasonable. Accordingly, the staff agrees that this SAMA
39 would not be cost beneficial for IP3.

40 The NRC-sponsored severe accident analyses performed subsequent to the time of the IPE
41 suggest that the probability of a TI-SGTR, given a core-damage event with high primary-side
42 pressure and a depressurized, dry secondary side, may be higher than the value used in the
43 IP2 and IP3 PSAs. In response to an NRC request, Entergy provided the results of a sensitivity
44 study in which it increased the conditional TI-SGTR probability from 0.01 (used in the baseline
45 analysis) to 0.25, which is comparable to the values reported in NUREG-1570 (NRC 1998).
46 Entergy identified the candidate SAMAs potentially affected by the TI-SGTR assumption and

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reassessed the benefits for these SAMAs, subject to the increased conditional failure probability and the impact of analysis uncertainties. Entergy identified no additional cost-beneficial SAMAs as a result of this reassessment. Entergy also noted that the IP2 and IP3 steam generators have only 0.19 percent and 0.12 percent of the tubes plugged for IP2 and IP3, respectively, and would be classified as “pristine,” in accordance with the Westinghouse criteria for categorizing steam generator tube integrity. With no observed corrosion, Entergy concludes—and the NRC staff concurs—that this sensitivity study is conservative relative to the application of the NUREG-1570 results for pristine generators (Entergy 2008b).

The NRC staff noted that for certain SAMAs considered in the ER, there may be alternatives that could achieve much of the risk reduction at a lower cost. The NRC staff asked the licensee to evaluate several lower cost alternatives to the SAMAs considered in the ER, including SAMAs that had been found to be potentially cost beneficial at other PWR plants. These alternatives were (1) implementation of improved instrumentation and/or procedures to aid in the mitigation of a SGTR, (2) implementation of a procedure for recovery of steam dump to condenser from the unaffected steam generator to aid the mitigation of a SGTR, (3) implementation of a procedure for recovery of the main feedwater/condensate postsafety injection actuation to aid in the mitigation of a SGTR, (4) reactivation of the IP3 postaccident containment venting system, and (5) purchase or manufacture of a “gagging device” that could be used to close a stuck-open steam generator safety valve on a faulted steam generator before core damage occurs (NRC 2007a and NRC 2007b). Entergy provided a further evaluation of these alternatives, as summarized below.

- Improve SGTR instrumentation and/or valve procedures. Operator actions to cool and depressurize the RCS to cold shutdown conditions following and SGTR before depleting RWST inventory are already contained in EOPs. EOPs also direct plant personnel to initiate RWST makeup, given a low RWST level without a corresponding increase in the containment recirculation sump water level, or if the ruptured steam generator narrow-range level indication is high.
- Institute a procedure for recovery of steam dump to condenser. Procedures for recovery of steam dump to condenser from the unaffected steam generator are currently available at both units.
- Recover main feedwater/condensate. For IP2, the operators are currently directed to attempt to establish a secondary heat sink with AFW, main feedwater, or condensate, should the AFW system initially not function or subsequently fail during implementation of the EOPs. For IP3, procedural guidance currently exists for reestablishing condensate flow, but there is no guidance to use main feedwater following a loss of the secondary heat sink. Thus, the development of guidance on aligning main feedwater for secondary heat removal was evaluated as a potential SAMA for IP3.
- Reactivate the IP3 containment venting system. IP3 has three alternate methods of containment depressurization and combustible gas control. These methods are backflow to the steam ejector line, containment pressure relief line, and the containment purge system. All of the venting functions require similar operator actions. Given these various alternatives, failure to vent would be dominated by human error and would not be substantially reduced by providing an additional means of venting.

With regard to the steam generator safety gagging device, which was found to be potentially cost beneficial at another pressurized-water reactor seeking license renewal, Entergy provided a separate assessment of the benefits and implementation costs. Entergy estimated the benefit associated with successfully gagging a stuck-open main steam safety valve following an SGTR by assuming all early steam generator isolation failures and all TI-SGTRs would be eliminated. The total benefits were estimated to be about \$2.9 million for IP2 and \$4.4 million for IP3. The implementation cost, including purchasing and storing a dedicated gagging device, revising procedures, and providing training, was estimated to be about \$50,000 for each unit. As such, the results indicate that this SAMA is potentially cost beneficial for both units. Entergy indicates that this additional SAMA has been submitted for an engineering project cost-benefit analysis for a more detailed examination of its viability and implementation cost (Entergy 2008b). The NRC staff concurs with Entergy's findings regarding these alternative SAMAs because the NRC staff finds the additional information provided by Entergy for the aforementioned alternative SAMAs to be technically sound.

The NRC staff notes that all nine potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9, 28, 44, 53, 54, 56, 60, 61, and 65) and five potentially cost-beneficial SAMAs for IP3 (IP3 SAMAs 52, 53, 55, 61, and 62), identified in either Entergy's baseline analysis or supplemental analyses provided in response to the NRC requests, as well as the additional SAMA regarding a dedicated gagging device for SGTR events (applicable to both units), are included within the set of SAMAs that Entergy will consider further for implementation. The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs would be higher than the associated benefits (i.e., no additional SAMAs appear to be cost-beneficial).

G.7 Conclusions

Entergy compiled a list of 231 candidate SAMAs for IP2 and 237 SAMAs for IP3, based on a review of the most significant basic events from the current plant-specific PSA, insights from the plant-specific IPE and IPEEE, and a review of other industry documentation. An initial screening removed SAMA candidates that (1) were not applicable at IP2 and IP3, (2) were already implemented or their intent had been met, or (3) were similar in nature and could be combined with another SAMA candidate. Based on this screening, 163 IP2 and 175 IP3 SAMAs were eliminated, leaving 68 IP2 and 62 IP3 candidate SAMAs for evaluation.

For the remaining SAMA candidates, more detailed evaluation was performed as shown in Table G-6. The cost-benefit analyses in the ER showed that five IP2 and five IP3 SAMA candidates were potentially cost beneficial in either the baseline analysis or sensitivity analysis using a 3 percent discount rate. Entergy performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. As a result, four additional IP2 SAMAs and one additional IP3 SAMA were identified as potentially cost beneficial. In addition, a SAMA regarding a dedicated gagging device for SGTR events was identified as potentially cost beneficial for both units. Correction of an error in the benefit analysis for IP2 SAMA 30 resulted in it no longer being considered cost beneficial. Entergy has indicated that all nine potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9, 28, 44, 53, 54, 56, 60, 61, and 65) and five potentially cost-beneficial SAMAs for IP3 (IP3 SAMAs 52, 53, 55,

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61, and 62), as well as the additional SAMA regarding a dedicated gagging device for SGTR events, will be considered further for implementation at IP2 and IP3.

The NRC staff reviewed the Entergy analysis and concludes that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process and inclusion of a multiplier to account for external events.

The NRC staff concurs with Entergy's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by Entergy is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" (10 CFR Part 54).

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40 and IP3 Nuclear Generating Unit Nos. 2 and 3 Licensee Renewal (TAC Nos. MD5411 and
41 MD5412), December 7, 2007. ADAMS Accession No. ML073110447.

Appendix G

- 1 Nuclear Regulatory Commission (NRC). 2008. Letter from Bo M. Pham to Entergy, Subject:
- 2 Request for Additional Information Regarding the Review of the License Renewal Application for
- 3 IP2 and IP3 Nuclear Generating Unit Nos. 2 and 3 (TAC Nos. MD5411 and MD5412), April 9,
- 4 2008. ADAMS Accession No. ML080880104.
- 5 U.S. Department of Agriculture (USDA). 2002. "Census of Agriculture." Accessed at:
- 6 <http://www.nass.usda.gov/census/> on April 26, 2005.us/ on April 26, 2005.

Appendix H

U.S. Nuclear Regulatory Commission Staff Evaluation of Environmental Impacts of Cooling System

Appendix H

U.S. Nuclear Regulatory Commission Staff Evaluation of Environmental Impacts of Cooling System

H.1 Environmental Impacts of Cooling System

Environmental issues associated with the operation of a nuclear power plant during the renewal term are discussed in the U.S. Nuclear Regulatory Commission (NRC) document, NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).^(a) The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a generic (Category 1) or site-specific (Category 2) designation. As set forth in the GEIS, generic issues are those that have the following characteristics:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, OR LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

No additional plant-specific analysis is required for generic issues unless new and significant information is identified. Site-specific issues do not have all the above characteristics, and a plant-specific review is required.

This appendix addresses the issues that are listed in Table B-1, Appendix B, Subpart A, of Title 10 of the *Code of Federal Regulations* (CFR), Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," and that are related to the operation of the cooling systems of Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) during their renewal term. Section H.1 addresses the impingement of fish and shellfish applicable to the IP2 and IP3 cooling systems. Section H.2 addresses the entrainment of fish and shellfish applicable to the IP2 and IP3 cooling systems. Section H.3 addresses the combined effects of impingement and entrainment, and Section H.4 discusses cumulative impacts. Finally, Section H.5 lists the references for Appendix H. Category 1 and Category 2

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issues that are not applicable to IP2 and IP3, because they are related to plant design features or site characteristics not found at IP2 and IP3, are listed in Appendix F.

H.1.1. Impingement of Fish and Shellfish

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or gradually, by exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwash and fish return system that is employed. Studies of impingement losses associated with the operation of IP2 and IP3 cooling systems were conducted annually from 1975 to 1990. Before the installation of modified Ristroph screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in 1985, studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design (Version 2), as reported in Fletcher (1990), appeared to reduce impingement mortality, based on a pilot study, in comparison to the existing (original) system in place at IP2 and IP3 (Table H-1). The impingement survival estimates reported in Fletcher (1990) were not validated, however, after the new Ristroph screens were installed at IP2 and IP3 in 1991.

Table H-1 Assumed Cumulative Mortality and Injury of Selected Fish Species after Impingement on Ristroph Screens

Species	Percent Dead and Injured
Alewife	62
American Shad	35
Atlantic Tomcod	17
Bay Anchovy	23
Blueback Herring	26
Hogchoker	13
Striped Bass	9
Weakfish	12
White Catfish	40
White Perch	14
Source: Fletcher 1990	

H.1.1.1. Summary of Impingement Monitoring Studies

The former owners of IP2 and IP3 conducted impingement monitoring between 1975 and 1990 using a variety of techniques. Between January 1975 and June 1981, fish were collected and sorted during a daily intake screen washing between 0800 and 1200 hours (hr). In July 1981

and continuing through October 1990, fish were collected during intake screen washings between 0800 and 1200 hr on selected days determined from a stratified random design intended to reduce the overall sampling effort without affecting data use and utility. Between October and December 1990, IP2 was sampled every Tuesday, and IP3 was not sampled because of a plant outage. During all collections, the wash water was circulated to draw a portion of the fish and debris into the forebay, where it was drained through a sluice containing a 1-millimeter (mm) (0.375-inch (in.)) square mesh screen. Collection efficiency was estimated in 1974, 1975, and 1977 at IP2. The results of these studies suggested that the collection efficiency was highly variable (ranging from 2 percent to 45 percent based on the recovery of dyed fish) and averaged 29 percent (Con Edison 1976; Con Edison 1979). Collection efficiency at IP3 in 1976 and 1977 ranged from 58 percent to 86 percent recovery of dyed fish with an average of 71 percent (Con Edison 1977, 1979). The difference in the collection efficiency at the two units was associated with the differences in the type of screens (fixed versus traveling screens) and the method used for screen washing. To estimate the total number of fish impinged, the total number of fish collected was multiplied by an adjustment factor representing the inverse of the collection efficiency. From 1975 to 1978, adjustment factors of 3.5 and 1.4 were used for IP2 and IP3, respectively (Con Edison 1980).

Analysis of variance and the correlation of environmental and IP2 and IP3 operation variables were employed to explain the variation in collection efficiency. Early studies suggested that collection efficiency increased during periods of low water temperature. In 1979, the adjustment factor became a function of the time of year, based on the increase in collection efficiency when water temperatures were less than 15 degrees Celsius (C) (59 degrees Fahrenheit (F)). Thus, cool water adjustment factors of 2.1 and 1.2 were adopted to estimate the number of fish impinged at IP2 and IP3, respectively, during January through April, November, and December. For May to October, the adjustment factor was 3.8 for IP2 and 1.5 for IP3. In 1981, the collection efficiency was estimated with a regression relationship with temperature:

$$\text{IP2 efficiency} = E_2 = -0.00945 (\text{Temperature degrees C}) + 0.54708; \text{ and}$$

$$\text{IP3 efficiency} = E_3 = -0.00792 (\text{Temperature degrees C}) + 0.71640 \text{ (Con Edison 1984).}$$

These regression relationships were updated in 1982, and screen-specific adjustments were devised from studies conducted in 1985 and 1986 (Table H-2).

Impingement monitoring designs changed through time (Con Edison 1980, 1984; Con Edison and NYPA 1986, 1987, 1988, and 1991) as follows. In 1979, the daily variation in impingement counts was analyzed to determine its effect on the precision and accuracy of reduced sampling plans. Starting in July 1981, a sampling plan employing a seasonally stratified random sample developed from these results was used for all further impingement studies except the last quarter of 1990. Instead of sampling daily, IP2 and IP3 were sampled a total of 110 days per year (a 30-percent sampling fraction with approximately 92-percent accuracy) (Con Edison 1984). Days were selected at random within four calendar strata defined by similar water temperatures and variance in the number of fish impinged (January–March, April–June, July–September, and October–December). The number of days sampled per stratum was proportional to the number of days available and the variance in impingement for all taxa combined (Table H-3) (Con Edison 1984). The number of days allocated to strata was updated in 1985 to take advantage of current data trends and again in 1990 because of known plant

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outages. Even though IP2 and IP3 had different numbers of samples allocated to each stratum, sampling was conducted on the same day at both units to the extent possible.

During 1981, the New York State Department of Environmental Conservation (NYSDEC) required daily sampling when total impingement counts were greater than 10,000 fish. Daily sampling was required to continue until the total was below 10,000 fish. Because these sampling dates were not part of the stratified design, they were used in place of random dates that were associated with unplanned unit outages. Outages were defined as circulating pump outages and were not necessarily associated with cessation of power generation. In 1981, randomly selected days that fell on planned outages were not replaced. From 1982 to October 1990, to minimize the effect of planned and unplanned outages on the selected days for collection, a randomly selected replacement day within the given stratum was sampled. In October 1990, a systematic sampling design was employed that required sampling at IP2 each Tuesday. No sampling was conducted at IP3 from October 1990 to December 1990 because of an extended outage.

Sampling for blue crabs began in April 1983 and continued through December 1990. Sampling was conducted on all days of plant operation. The total number of impinged crab and their total weight were obtained for each sampling. In addition, the carapace width, total weight, and observed condition were recorded for each collected individual.

Table H-2 Estimates of Collection Efficiency Based on Temporal Averages, Regressions as a Function of Temperature, and Specific Screens

Year	IP2 Conventional Screen	IP3 Conventional Screen	Ristroph Screen Version ¹
1975–1978	29 percent	71 to 73 percent	None installed
1979–1980	Jan.–April and Nov.–Dec. = 48 percent	Jan.–April and Nov.–Dec. = 83 percent	None installed
	May–Oct. = 26 percent	May–Oct. = 66 percent	
1981	$E_2 = -0.00945 T + 0.54708$	$E_3 = -0.00792 T + 0.71640$	None installed
1982–1985	$E_2 = -0.00871 T + 0.51858$	$E_3 = -0.00792 T + 0.71640$	None installed

1

Table H-2 (continued)

Year	IP2 Conventional Screen	IP3 Conventional Screen	Ristroph Screen Version ¹
1986	$E_2 = -0.00871 T + 0.51858$	$E_3 = -0.00792 T + 0.71640$	Jan.–Mar. = 70.8 percent Apr.–June = E_2 or E_3 July–Aug. = 18.7 percent Sept. = 29.6 percent Oct.–Dec. = E_2 or E_3 Jan.–Mar. = 74.4 percent
1987–1990	$E_2 = -0.00871 T + 0.51858$	$E_3 = -0.00792 T + 0.71640$	Apr.–June = E_2 or E_3 July–Aug. = 18.7 percent Sept. = 29.6 percent Oct.–Dec. = E_2 or E_3
¹ Number of Ristroph Screens at IP2. E_2 = Collection Efficiency at IP2 E_3 = Collection Efficiency at IP3 T = Temperature in degrees C			In 1986, a Ristroph Screen was installed on Intake Bay 26.
Sources: Con Edison 1980, 1984; Con Edison and NYPA 1986, 1987, 1988, and 1991			

2 **Table H-3 Number of Days Allocated to Each Quarter Based on the Stratified Random**
3 **Sampling Design**

Stratum	Dates	Total Days	Allocation to IP2 in 1981; 1982–84; 1985–89; and 1990	Allocation to IP3 in 1981; 1982–84; 1985–89; and 1990
Winter	Jan. 1–Mar. 31	90	N/A ^a ; 30; 23; 23	N/A; 27; 35; 35
Spring	Apr. 1–June 30	91	N/A; 10; 8; 8	N/A; 18; 20; 20
Summer	July 1–Sept. 30	92	11; 11; 11; 11	31; 31; 31; 31
Fall	Oct. 1–Dec. 31	92	59; 59; 68; 13	34; 34; 24; 0

4 ^a N/A = Not Applicable, the reduced sampling began July 1, 1981 (Con Edison 1984)

5 Sources: Con Edison 1984; Con Edison and NYPA 1986, 1987, 1988, and 1991

6 For all impingement studies, fish were sorted and counted completely if either the identified
7 species was white perch, striped bass, or tomcod, or the total number collected for a given
8 species was less than 100 individuals (with heads). All other sorted samples were enumerated
9 by subsampling and weighing to four general length classes. This information was used to
10 determine the total sample size. To estimate the number of fish impinged, the estimated daily
11 counts (taken before July 1981) were multiplied by the collection efficiency adjustment factor
12 (Con Edison 1984). During the period of stratified random sampling (July 1981–1990), the

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mean of the estimated number of fish counted within a stratum was multiplied by the collection efficiency adjustment factor and the number of days of plant operation (Con Edison 1984).

H.1.1.2. Historic Assessment of Impingement Impacts

As discussed in the previous section, numerous studies have been conducted to evaluate the effects of impingement associated with the Indian Point cooling systems. Studies have also been conducted to evaluate the trends of fish populations in the Hudson River. Entergy Nuclear Operations, Inc. (Entergy, or the applicant) and NYSDEC have used the results of these studies to evaluate the potential for adverse effects associated with the operation of the Indian Point cooling systems. The results of these assessments are described below. Nongovernmental groups and members of the public have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the river are in decline and that the entrainment of juvenile and adult fish at Indian Point is contributing to the decline, destabilization, and ultimate loss of these important aquatic resources.

Applicant Assessment

In the draft environmental impact statement (DEIS) (CHGEC 1999) and environmental report (ER) (Entergy 2007), the applicant acknowledged that some impinged fish survive and others die. Mortality can be immediate or occur at a later time (latent or long-term mortality), and mortality rates depend on the species, the size of the fish, the water's temperature and salinity, the design of the screens, the water velocity through the screen, the length of time the fish was impinged, and the design and operation of the fish return system. Impingement effects were examined by evaluating conditional mortality rates (CMRs) and trends associated with population abundance for eight selected taxa representing 90 percent of those fish species collected from screens at IP2 and IP3, including striped bass, white perch, Atlantic tomcod, American shad, bay anchovy, alewife, blueback herring, and spottail shiner. Estimates of the CMR, defined as the fractional reduction in the river population abundance of the vulnerable age group caused by one source of mortality only, were assumed to be the same as or lower than that which occurred in past years, caused by the installation of Ristroph screens and fish return systems at IP2 and IP3. For species exhibiting low impingement mortality (e.g., striped bass, white perch, and Atlantic tomcod), future impingement effects were expected to be substantially lower than they were before the installation and use of the present protective measures.

Central Hudson Gas and Electric Corporation (CHGEC) (1999) concluded that the maximum expected total impingement CMR was 0.004 for white perch and less for all other taxa. The ER (Entergy 2007) stated that the results of in-river population studies performed from 1974 to 1997 have not shown any negative trend in overall aquatic river species populations attributable to plant operations:

1 More than 30 years of extensive fisheries studies of the Hudson River in the
2 vicinity of IP2 and IP3 support current operations. The results of the studies
3 performed from 1974 to 1997, the period of time covered in the DEIS, are
4 referenced and summarized in the DEIS, and have not shown any negative
5 trend in overall aquatic river species populations attributable to plant
6 operations...

7 The ER also stated that ongoing studies continue to support these conclusions. Thus, the
8 applicant determined impingement impacts to be small, suggesting that the withdrawal of water
9 from the Hudson River for the purposes of once-through cooling for IP2 and IP3 did not have
10 any demonstrable negative effect on representative Hudson River fish populations, nor did it
11 warrant further mitigation measures.

12 To support this assessment, the applicant provided two reviews, Barnthouse et al. (2002) and
13 Barnthouse et al. (2008). These reviews addressed the status and trends of fish populations
14 and communities of the Hudson River estuary in relation to the operation of Bowline Point, IP2
15 and IP3, and Roseton generating stations, which currently share a State Pollutant Discharge
16 Elimination System (SPDES) permit. Barnthouse et al. (2002) was based on a review of the
17 DEIS, comments on the DEIS abundance indices though 2000 (CHGEC 1999), and the annual
18 Year Class Report (ASA 2000). Barnthouse et al. (2008) was based on abundance indices
19 through 2005, the spawning stock biomass-per-recruit model (SSBR), and CMR estimates.
20 Although both reviews recognized that the long-term population trends reflected the combined
21 effects of entrainment and impingement, the 2008 report focused on entrainment and suggested
22 that the existing retrofits (Ristroph screens and fish returns) have resolved the concerns
23 regarding impingement. Additional discussions concerning the results of the Barnthouse et al.
24 (2008) analyses are provided in Section H.2.

25 NYSDEC Assessment

26 With respect to the operation of the IP2 and IP3 cooling systems, the NYSDEC regulatory role
27 includes protecting aquatic resources from impacts associated with impingement, entrainment,
28 and thermal and chemical discharges. Based on activities conducted under the Hudson River
29 Settlement Agreement (HRSA), subsequent Consent Orders, and existing agreements with the
30 operators of IP2 and IP3, Roseton, and Bowline Point power generation stations, NYSDEC has
31 concluded that IP2 and IP3 have achieved some reductions in intake volumes through the use
32 of dual-speed and variable-flow pumps and have improved impingement survival through the
33 installation of modified Ristroph traveling screens (NYSDEC 2003a). However, NYSDEC states
34 that "while these represent some level of improvement compared to operations with no
35 mitigation or protection, there are still significant unmitigated mortalities from entrainment and
36 impingement at all three of the HRSA facilities." In a petition submitted to the NRC, dated
37 November 30, 2007, the NYSDEC stated the following:

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The plants' outdated design and operation have caused significant adverse environmental impacts to the Hudson River. These impacts include impingement, entrainment, and heat shock to numerous fish species in the Hudson, including the endangered sturgeon... In the alternative, even if the NRC were to grant the license renewal application, it could only do that by conditioning the renewal on the construction and use of closed-cycle cooling water intake systems at IP2 and IP3. As was stated in the above contention on impingement and entrainment, the perpetuation of once-through cooling here, with its long history of massive injury and destruction of tens of millions of Hudson River fish, is simply no longer tenable, either in fact or in law.

NYSDEC stated further that the applicant would need a Clean Water Act Section 316(b) determination, a demonstration that the current cooling water intake structure reflects the best technology available for minimizing adverse environmental impacts (NYSDEC 2007). However, the NYSDEC states the following:

Entergy has not and could not demonstrate that its once-through cooling water intake structures at IP2 and IP3 reflects the best technology available for minimizing adverse environmental impacts. Indeed, the New York State Department of Environmental Conservation has determined in the pending SPDES permit renewal proceeding that closed-cycle cooling, and not once-through cooling, represents the best technology available for minimizing adverse environmental impacts.

H.1.1.3. NRC Staff Assessment of Impingement Impacts

To assess impingement impacts, the NRC staff evaluated weekly estimated impingement numbers at IP2 and IP3 from January 1975 to November 1980, and seasonally estimated impingement numbers from January 1981 and December 1990. The combined numbers of young of year (YOY), yearling, and older fish were used for analysis since these data were available for all years of sampling.

A total of 127 identified fish taxa and blue crab were collected at IP2 and IP3 during this 15-year period. At IP2, the estimated number of representative important species (RIS) fish (as defined in Table 2-4 in the main text) impinged made up greater than 85 percent of all impinged taxa (Figure H-1, solid lines). Until 1984, the RIS fish made up greater than or equal to 95 percent of all impinged taxa. This percentage has significantly decreased at a rate of 0.8 percent per year (linear regression; $n = 16$; $p = 0.002$) from 1985 to 1990. When blue crab are included with the RIS fish, the estimated number impinged made up greater than 90 percent of all impinged taxa for all but one year. Total impingement trends for all fish and blue crab are presented in Figure H-1 (dashed line) and show impingement approached or exceeded 4 million in 1977 and 1981. Impingement of all fish and blue crab was lowest in 1984 (about 0.5 million) and 1990 (about 1 million (Figure H-1, dashed line).

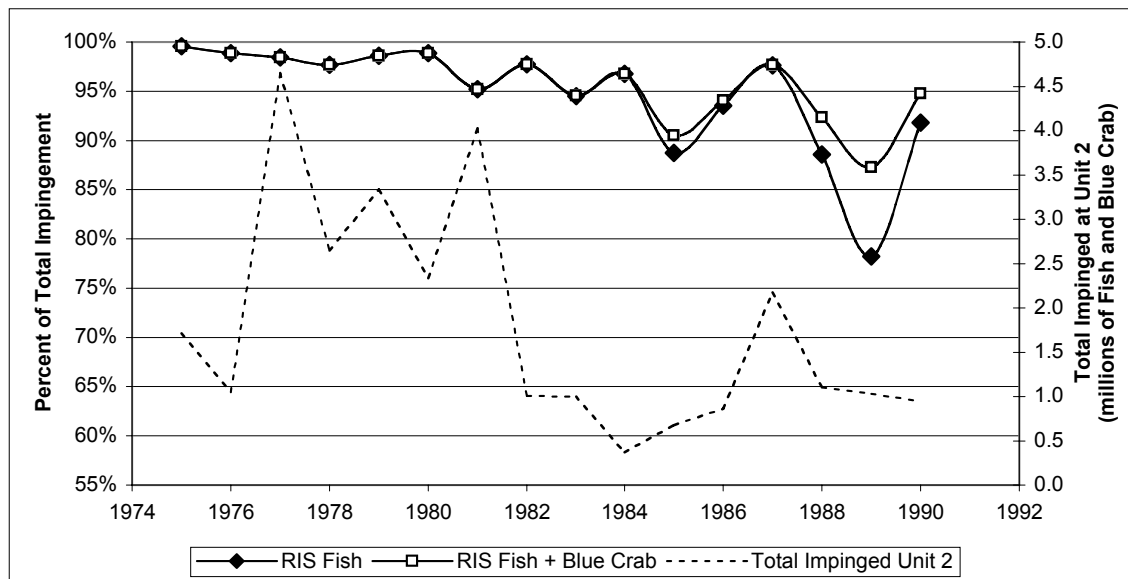


Figure H-1 Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP2 (data from Entergy 2007b)

At IP3, the estimated number of RIS fish impinged made up greater than or equal to 95 percent of all impinged taxa except for the last 3 years (Figure H-2, solid lines). A significant decrease in this percentage was observed during that time at a rate of 1.7 percent per year (linear regression; $n = 15$; $p = 0.005$). When blue crabs are included with the RIS fish, the estimated number impinged was greater than 85 percent for all but one year. Except for 1983, which had extensive outages, IP2 had, on average, 2.6 times greater numbers of fish and crab impinged annually than IP3. The highest total impingement occurred in 1976 at just over 1.8 million fish and blue crab; the lowest occurred in 1983 at less than 0.1 million (Figure H-2, dashed line).

Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab impinged tended to decrease between 1977 and 1982, then leveled off between 1982 and 1990. From 1975 to 1990, the number of days of operation at IP2 and IP3 has shown a general increase of 8 days per year for IP2 and 5 days per year for IP3 (linear regression, $p = 0.004$ and $p = 0.286$ for IP2 and IP3, respectively). The total volume circulated at IP2 and IP3 combined has also shown a general increase of 26.2×10^6 cubic meters (m^3) (linear regression, $p = 0.164$). If the IP2 and IP3 cooling systems are considered a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in frequency and volume of water circulated), then the decrease in the percent of RIS impinged and total impingement would suggest that RIS and all other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively constant lower level of impingement between 1984 and 1990. This will be explored further in Section H.3.

To determine trends in RIS impingement, NRC Staff examined quarterly data from IP2 and IP3 from 1975 to 1990 (Table H-4). The two major time periods (1975–1980) and (1981–1990)

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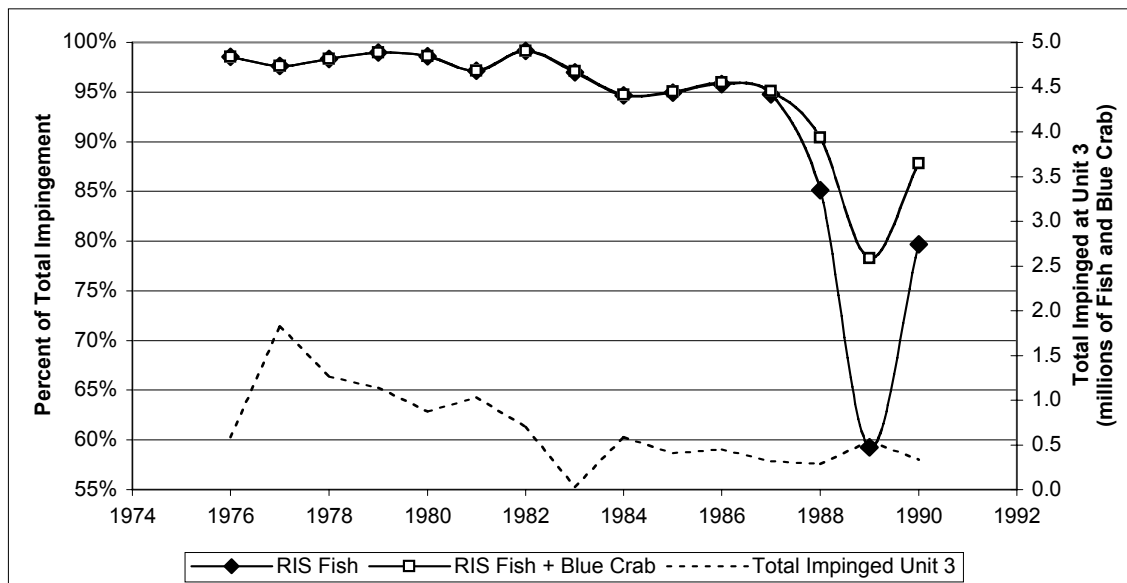


Figure H-2 Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP3 (data from Entergy 2007b)

were analyzed separately to account for the differences in impingement sampling strategies discussed above. Summed over all years, six RIS fish species accounted for 93 percent (IP2) and 89 percent (IP3) of the total number of RIS impinged, including contributions from blue crab. During January to March sampling events for both units and all years, white perch were the most commonly impinged species, accounting for 89 to 96 percent of the RIS impinged. Impingement of RIS was more variable during other sampling periods but was generally dominated by four species (white perch, Atlantic tomcod, bay anchovy, blueback herring). The notable exception to this pattern occurs between 1981 and 1990, when the percentage of hogchoker and weakfish increased near both units during spring and summer sampling periods compared to estimates obtained from 1975 to 1980 (Table H-4). Greenwood (2008) suggested that cooling systems associated with IP2 and IP3 are considered an efficient environmental sampler. Impingement data suggest that a change in the species composition in the vicinity of IP2 and IP3 may have occurred in the 1980s.

As a result of the HRSA, operational measures were implemented to reduce the loss of aquatic resources to impingement. These measures included the installation of dual-speed intake pumps at IP2 in 1984, installation of variable-speed pumps at IP3 in 1985, and the installation of modified Ristroph screens and fish return systems in 1991. The plant operators also developed programs to employ flow-reduction measures and scheduled outages to reduce impingement and entrainment impacts. Flow rates are dependent on intake water temperature, with increased flow required when water temperatures rise above 15 degrees C. For example, the average monthly water temperatures taken near Poughkeepsie, New York from 1992 to 2006 (Figure H-3) suggest to NRC Staff that greater flow would be required during the months of May through October. This roughly corresponds to the second and third quarters of impingement sampling (April–September timeframes in Table H-4). Although the seasonal percentage of annual impingement of RIS fish was not significantly different between seasons (analysis of variance (ANOVA), $p = 0.095$ with a coefficient of variation (CV) = 68 percent and $p = 0.27$ with

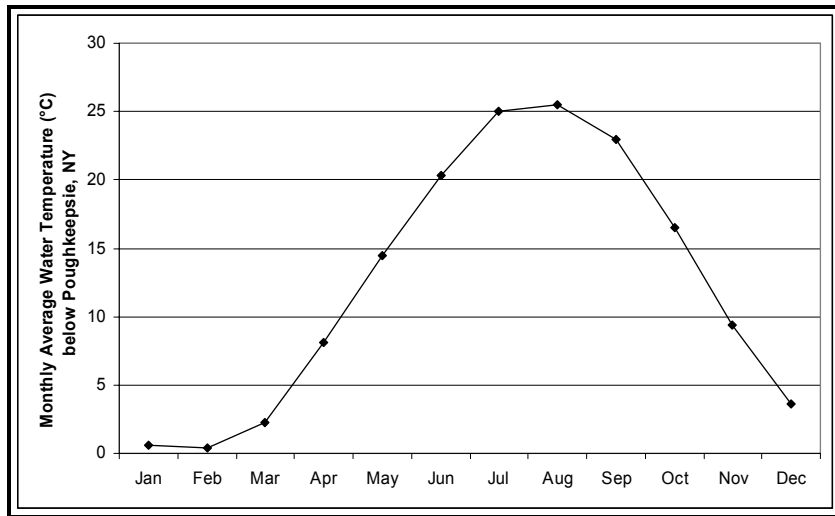
a CV = 84 percent for IP2 and IP3, respectively), they were generally lower between April and June and similar across the remaining three quarters (Figure H-4). Thus, even though there is a greater volume of water used between May and October (analysis of variance (ANOVA), $p = 0.02$ with a CV = 41 percent and $p = 0.53$ with a CV = 61 percent for IP2 and IP3, respectively), impingement does not increase during these periods. Instead, the seasonal pattern of impingement may be a reflection of when susceptible fish are present near the facility.

Table H-4 Average Percentage Impingement of RIS Compared to Total Impingement per Season for 1975–1980 and 1981–1990 for Selected Taxa (data from Entergy 2007b)

IP2 COOLING SYSTEM									
RIS Species	1975–1980				1981–1990				Percent of RIS Taxa ¹
	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	
White Perch	96	35	17	39	92	38	13	55	48
Atlantic Tomcod	1	55	27	1	1	38	27	4	16
Bay Anchovy	0	2	32	7	0	7	21	10	11
Blueback Herring	0	0	10	46	0	1	2	13	14
Hogchoker	0	3	4	3	0	9	13	4	2
Weakfish	0	0	3	0	0	0	12	4	2
Percent of RIS Fish	96	95	94	95	93	92	89	88	93
IP3 COOLING SYSTEM									
RIS Species	1975–1980				1981–1990				Percent of RIS Taxa ¹
	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	
White Perch	95	55	10	43	89	54	19	52	50
Atlantic Tomcod	0	23	40	2	0	17	19	3	17
Bay Anchovy	0	3	23	2	0	7	18	5	8
Blueback Herring	0	3	6	38	0	4	3	27	10
Hogchoker	0	0	8	1	1	7	16	3	3
Weakfish	0	0	3	0	0	0	10	2	1
Percent of RIS Fish	96	84	89	86	91	89	86	91	89

¹ RIS Taxa include Blue Crab

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Source: U.S. Geological Survey Surface Water Data, http://waterdata.usgs.gov/usa/nwis/uv?site_no=01372058

Figure H-3 Average monthly water temperature taken from below Poughkeepsie, NY, from 1992 to 2006

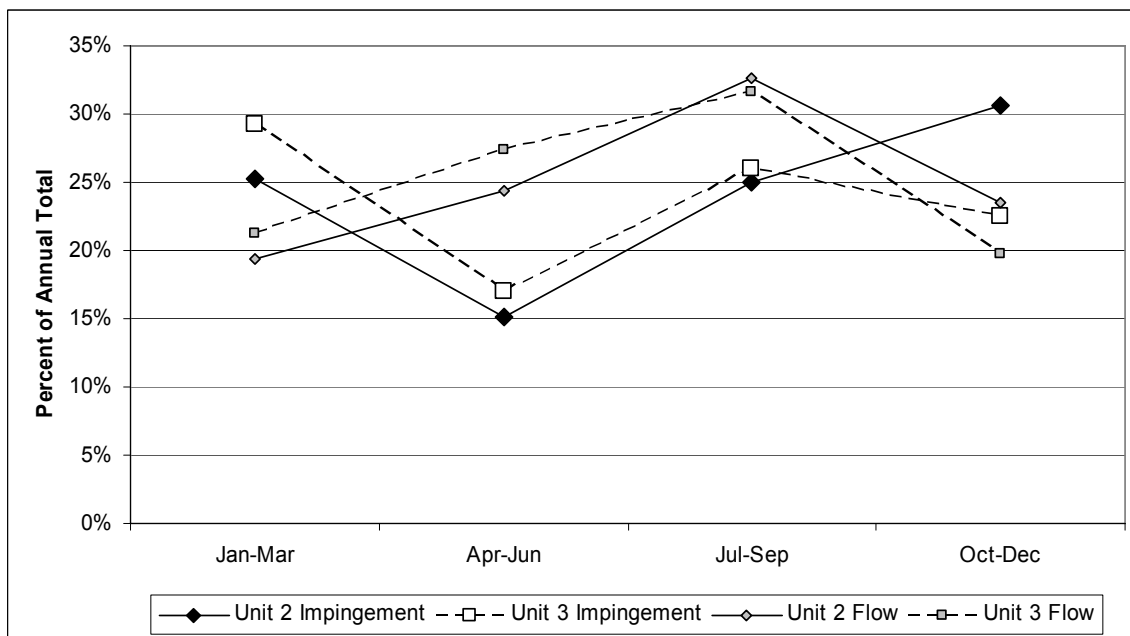


Figure H-4 Seasonal percentage of RIS fish impinged out of the annual total taxa impinged and the seasonal percentage of the volume circulated out of the annual total volume circulated from 1975–1990 (data from Entergy 2007b)

Based on the above NRC Staff analyses, the species with the highest percentage of impingement at IP2 and IP3 from 1975 to 1990 were white perch, Atlantic tomcod, blueback herring, bay anchovy, and hogchoker. Impingement trends for both units show that each of

these species was impinged during at least one sampling season in quantities representing at least 10 percent of the total impingement counts for that period. During some sampling seasons, a single species represented over 90 percent of the total impingement (e.g., white perch during January to March). Impingement magnitude does not appear to be directly related to flow; rather, the available information suggests that the frequency of impingement is associated with seasonal patterns of fish and their proximity to IP2 and IP3. The environmental significance of impingement is explored further in Section H-3.

H.1.2. Entrainment of Fish and Shellfish in Early Life Stages

Entrainment occurs when small aquatic life forms are carried into and through the cooling system as water is withdrawn for use in the plant's cooling system. Entrainment can affect organisms smaller than the screen mesh (0.25 to 0.5 in.) that are carried into the plant with the pumped water mass and have limited swimming ability to escape. This includes phytoplankton, microzooplankton, and macrozooplankton. Entrained organisms also include the young life stages of fish (eggs, larvae, post-yolk-sac larvae (YSL), and juveniles) and shellfish.

Entrained organisms pass through the circulating pumps and are carried with the flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam and enter the discharge canal for return to the water. As entrained organisms pass through the intake, they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing, pressure changes, sheer stress, thermal shock, and chemical exposure to chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000). Death can occur immediately (direct effect) or after being discharged (indirect effect) from an inability to escape predators, a reduced ability to forage, or other factors.

The former owners of IP2 and IP3 conducted studies of entrainment loss associated with IP2 and IP3 in 1981 and then annually from 1983 to 1987. Entrainment survival is a particularly controversial subject. The U.S. Environmental Protection Agency (EPA) assumes that the mortality associated with entrainment is 100 percent (NYSDEC 2003a). Consolidated Edison Company of New York (Con Edison) and New York Power Authority (NYPA 1984) assume that, for the more delicate species (bay anchovy, American shad, clupeids), mortality was 100 percent. However, for other species, mortality could be separated into thermal and mechanical components and overall was less than 100 percent. By 1987, Con Edison estimated the survival of entrained bay anchovy up to 52 percent (EA 1989). This assessment recognizes that 96-hr survival of fish following entrainment is not a measure of the potential reduction in ability to forage and avoid predation within hours or days of being discharged at the diffuser ports. Thus, indirect losses for a given species from entrainment for the purpose of this assessment are unknown.

H.1.2.1. Summary of Entrainment Survival Monitoring Studies

Entrainment studies to evaluate the survival of entrainable aquatic organisms (eggs, larvae, YSL, small juveniles) have been conducted at IP2 and IP3 since the early 1970s. A variety of sampling gear has been employed. Study endpoints included estimates of immediate and latent mortality by monitoring collected organisms for up to 96 hr. Initial monitoring efforts were based

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on the assumption that survival of organisms collected by nets was the same from intake canal samples as it was from discharge canal samples. It was discovered, however, that differences in water velocity at intake and discharge sampling stations may have affected ichthyoplankton survival, and subsequent studies demonstrated that the survival of striped bass eggs and larvae collected using fixed nets were velocity dependent. Based on these results, entrainment survival sampling at IP2 and IP3 in 1977 and 1978 was expanded to include new sampling gear designed to reduce or eliminate the effects of intake and discharge water velocity on apparent postcollection survival. The primary change involved the use of centrifugal pumps to transport water into a flume and larval collection table, where water quality conditions could be optimized and samples concentrated for survival and latent mortality analyses. In spite of these refinements, entrainment survival estimates derived from the pump/larval table collection system were again compromised by poor ichthyoplankton survival in control samples collected in front of intakes representing initial larval conditions before passage through the IP2 and IP3 cooling systems.

Subsequent revisions to sampling gear have been employed in 1979, 1980, and 1989, and are discussed below. Because the survival estimates conducted before 1979 were significantly compromised by sampling gear design and choice, NRC staff focused on the later studies to evaluate entrainment mortality at IP2 and IP3. Sampling was also conducted in 1985 to determine the effects of entrainment mortality resulting from an upgrade to the pumping system associated with IP2. The results of this study are not directly comparable to the 1979 and 1980 studies, because a different sampling design was employed.

Details of the 1979 entrainment survival and related studies are presented in EA (1981a). Entrainment survival studies were conducted during two separate sampling periods, the late winter season from March 12–22, 1979, to evaluate the larvae of Atlantic tomcod (*M. tomcod*), and in the spring–summer season from April 30 to August 14, 1979, to evaluate early life-stages of striped bass (*M. saxatilis*), white perch (*M. americana*), herring (Clupeidae), and anchovies (Engraulidae). During the winter season, sampling with a pump/larval table collection system was conducted at the intakes associated with IP2 and IP3, in the IP3 effluent before it enters the discharge canal, and in portions of the discharge canal containing effluent water from both units. The shutdown of IP3 from March 20–22 provided an opportunity to evaluate Atlantic tomcod larval survival under one- and two-unit operation. During the spring–summer season, a raft-mounted flume collection was used for the first time at IP2 and IP3. This system was designed to reduce sampling stress on target organisms by taking advantage of head pressure created caused by a difference between water levels on either side of the flume apparatus. The shutdown of IP2 after June 16, 1979, provided an opportunity to assess the survival of other species during both one- and two-unit operation.

For the Atlantic tomcod study during the winter of 1979, sampling was initiated upon notification of the first occurrence of tomcod larvae and conducted on 4 consecutive nights per week over the 2-week sampling period from March 12–22, for a total of 8 sampling days. Sampling occurred between 1700 and 0200 hr to coincide with the diel period of peak larval abundance. At the beginning of the study, both IP2 and IP3 units were operating, but an unscheduled shutdown of IP3 occurred on March 20 and continued through the remainder of the study. Although the unit did not generate power, two circulating water pumps continued to operate. Thus, for the tomcod study, a total of 11 circulating pumps were operating from March 12–19 (6 at IP2, 5 at IP3), and a total of 8 pumps were operating from March 20–22 (6 at IP2, 2 at IP3).

1 The pump/larval table collection system used for the tomcod study consisted of a modular two-
2 screen collection flume that allowed collection of larval samples with minimal sampling stress
3 associated with turbulent flow or temperature changes. Sample water was delivered to the table
4 by two centrifugal pumps equipped with flowmeters. Collected entrainment samples were
5 transferred to an onsite laboratory for sorting, where ichthyoplankton were sorted and classified
6 as live (fish, eggs), stunned (fish only), or dead (fish and eggs). Dead eggs and larvae were
7 preserved; live or stunned fish or eggs were transferred to holding facilities to determine latent
8 effects on survival at 3, 6, 12, 24, 48, 72, and 96 hr. Specific sampling procedures are
9 discussed in EA (1981a).

10 The spring–summer sampling to evaluate entrainment survival of striped bass, white perch,
11 herrings, and anchovies was conducted from April 30 to August 14, 1979, coincident with the
12 primary spawning and nursery seasons of these species. Samples were collected on
13 2 consecutive nights each week for a total of 32 sampling days from 1800 to 0200 hr that
14 coincided with maximum abundance. As described above, a pumpless, rear-draw plankton
15 sampling flume mounted on rafts was employed during this study to minimize stress associated
16 with the use of centrifugal pumps. The volume of water samples collected from all samplers
17 was measured with integrated flowmeters, and vertical 505-micron (μm) mesh screens were
18 employed to divert entrained organisms into collection boxes, where they were concentrated
19 and processed to determine latent survival as described for the tomcod study.

20 Details of the 1980 entrainment survival and related studies are presented in EA (1982). In
21 1980, entrainment survival sampling at IP2 and IP3 was conducted from April 30 to July 10.
22 Sampling was focused on entrainable life stages of striped bass (*M. saxatilis*), white perch (*M.*
23 *americana*), herrings (Clupeidae), and anchovies (Engraulidae). Juvenile Atlantic tomcod (*M.*
24 *tomcod*) were also collected. To correct possible sources of gear-related effects on study
25 results, the rear-draw and pumpless plankton flumes used in 1979 were modified with flow
26 diffusion panels and slotted standpipes installed behind the angled diversion screens. These
27 refinements were intended to more evenly distribute the water across the surface of the screens
28 and eliminate localized areas of high-velocity flow that may have caused impingement. This,
29 along with other improvements to the sampling system, was expected to decrease the gear-
30 related mortality observed in control samples from the intakes at IP2 and IP3.

31 Entrainment survival sampling for striped bass, white perch, herring and anchovies was
32 conducted from April 30 to July 10, 1980, coinciding with the primary spawning and nursery
33 seasons of these taxa. Samples were collected on 4 consecutive nights each week for a total of
34 44 sampling days between the hours of 1600 and 0200. Sampling was conducted at discharge
35 canal station DP and at the IP3 intake using the modified rear-draw plankton sampling flumes.
36 Live and dead ichthyoplankton collected during the study were sorted at the onsite laboratory
37 immediately after sample collection and classified as live (fish and eggs), stunned (fish only), or
38 dead (fish and eggs). Dead eggs and larvae were preserved; live or stunned fish or eggs were
39 transferred to holding facilities to determine latent effects with checks at 3, 6, 12, 24, 48, 72, and
40 96 hr.

41 During the summer and early fall of 1984, dual-speed cooling water pumps were installed at
42 IP2. In 1985, variable-speed pumps were installed at IP3. The specific objectives of the 1988
43 entrainment studies were to (1) estimate the initial and extended survival of ichthyoplankton
44 entrained at IP2 and IP3 and compare the results to those from previous years, (2) determine
45 whether live and dead ichthyoplankton are randomly dispersed in the IP2 and IP3 discharge

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canal at sampling station D2, and (3) assess whether the thermal and mechanical components of entrainment stress are independent. The study description that follows was obtained from EA (1989).

The 1988 study EA (1989) was designed to sample 180 m³ per day with each flume system. One flume was deployed at intake Station I3; two flumes were deployed at discharge station D2. The original design required that flumes be operated 3 days per week from May 23 to June 30, 1989, resulting in 18 total sampling days. Specific daily volume requirements and numbers of sampling days were developed to ensure sufficient numbers of organics were collected. Because of a number of logistical challenges, the actual number of sampling days was 13, from June 8–30. The flume design and collection procedures employed in 1988 were consistent with previous studies described above. Average daily sample volumes collected at the intake were 143.3 m³, and the daily combined volume sampled by both flumes in the discharge canal was 271.2 m³. The sampling program was conducted during afternoon and evening hours (1300–2300). Live and dead ichthyoplankton collected during the study were sorted at the onsite laboratory immediately after sample collection and classified as described above. Other studies conducted in 1988 included sampling stress evaluations to provide a better understanding of mortality caused by sampling stress at intake versus discharge sampling locations, direct release studies to augment entrainment studies based on wild animal captures, and net studies in the discharge canal to provide additional information on ichthyoplankton distribution.

The results of entrainment survival from the 1977–80, 1985, and 1988 studies are presented in EA (1989) for initial intake survival (EA 1989, Figure 4-8), initial discharge survival (EA 1989, Figure 4-9), and overall entrainment survival (EA 1989, Figure 4-10). Summary information for the 1979, 1980, and 1988 study years are summarized in Table H-5 below:

Table H-5 Entrainment Survival Estimates for Study Years 1979, 1980, and 1988

Species	Initial Intake Proportion Survival	Initial Discharge Proportion Survival	Estimated Entrainment Proportion Survival
Bay Anchovy PYSL	~0.09–0.32	~0.01–0.05	~0.12–0.52
Striped Bass YSL	~0.52–0.95	~0.61	~0.62–0.72
Striped Bass PYSL	~0.50–0.95	~0.70–0.78	~0.68–0.80
White Perch PYSL	~0.15–0.95	~0.19–0.85	~0.30–0.92
<i>Alosa</i> spp. PYSL	~0.25–0.90	~0.30–0.60	~0.30–0.65

Adapted from Figures 4-8–4-10 in EA (1989)

H.1.2.2. Summary of Entrainment Abundance Monitoring Studies

During 1981, EA employed an Automated Abundance Sampler (AUTOSAM) to collect ichthyoplankton samples from IP2 and IP3. Middepth water samples were collected twice a week during May–August from discharge station D2. Each sampling effort consisted of collecting 90-minute (min) composite samples within eight 3-hr sampling intervals extending over a 24-hr period. Ichthyoplankton samples were sorted, identified to species and life stage, and counted (EA

1981b). In 1983, entrainment abundance samples were again collected at discharge canal station D2 from May 3 to August 13, 1983, using the AUTOSAM collector. From May 3–18, each sample consisted of a 90-min composite sample within eight 3-hr sampling periods. From May 19 to August 13, the 90-min composites reflect a shorter collection time to reduce clogging caused by the presence of detritus. Ichthyoplankton samples were sorted, identified to species and life stage, and counted (EA 1984). In 1984, ichthyoplankton samples were collected from discharge canal station D2 from May 3 to August 11, 1984. Sampling equipment, collection procedures, and sample processing were consistent with past sampling efforts described above (EA 1985).

In 1985, ichthyoplankton samples were taken continuously (24 hr/day) from May 1 to August 11. Each sample consisted of one 3-hr period, resulting in eight samples per day. Total sample volumes were 150 m³. Replicate sampling to determine variance estimates was conducted on Wednesdays and Thursdays of each week. Samples were collected by pumping water through a 10-centimeter (cm) (4-in.) diameter pipe submerged to a depth of 3 m at discharge canal Station D2 and passing the collected water into a plankton net with a codend cup. The collected sample was transferred to a sample jar, preserved, and transferred to a laboratory for sorting, identification to species and life stage, and enumeration (Normandeau 1987a). Pump samples to quantify ichthyoplankton entrained at IP2 and IP3 were collected from May 1 to August 10, 1986, at discharge canal station D2. Sampling duration was 3 hr without replication from May 1 to May 14, and 2 hr from May 15 to August 10 to increase the number of collected samples. Replicate sampling to provide variance estimates were collected 5 days per week from May 16 through August 10. Sampling equipment and processing were consistent with the 1985 sampling study (Normandeau 1987b). In 1987, pump samples to determine ichthyoplankton entrainment abundance were collected 24 hr per day from May 6 to August 10 from discharge canal station D2. Sample duration was 2 hr, which allowed a large number of samples to be collected. Replicate sampling to provide variance estimates was collected 5 days per week from May 6 to August 7 (Normandeau 1988).

H.1.2.3. Historic Assessment of Entrainment Impacts

As discussed in Sections 4.1.2.1 and 4.1.2.2, numerous studies have been conducted to estimate the quantity of RIS that are entrained by the Indian Point cooling systems and evaluate the survival of these species after entrainment occurs. Studies have also been conducted to evaluate the trends of fish populations in the Hudson River. The applicant and NYSDEC have used the results of these studies to evaluate the potential for adverse effects associated with the operation of the Indian Point cooling systems. The results of these assessments are described below. As described in Section 4.1.1.2, nongovernmental groups and members of the public have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the river are in decline and that entrainment of eggs, larval, and juvenile fish at Indian Point is contributing to the decline, destabilization, and ultimate loss of these important aquatic resources.

Applicant Assessment

In the environmental report for IP2 and IP3 (Entergy 2007), the applicant presents estimates of CMR for American shad, Atlantic tomcod, bay anchovy, river herring, striped bass, and white

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perch and discusses the results of the assessment conducted by Barnthouse et al. (2002). The conclusions of the ER are as follows:

More than 30 years of extensive fisheries studies of the Hudson River in the vicinity of IP2 and IP3 support current operations. The results of the studies performed from 1974 to 1997, the period of time covered in the DEIS, are referenced and summarized in the DEIS, and have not shown any negative trend in overall aquatic river species populations attributable to plant operations. Ongoing studies continue to support these conclusions [ASA]. In addition, current mitigation measures implemented through the HRSA and retained in the four Consent Orders, the current agreements with NYSDEC, and the outcome of the draft SPDES Permit proceeding, will ensure that entrainment impacts remain SMALL during the license renewal term. Therefore, withdrawal of water from the Hudson River for the proposes of once-through cooling at the site does not have any demonstrable negative effect on representative Hudson River fish populations, nor does it warrant further mitigation measures.

Additional impact assessment information was also provided to the NRC staff in Barnthouse et al. (2008) that used environmental risk-assessment techniques to evaluate the potential for adverse impacts to Hudson River RIS from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 cooling water intake system (CWIS), fish pressure, the presence of zebra mussels, predation by striped bass, and water temperature. Summary results available in Barnthouse et al. (2008) are presented in Table H-6. Using this information, the authors concluded the following:

Considered together, the evidence evaluated in this report shows that the operation of IP2 and IP3 has not caused effects on early life stages of fish that reasonably would be considered "adverse" by fisheries scientists and/or managers. The operation of IP2 and IP3 has not destabilized or noticeably altered any important attribute of the resource.

1

Table H-6 Summary of Impact Assessment for IP2 and IP3

Species	Suspected Cause of Apparent Hudson River Decline
American Shad	CWIS and zebra mussel hypothesis rejected. Most likely cause: fishing, with striped bass predation a potential contributing factor. (Barnthouse et al. 2008, Table 5)
Atlantic Tomcod	CWIS hypothesis rejected. Temperature a significant influence, but cannot explain post-1990 decline. Most likely cause of decline: striped bass predation. (Barnthouse et al. 2008, Table 6)
Bay Anchovy	CWIS hypothesis rejected. Striped bass predation most likely cause of change. (Barnthouse et al. 2008, Table 8).
River Herring	CWIS and zebra mussel hypothesis rejected. Most likely cause: striped bass predation. (Barnthouse et al. 2008, Table 7).
Striped Bass	CWIS and zebra mussel hypothesis rejected. Most likely cause: fishing. (Barnthouse et al. 2008, Table 3)
White Perch	CWIS hypothesis rejected. Zebra mussel and striped bass predation may have contributed to declines occurring in later years, but other unknown causes were responsible for declines occurring between 1975 and 1985. (Barnthouse et al. 2008, Table 4)
Source: Entergy 2008, adapted from Barnthouse et al. 2008	

2 NYSDEC Assessment

3 In 2003, NYSDEC developed a Final Environmental Impact Statement (FEIS) (NYSDEC 2003a)
4 in response to the DEIS submitted by the operators of IP2 and IP3, Roseton, and Bowline Point
5 (CHGEC 1999). In the FEIS, NYSDEC noted that “while the DEIS was acceptable as an initial
6 evaluation and assessment, it was not sufficient to stand as the final document, and additional
7 information as to alternatives and evaluation of impacts must be considered.” The Public
8 Comment Summary portion of the FEIS presents a summary of comments received on the 1999
9 DEIS (CHGEC 1999); a subsequent section, Responses to Comments, provides the NYSDEC
10 reply. In response to comments associated with the “cropping of fish populations by power
11 plants,” NYSDEC provided a detailed response. The following excerpt is from pages 53 and 54
12 of the document:

13 Rather than “selective cropping”, the impacts associated with power plants are
14 more comparable to habitat degradation; the entire natural community is
15 impacted. These “once-through cooling” power plants do not selectively harvest

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individual species. Rather, impingement and entrainment and warming of the water impact the entire community of organisms that inhabit the water column. For example, these impacts diminish a portion of the forage base for each species that consumes plankton (drifting organisms in the water column) or nekton (mobile organisms swimming through the water column) so there is less food available for the survivors. In an intact ecosystem, these organisms serve as compact packets of nutrients and energy, with each trophic (food chain) level serving to capture a diffuse resource and make it more concentrated.

Ichthyoplankton (fish eggs, larvae and very small fish which drift in the water column) and small fish feed on a base of zooplankton (drifting animal life) and phytoplankton (drifting plant life). The loss of these small organisms in the natural community may be a factor that leads to harmful algal blooms. The small fish themselves serve as forage for the young of larger species, which serve as forage for larger individuals, and so on up the food chain, more correctly understood as a "trophic pyramid." Once-through cooling mortality "short-circuits" the trophic pyramid and compromises the health of the natural community. For example, while an individual bay anchovy might ordinarily serve as food for a juvenile striped bass or even for a common tern, entrainment and passage through a power plant's cooling system would render it useful only as food to lower trophic level organisms. It could no longer provide its other ecosystem functions of consuming phytoplankton, digesting and concentrating it into its tissues, and ranging over a wide area, distributing other nutrients as manure. This is just a single example from a very complex natural system, where the same basic impact is multiplied millions of times over more than one hundred fish species.

NYSDEC also expressed concern about entrainment in the 2003 "Fact Sheet" pertaining to SPDES license renewal at IP2 and IP3 (NYSDEC 2003b, Attachment B, 1. Biological Effects):

1. Biological Effects

Each year Indian Point Units 2 and 3 (collectively "Indian Point") cause the mortality of more than a billion fish from entrainment of various life stages of fishes through the plant and impingement of fishes on intake screens. Entrainment occurs when small fish larvae and eggs (with other aquatic organisms) are carried into and through the plant with cooling water, causing mortality from physical contact with structures and thermal stresses. Impingement occurs when larger fish are caught against racks and screens at the cooling water intakes, where these organisms may be trapped by the force of the water, suffocate, or otherwise be injured. Losses at Indian Point are distributed primarily among 7 species of fish, including bay anchovy, striped bass, white perch, blueback herring, Atlantic tomcod, alewife, and American shad. Of these, Atlantic tomcod, American shad, and white perch numbers are known to be declining in the Hudson River (ASA Analysis and Communications 2002). Thus, current losses of various life stages of fishes are substantial.

Finally, in the petition submitted to the NRC on November 30, 2007, regarding the relicensing of IP2 and IP3 (NYSDEC 2007), the agency comments on impingement and entrainment impacts:

Impingement and Entrainment Contention

The operation of Indian Point consumes and returns approximately 2.5 billion gallons of Hudson River water each day. The River is an important estuarine ecosystem, and this operation has significant adverse impacts to the fish that call the Hudson home. Large fish are “impinged” on screens at the water intake where they are severely stressed and then suffocated. Smaller fish are “entrained” in the water intake, pulled through the operating plant and killed. This relentless process has continued relatively unabated for almost 40 years, and the applicant now seeks 20 more years. This must not continue because the environmental costs are too high. The NRC must fully consider the alternative of closed cycle cooling to mitigate these significant adverse impacts in this license renewal proceeding.

H.1.2.4. NRC Staff Assessment of Entrainment Impacts

Entergy (2007b) provided to NRC weekly average densities of entrained taxa for a given life stage for IP2 and IP3 for analysis. The data were collected from May to August in 1981 and 1983 through 1985, from January to August in 1986, and from May to August in 1987. The sum of the mean densities of all life stages for a given taxon and season (January–March, April–June, July–September, and October–December) times the volume of circulated water was used to estimate the mean number entrained per taxon and season.

NRC found a total of 66 taxa identified during entrainment monitoring in the data supplied. There were no blue crabs, shortnose or Atlantic sturgeon, or gizzard shad identified in the 1981–1987 entrainment data. Because of the difficulty in identification of early life stages, RIS included those taxa identified only to family or genera (herring family, *Alosa* spp., anchovy family, and *Morone* spp.). The percent RIS fish entrained and total fish entrained were compared to the total estimated mean number (Figure H-5). Except for 2 weeks in 1984 and 1985 (1 week in May and June) for which amphipods (*Gammarus* sp.) were recorded, the percentage RIS fish entrained was greater than 90 percent of entrained taxa. The number of amphipods collected in 2 weeks in 1984 was two times greater than identified fish collected over 15 weeks within the same year. Linear regression ($n = 6$; $p = 0.02$) indicated that the number of identified fish entrained decreased at a rate of 1.6 billion fish per year, a result consistent with the decrease observed in the number of fish impinged.

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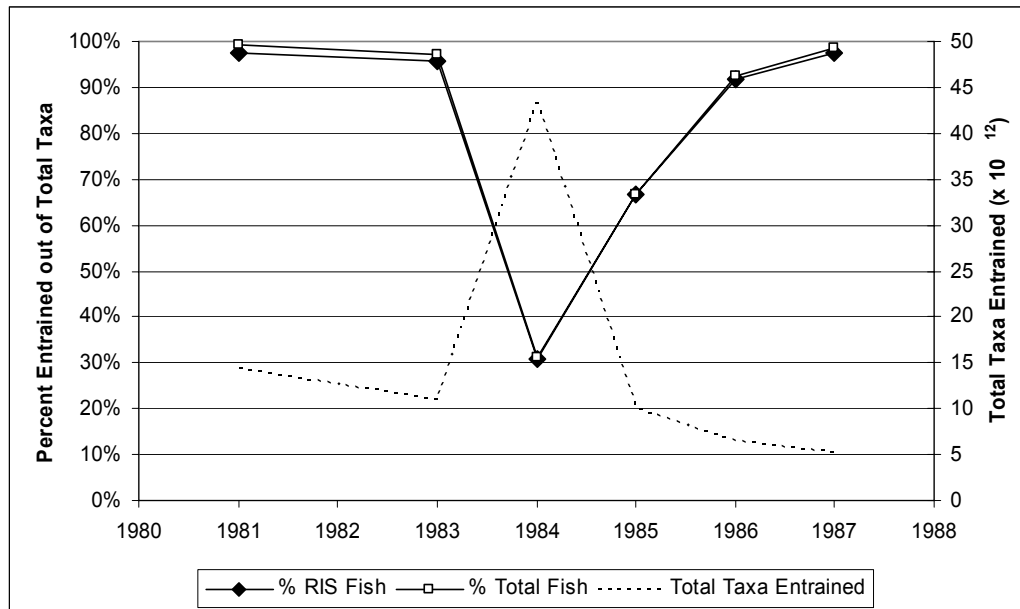


Figure H-5 Percentage of entrainment comprised of RIS fish and total fish in relation to the total estimated entrainment at IP2 and IP3 combined (data from Entergy 2007b)

A seasonal pattern in the percentage entrainment of each RIS out of the total RIS fish entrained was evaluated (Table H-7). Entrainment of herring, American shad, *Alosa* spp., white perch, and striped bass was mainly observed in the second quarter (April–June). Entrainment of weakfish and hogchoker was mainly observed in the third quarter (July–September). Rainbow smelt and Atlantic tomcod were observed in entrainment samples only in the first quarter (January–March) of 1986. Based on the available information, species representing 10 percent or greater of total RIS entrained for at least one sampling period were alewife, bay anchovy, American shad, rainbow smelt, striped bass, Atlantic tomcod, and white perch (Table H-7). Entrainment losses may affect populations directly by reducing the number of individuals available for recruitment and indirectly through the removal of potential food for predators. The environmental significance of entrainment is explored further in Section H.3.

H.1.3. Combined Effects of Impingement and Entrainment

The combined effects of impingement and entrainment were evaluated by the applicant in the DEIS (CHGEC 1999) by estimating CMR, which is intended to represent the fractional reduction in abundance of the vulnerable age groups (primarily those fish hatched during the current year) from a single source. The CMR is model-dependent and has been a source of controversy since it was developed. The NRC Staff analysis presented here will instead rely on the extensive fishery datasets collected under the direction and oversight of the NYSDEC.

1 **Table H-7 Percentage Entrainment of RIS by Year and Season (data from Entergy 2007b)**

Year/ Season	1981			1983			1984			1985			1986			1987		
	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
Herring Family	2.2	<0.05	40	<0.05	24	<0.05	0.3	- ^a	-	-	31	<0.05	1.2	-	-	-	-	-
Blueback Herring	-	<0.05	<0.05	0.1	<0.05	<0.05	-	<0.05	-	<0.05	<0.05	<0.05	-	-	-	-	-	-
Alewife	-	-	-	<0.05	<0.05	-	-	-	-	-	<0.05	<0.05	<0.05	-	-	-	-	-
American Shad	0.1	<0.05	0.1	<0.05	3.9	<0.05	<0.05	-	-	-	0.1	-	<0.05	<0.05	-	-	-	<0.05
Alosa Species	7.4	<0.05	30	<0.05	36	<0.05	0.6	-	0.4	-	<0.05	-	<0.05	-	-	-	-	-
Atlantic Menhaden	-	-	-	-	-	-	0.1	-	-	-	0.3	-	-	-	-	-	-	-
Anchovy Family	3.1	8.2	<0.05	43	1.1	8.4	-	-	-	-	-	-	-	-	-	-	-	-
Bay Anchovy	46	91	0.1	53	16	86	73	99	-	-	4.0	99	47	99	-	-	-	99
Rainbow Smelt	-	-	<0.05	-	0.2	<0.05	<0.05	<0.05	64	<0.05	2.0	0.2	0.8	0.1	-	-	-	0.1
White Catfish	-	-	-	-	-	<0.05	-	-	0.1	-	<0.05	-	-	-	-	-	-	-
Atlantic Tomcod	0.9	-	0.1	<0.05	1.2	0.1	6.8	<0.05	34	<0.05	1.8	-	1.4	<0.05	-	-	-	<0.05
White Perch	15	0.1	14	0.6	6.0	0.4	5.8	0.1	2.3	0.1	27	0.4	8.6	0.3	-	-	-	0.3
Striped Bass	25	<0.05	8.0	0.8	9.4	3.0	11	<0.05	-	<0.05	31	0.2	38	0.3	-	-	-	0.3
Morone Species	-	-	6.6	0.2	1.2	0.1	2.7	<0.05	-	<0.05	2.9	<0.05	2.9	<0.05	-	-	-	<0.05
Bluefish	-	-	-	-	-	<0.05	-	<0.05	-	<0.05	-	-	-	-	-	-	-	-
Weakfish	-	0.3	-	1.2	-	2.2	0.1	0.7	-	0.7	-	-	<0.05	<0.05	-	-	-	<0.05
Hogchoker	-	-	-	<0.05	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	<0.05	0.3	<0.05	0.6	<0.05	0.2	<0.05	0.3	-	0.3	<0.05	0.3	<0.05	0.1	-	-	-	0.1

2 (a) Season 1 is January–March, 2 is April–June, 3 is July–September.

3 (b) – indicates no identified observation.

4 Units = percent

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1 The purpose of this analysis is to determine the potential for adverse impacts to the aquatic
2 resources of the Hudson River estuary associated with the operation of IP2 and IP3 once-
3 through cooling systems during the relicensing period. The National Environmental Policy Act,
4 as amended (NEPA), requires an ecologically relevant analysis of potential impacts that is more
5 holistic than a general fisheries biology approach. Fisheries biology tends to focus on single
6 species issues, such as sustaining a harvest rate, no matter what the effect may be on other
7 species within the system. Thus, although still simplistic, this analysis considers potential
8 impacts across trophic levels.

9 The operation of the IP2 and IP3 cooling systems can directly affect the aquatic communities of
10 the Hudson River through impingement, entrainment, or thermal releases. Loss of YOY,
11 yearling and older fish, blue crabs (*Callinectes sapidus*), and other aquatic species can occur
12 from impingement against intake screens. Eggs, YSL, post-yolk-sac larvae (PYSL), and
13 juvenile fish and invertebrates small enough to pass through the intake screens (9.5-mm or
14 0.375-in. square mesh) may become entrained within the intake units of the once-through
15 cooling system and experience adverse effects associated with mechanical, chemical, and
16 thermal stressors. Releases of heated noncontact cooling water through subsurface diffuser
17 ports into the Hudson River can result in heat- or cold-shock effects. Cooling system operation
18 can also result in indirect effects to aquatic resources. Impingement may injure, stun, or
19 debilitate an organism, reducing its ability to avoid predation, capture prey, or grow and
20 reproduce in a normal manner. Entrainment of larval or small juvenile forms not resulting in
21 death may reduce viability or survival success. Entrainment can also create an indirect adverse
22 impact to estuarine food webs by removing potential prey items from predators, or altering and
23 redistributing the aquatic organic carbon represented by entrained organisms. In addition, the
24 release of heated water can result in sublethal effects, including changes in reproduction or
25 development, increased susceptibility to other environmental stressors, or behavioral changes
26 associated with avoiding thermal plumes.

27 Evaluating the potential for adverse impacts of the IP2 and IP3 cooling systems to the aquatic
28 resources of the Hudson River estuary presents a significant challenge for a variety of reasons.
29 First, the potential stressor of interest (the IP2 and IP3 cooling systems) occupies a fixed
30 position on the Hudson River, while RIS associated with the Hudson River generally have large
31 spatial and temporal distributions that can change for each life stage. Thus, evaluation of
32 causal relationships between potential stressors and receptors is difficult and requires a
33 systems-level understanding that may not be possible with existing environmental information.
34 Second, the Hudson River estuary represents a dynamic, open-ended system containing a
35 complex food web that is hydrologically connected from freshwater locations near the Troy Dam
36 to the Atlantic Ocean. Detectable trends at population levels that suggest adverse effects may
37 be attributable to a variety of anthropogenic and natural stressors, including the activities at IP2
38 and IP3. Finally, because the Hudson River estuary represents a complex system with
39 hundreds of aquatic species, it is necessary to focus primarily on a subset of RIS. While this
40 simplifies the assessment of impact, it also introduces additional uncertainties that must be
41 acknowledged and addressed.

42 The GEIS defines impingement, entrainment, and heat shock from cooling system operation as
43 Category 2 issues requiring site-specific review. Levels of impact associated with these issues
44 are defined as potentially SMALL, MODERATE, or LARGE, consistent with the criteria that the
45 NRC established in Footnote 3 to Table B-1, Appendix B, 10 CFR Part 51, as follows:

- 1 • SMALL—Environmental effects are not detectable or are so minor that they will neither
2 destabilize nor noticeably alter any important attribute of the resource.
- 3 • MODERATE—Environmental effects are sufficient to alter noticeably, but not to
4 destabilize, any important attributes of the resource.
- 5 • LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize
6 any important attributes of the resource.

7 To evaluate whether the operation of the IP2 and IP3 cooling systems adversely affects RIS,
8 NRC Staff employed a modified weight-of-evidence (WOE) approach as represented in Figure
9 H-6. The approach used impingement and entrainment monitoring data obtained from the IP2
10 and IP3 facilities, data from the lower Hudson River collected during the Long River Survey
11 (LRS), Fall Juvenile/Fall Shoals Survey (FJS/FSS), and Beach Seine Survey (BSS), as
12 described in Table 2-3 in the main text, and coastal fishery trend data, when available. Lines of
13 evidence (LOE) associated with the population trends and strength of connection were
14 developed. The WOE is a technique used to integrate multiple LOE, or types of variables, to
15 make a single decision concerning the magnitude of impact and its association with a potential
16 stressor (IP2 and IP3 cooling systems). The WOE approach employed was based on Menzie et
17 al. (1996) and consisted of the following steps depicted in Figure H-7:

- 18 (1) Identify the environmental component or value to be protected.
- 19 (2) Develop LOE and quantifiable measurements to assess the potential for adverse
20 environmental effects and evaluate whether the IP2 and IP3 cooling systems are
21 contributing to the effect.
- 22 (3) Quantify the use and utility of each measurement for supporting the impact assessment.
- 23 (4) Develop quantifiable “decision rules” for interpreting the results of each measurement.
- 24 (5) Use the WOE to integrate the results, assign a level of potential impact, and determine if
25 adverse effects in RIS populations, if present, are related to the operation of the IP2 and
26 IP3 cooling systems.

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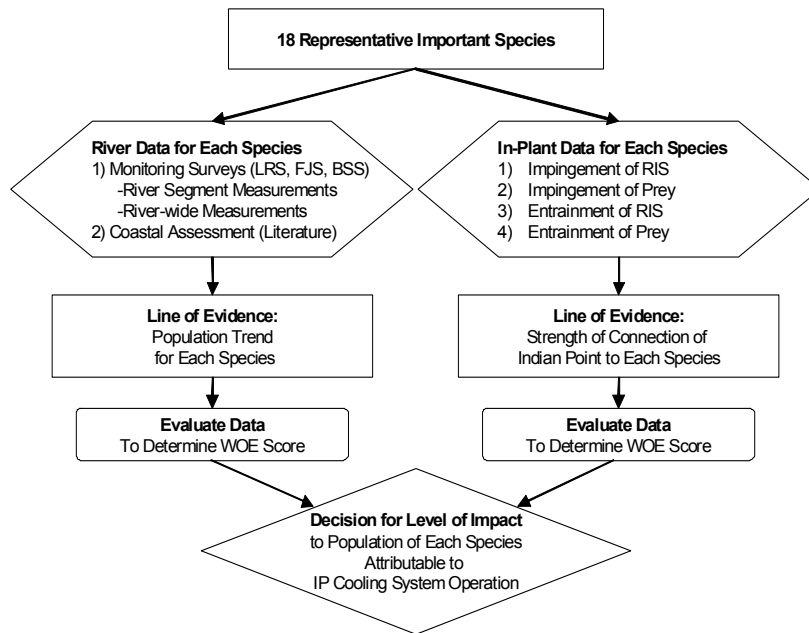


Figure H-6 General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation

These steps are discussed below in more detail. Supporting information for the statistical analyses used in this determination is presented in Appendix I. A WOE approach was not used to evaluate thermal effects, because recent monitoring or modeling data were not available.

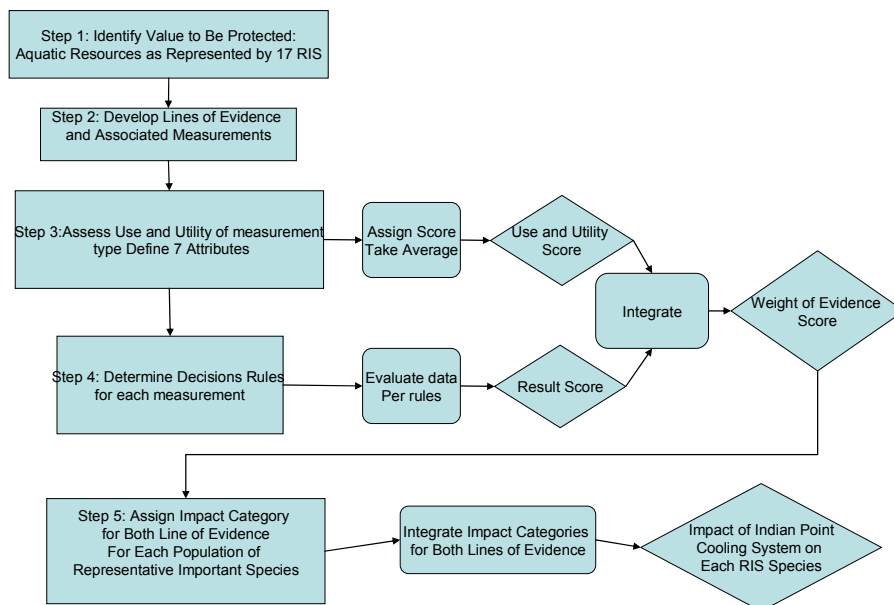


Figure H-7 Steps used to conduct the weight-of-evidence assessment

Step 1: Identify the Environmental Component or Value To Be Protected

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4 in the main text. These species represent a variety of feeding strategies and food web classifications and are considered ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to YOY and yearling fish and their food sources. Although eggs, larvae, and PYSL are important components to the food web, the natural mortality to these life stages is high, as noted by Barnthouse et al. (2008) and Secor and Houde (1995). In contrast, fish surviving to YOY and older are more likely to add to the adult breeding population and are at greater risk from the cooling system operation. Any factor that increases (or decreases) the survival of those fish during juvenile and yearling stages can affect the sustainability of the population.

The conceptual model considers that the dynamics of the system are subject to large changes based on a wide variety of controlling factors. Phytoplankton and zooplankton communities form the basis of the food web and are used by a variety of fish and invertebrates during their development from larvae to adults. Plankton abundances generally increase during the spring and summer, coinciding with the emergence of larval and juvenile forms of fish and invertebrates after spawning. For some species, such as striped bass, PYSL and juvenile forms initially eat small, planktonic prey, then switch to larger prey as they grow. For other species, such as herring and alosids, adults remain planktivores. Predator-prey relationships within the estuary are complex and are influenced by a variety of physical, chemical, spatial, and temporal factors. Within this system, predation may be inter- or intraspecific, and operate at a variety of levels simultaneously. There are also a variety of controlling factors that may exert influence on the estuarine food web and inhabitants of the estuary. Physical and chemical fluctuations can serve as cues for reproduction and promote or inhibit growth, the nature and extent of predation can result in shifts in food web dynamics, and the influence of invasive or exotic species and anthropogenic activities can affect year-classes or result in long-term changes to populations.

After reviewing available information, the NRC staff could not determine if the operation of the IP2 and IP3 cooling systems is adversely affecting the RIS through the phytoplankton and zooplankton populations present near the facilities. It is possible, however, that the entrainment of these food web constituents can alter or influence the food web by removing potential prey items from the water column and reintroducing and redistributing them in the river in an altered state. As a result, the form and distribution of organic carbon can be fundamentally changed, even though the overall mass-balance remains the same. A similar effect may exist for larval forms that experience entrainment and are thus unavailable in their natural state for predation. Impingement losses may also alter the food web by removing potential predator or prey items from the system or by changing the dynamics of the relationships at critical periods. At the higher levels of the food web, large predators such as bluefish, weakfish, and striped bass may be affected by alterations to the food web in ways that are not always obvious. For instance, work by Baird and Ulanowicz (1989) suggested that, even though striped bass and bluefish in the Chesapeake Bay ecosystem were both piscivorous predators, 63 percent of the bluefish intake depended indirectly on benthic organisms, whereas striped bass depended mainly on planktonic organisms.

Within this food web context, the IP2 and IP3 cooling systems can be viewed as hybrid predators. Although the operation of the cooling water systems exerts a predatory effect at

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multiple levels within the estuarine food web, the fixed position of the plants in the environment, their relatively continuous operation, and their lack of sensitivity to traditional environmental stressors that affect predators place them in a unique position within the estuarine system. The cooling system also functions as an environmental sampling device through impingement and entrainment. To fully explore the potential adverse impacts of cooling system operation to the aquatic resources of the Hudson River estuary, it is necessary to examine both the direct impacts associated with losses caused by impingement, entrainment, and heat, and the indirect impacts of these potential stressors that may work through the food web and contribute to detectable long-term changes to RIS populations.

Step 2: Identify Lines of Evidence and Quantifiable Measurements

The LOE and measurements used by NRC Staff to assess the impacts of the IP2 and IP3 cooling systems on RIS in the Hudson River estuary are presented in Table H-8. The first LOE (LOE-1) was a population-trend analysis using data from the three surveys conducted for the Hudson River utilities and from recent coastal fisheries information, when available. Population trends over time are often used to assess long-term changes in population abundance or species composition and to provide information on sustainability.

For Measure 1-1, the river-segment trends were based on the fish caught within River Segment 4 (IP2 and IP3) or, if this sampling area had a consistently low catch, an adjoining segment (River Segments 2 through 6), whichever had a greater catch (Figure 2-6 in the main text). The river-segment data were the weekly catch-per-unit-effort (CPUE) and catch density from the FJS, BSS, and LRS. The annual estimate of the population response was the 75th percentile of the weekly data for a given year, because it was not as sensitive as the mean to the few large observations collected each year.

For Measure 1-2, riverwide population trends were based on the annual CPUE and the annual abundance index derived by the applicant. Commercial harvest data were used to represent coastal population trends. Population trends also formed the basis of the WOE analysis used by the NRC staff to assess the cumulative impacts of IP2 and IP3 activities, as well as other anthropogenic and natural environmental stressors, including the potential effects of zebra mussels in the freshwater portion of the Hudson River.

Table H-8 Lines of Evidence and Measurements Used To Assess Cooling System Impacts

LOE-1: ASSESSMENT OF POPULATION TRENDS OF RIS

Measurement 1-1	River-segment RIS population trends from FSS and BSS (and LRS for tomcod)
Measurement 1-2	Riverwide RIS population trends from FSS and BSS (and LRS for tomcod)
Measurement 1-3	Coastal population trends from State or Federal regulatory agency databases

1

Table H-8 (continued)

LOE-2: ASSESSMENT OF STRENGTH OF CONNECTION	
Measurement 2-1	Impingement of RIS
Measurement 2-2	Entrainment of RIS
Measurement 2-3	Impingement of RIS prey
Measurement 2-4	Entrainment of RIS prey

2 The second LOE (LOE-2) measures the strength of the connection between the operation of the
 3 IP2 and IP3 cooling systems and the aquatic resources in the Hudson River. NRC Staff derived
 4 measurements of connection strength from monitoring data at IP2 and IP3 from 1975–1990 that
 5 provide information on impingement and entrainment rates for RIS and prey of RIS. As
 6 discussed above, the operation of the cooling system can result in direct mortality of RIS or may
 7 debilitate or damage organisms in a manner that causes latent mortality.

8 Impingement and/or entrainment can also remove and reintroduce RIS prey into the aquatic
 9 system in a manner that alters food web dynamics and produces indirect effects that may result
 10 in decreased recruitment, changes in predator-prey relationships, changes in population feeding
 11 strategies, or movements of populations closer to or farther away from the cooling system
 12 intakes or discharges. Staff based the analysis of impingement on the concordance of two
 13 ranked proportions. The first proportion was the ratio of the number of YOY and yearling fish of
 14 each species impinged in relation to the sum of all fish impinged. The second proportion was
 15 the ratio of each species abundance in the river near IP2 and IP3 relative to the total abundance
 16 of all 18 RIS. A large rank for both proportions would mean that the proportion impinged for the
 17 given RIS and the proportion abundance in the river were both large. The ratio of these two
 18 ranks would then be close to 1, suggesting that the stationary sampler was sampling
 19 proportionately to the abundance in the river (a medium strength of connection).

20 Likewise, NRC Staff based the effects of entrainment on the concordance of two ranked
 21 proportions. The first proportion was the estimated number entrained for all life stages for a
 22 given species in relation to the abundance of all fish entrained. The second proportion was the
 23 ratio of each species abundance in the river near IP2 and IP3 relative to the total abundance of
 24 all RIS. The estimated number entrained was the sum of the mean density for each life stage
 25 and sampling date within a given quarter of the year multiplied by the volume of circulated water
 26 (flow). Staff also considered potential food web impacts to RIS associated with the loss of prey
 27 caused by impingement or entrainment, based on the relationship presented in the conceptual
 28 model.

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Step 3: Quantify the Use and Utility of Each Measurement

The following attributes of each measurement within each LOE were adapted from Menzie et al. (1996) and were assigned an ordinal score corresponding to a ranking of its use and utility as low (1), medium (2), or high (3).

- (1) Strength of Association Between the Measured Parameter and the Aquatic Community—the extent to which the measurement parameter is representative of, correlated with, or applicable to the assessment of the target fish community
- (2) Stressor-specificity—the extent to which the measurement parameter is associated with the specific stressor (e.g., impingement mortality)
- (3) Site-specificity—the extent to which data, media, species, environmental conditions, and other factors relate to the site of interest
- (4) Sensitivity of the Measurement Parameter for Detecting Changes—the ability to detect a response in the measurement parameter
- (5) Spatial Representativeness—the degree of compatibility between the study area, location of measurements or samples, locations of stressors, and locations of biological receptors and their points of exposure
- (6) Temporal Representativeness—the temporal compatibility between the measurement parameter and the period during which effects of concern would occur
- (7) Correlation of Stressor to Response—the degree to which a correlation is observed between levels of response, and the strength of that correlation

Staff then calculated overall use and utility scores for each measurement within each LOE as the average of the individual attribute scores. For a given LOE, the average score for all attributes was used to characterize the overall use and utility of the measurement as low, medium, or high, using the following definitions:

- low use and utility—overall score of <1.5 (questionable for decision-making)
- medium use and utility—overall score of ≥ 1.5 and ≤ 2 (adequate for decision-making)
- high use and utility—overall score of >2 (very useful for decision-making)

The results of these evaluations are presented for each LOE and supporting measurements in Tables 4-2 and 4-3. For LOE-1, RIS population trends, measurements with the highest use and utility are those that provide information on long-term trends in RIS populations at river-segment and riverwide scales (Table H-9). Comprehensive data sets extending over 30 years yield high use and utility for assessing impacts. As measurements of populations become more spatially distributed, the ability to use the measurement to assess impacts associated with IP2 and IP3 decreases.

When assessing the strength of the connection between the IP2 and IP3 cooling systems and the aquatic environment (i.e., the ability of the IP2 and IP3 cooling systems to affect RIS populations in the Hudson River estuary), measurements associated with loss of prey caused by entrainment have the highest use and utility values (Table H-10) because stressor-specificity is higher than for the other measures. Even though the sensitivity of the measure is lower because of food web complexities, the loss of a food base for YOY predators has a greater

1 impact on more individuals than the direct loss of single individuals. While the evaluation of
 2 food-web impacts associated with the impingement and entrainment of RIS prey is complex,
 3 other investigators have found that alterations to lower levels of complex food web relationships
 4 result in measurable impacts at higher trophic levels. For instance, work by Ulanowicz (1995)
 5 suggests that when ecosystems are disturbed or stressed, the resulting changes in carbon flow
 6 can result in the disappearance of higher trophic-level predators or a reallocation of trophic
 7 positioning at the higher levels. Frank et al. (2007) report the potential for a “top-down”
 8 response that can affect lower trophic level prey items, though the existence of this
 9 phenomenon is debatable.

10 **Table H-9 Use and Utility of Each Measurement Type To Evaluate RIS Population Trends**
 11 **Potentially Associated with IP2 and IP3 Cooling System Operation**

Use and Utility Attribute	River-Segment RIS Community Trends	Riverwide RIS Community Trends	Coastal RIS Community Trends
Strength of Association between Measurement and Community Response	3	2	1
Stressor-specificity	2	1	1
Site-Specificity of Measurement in Relation to the Stressor	2	1	1
Sensitivity (Variability) of Measurement	2	2	1
Spatial Representativeness	3	2	1
Temporal Representativeness	3	3	3
Correlation of Stressor to Response	2	1	1
Overall Utility Score	2.4	1.7	1.3
Overall Assessment ^(a)	High	Medium	Low
(a) Overall Assessment: scores <1.5: low utility (questionable use for decision-making); 1.5≤ scores ≤2.0: medium utility (adequate for decision-making); scores >2.0: high utility (very useful for decision-making)			

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Table H-10 Use and Utility of Each Measurement Type To Evaluate the Strength of Connection between the IP2 and IP3 Cooling Systems and Hudson River RIS Populations

Use and Utility Attribute	RIS Impinged	RIS Entrained	RIS Prey Impinged	RIS Prey Entrained
Strength of Association between Measurement and Community Response	1	1	1	3
Stressor-Specificity	2	2	2	3
Site-Specificity of Measurement in Relation to the Stressor	2	2	2	2
Sensitivity (Variability) of Measurement	2	1	2	1
Spatial Representativeness	3	3	3	3
Temporal Representativeness	2	1	2	1
Correlation of Stressor to Response	1	1	2	2
Overall Utility Score	1.9	1.6	2.0	2.1
Overall Assessment ^(a)	Medium	Medium	Medium	High

(a) Overall Assessment: scores <1.5: low utility (questionable use for decision-making); 1.5 ≤ scores ≤2.0: medium utility (adequate for decision-making); scores >2.0: high utility (very useful for decision-making)

Step 4: Develop Quantifiable Decision Rules for Interpreting the Results of Each Measurement

For all population trend assessments in the first LOE, NRC Staff used a two-step process to assign the level of potential for an adverse impact suggested by a given measurement. The first step was to evaluate the shape of the resulting best-fit model and the second step was to evaluate the annual variability in the data to determine whether or not the abundance data could support a claim of potential adverse impact. The shape of the trend data was evaluated using simple linear regression and segmented regression as a function of time with a single join point (see the statistical approach below and Appendix I for specific details). The segmented regression analysis allowed a delayed response and two time periods to evaluate trends. The model with the smallest error mean square was chosen as the better fit and used to assess the level of potential adverse impact. In the second step, staff used the proportion of data outside a defined level of noise to assess whether the potential adverse impact could be supported.

Based on four possible outcomes, the following decision rules were used to evaluate RIS population trend data. A population trend result score of either 1, 2, or 4 is assigned as follows:

- A SMALL potential for an adverse impact to an RIS population was determined if population trends had slopes that were not significantly different from zero (i.e., no detectable slope) and had ≤40 percent annual abundances falling outside a predetermined level of noise (defined here as +/-1 standard deviation from the mean of the first 5 years of data). This suggested that the RIS population had not changed detectably over time, and adverse environmental impacts were unlikely. Measurements satisfying this description were assigned a result score of 1.

- 1 • A MODERATE potential for an adverse impact to an RIS population was determined if
2 population trends had slopes that were not significantly different from zero (i.e., no
3 detectable slope) but had greater than 40 percent of abundance observations outside
4 the defined level of noise. If this response was observed, an adverse environmental
5 impact was probable. Measurements satisfying this description were assigned a result
6 score of 2.
- 7 • A MODERATE potential for an adverse impact to an RIS population was determined if
8 population trends with slopes that were significantly different from zero (i.e., detectable
9 slope) but had ≤ 40 percent annual abundances falling outside a predetermined level of
10 noise. If this response was observed, an adverse environmental impact was probable
11 but estimated below the detection limit set by the annual variability. Measurements
12 satisfying this description were assigned a result score of 2.
- 13 • A LARGE potential for an adverse impact to an RIS population was determined if
14 population trends had slopes that were significantly different from zero (i.e., detectable
15 slope) and had greater than 40 percent of annual abundance outside the defined level of
16 noise (i.e., support for potential impact). This response was considered clearly
17 noticeable, and an adverse environmental impact was likely. Measurements satisfying
18 this description were assigned a result score of 4.

19 This “1224” ranking is sometimes called “standard competition ranking.”

20 To evaluate the strength of connection between the operation of the IP2 and IP3 cooling
21 systems and the observed RIS population declines, decision rules were developed for
22 assessing the influence of impingement and entrainment directly on RIS and the potential
23 effects on RIS food web dependencies caused by loss of prey to impingement and entrainment.
24 Details of the development of the ratio of ranked proportions are discussed in the statistical
25 approach below and in Appendix I. A strength-of-connection result score of 1, 2, or 4 is
26 assigned as follows:

- 27 • Low Strength of Connection: The ratio of ranked proportions of impinged or entrained
28 RIS or RIS prey relative to total impingement or entrainment and the ranked proportion
29 of the population size in the river relative to the total RIS abundance is less than 0.5.
30 The species is considered underrepresented in the cooling system impingement or
31 entrainment samples, and thus, there is minimal evidence to suggest the IP2 and IP3
32 cooling systems are affecting the RIS. Measurements satisfying this description were
33 assigned a result score of 1.
- 34 • Medium Strength of Connection: The ratio of ranked proportions of impinged or
35 entrained RIS or RIS prey relative to total impingement or entrainment and the ranked
36 proportion of the population size in the river relative to the total RIS abundance is greater
37 than or equal to 0.5 and less than 1.5. The species is considered proportionally
38 represented in the cooling system impingement or entrainment samples, and thus, there
39 is some evidence to suggest the IP2 and IP3 cooling systems are affecting aquatic
40 resources. Measurements satisfying this description were assigned a result score of 2.
- 41 • High Strength of Connection: The ratio of ranked proportions of impinged or entrained
42 RIS or RIS prey relative to total impingement or entrainment and the ranked proportion
43 of the population size in the river relative to the total RIS abundance is greater than or

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equal to 1.5. The species is considered overrepresented in the cooling system impingement or entrainment samples, and thus, there is strong evidence to suggest the IP2 and IP3 cooling systems are affecting the RIS. Measurements satisfying this description were assigned a result score of 4.

Step 5: Integrate the Results and Assess Impact

NRC Staff derived separate WOE scores for the population trend LOE and the strength of connection LOE. The above decision rules enabled the NRC to assign levels of impact to RIS populations and strength of connection between the IP2 and IP3 cooling systems and the observed RIS population declines with the weighted mean equation:

$$\text{WOE Score} = \frac{\sum_i (\text{overall utility score}_i)(\text{decision rule result score}_i)}{\sum_i \text{overall utility score}_i},$$

where $i = 1$ to the number of measurements; the overall utility score $_i$ is defined in Tables H-9 and H-10; and the result score $_i$ equals 1, 2, or 4, based on the above decision rules.

For population trend analyses, impact categories were defined as follows:

- small impact: WOE score <1.5
- small-moderate impact: WOE score = 1.5
- moderate impact: WOE score >1.5 but <2.0
- moderate-large: WOE score = 2.0
- large: WOE score >2

Staff used a similar scaling system to evaluate the strength of connection between the operation of the IP2 and IP3 cooling systems and the observed RIS population decline, using the primary scaling terms low, medium, and high.

The resulting impact categories for the population trend and strength of connection LOE were then integrated by applying the logic developed by EPA for evaluating the ecological effects of environmental stressors (EPA 1998). Ecological risk assessment (EPA 1998) requires a connection between the stressor and the response to assign any level of impact. For the purpose of this assessment, the stressor is the IP2 and IP3 cooling systems, while the receptor is the aquatic community, as represented by the RIS populations, and the degree of exposure is quantified by the strength of connection.

Statistical Approach for Each Line of Evidence

The decision rules developed above to determine the level of adverse impact to the aquatic resources of the Hudson River estuary associated with the operation of the IP2 and IP3 once-through cooling systems use (1) population trend data to provide a measure of potential impacts to the aquatic resources, and (2) impingement and entrainment data to provide a measure of the strength of connection between IP2 and IP3 operations and the aquatic environment. The statistical approach used to evaluate each measurement is described below. Results were

1 compared to the decision rules to assign a result score that was then integrated using the
 2 weighted mean presented above. WOE was then used to integrate the measures of potential
 3 impact with the measures of strength of connection to assign a level of impact attributable to the
 4 operation of the IP2 and 3 cooling systems.

5 Statistical Approach to Assessing Long-Term RIS Population Trends: Simple linear regression
 6 and segmented regression with a single join point were statistically fit to an annual measure of
 7 abundance (y) for each RIS using Prism Version x, 2005. The form of the segmented
 8 regression model was:

$$9 \quad y = \begin{cases} a + S_1 x & \text{for } x < J_p \\ a + J_p (S_1 - S_2) + S_2 x & \text{for } x \geq J_p \end{cases}$$

10 where x was the year, a was the intercept, S_1 and S_2 were early (associated with years $< J_p$) and
 11 recent slopes of the line, and J_p was the estimated point in time when the slope changed
 12 (i.e., the join point). The model with the smallest mean squared error (MSE) was chosen as the
 13 better fit to the data. If the best-fit model was the simple linear regression and the slope was
 14 statistically significant (negative or positive, $\alpha = 0.05$), a population trend was detected. If the
 15 slope was not significantly different from zero, then a population trend was not detected. If the
 16 best-fit model was the segmented regression and either slope, S_1 or S_2 , was statistically
 17 significant ($\alpha = 0.05$), then a population trend was considered detected. If both slopes S_1 and
 18 S_2 were not significantly different from zero ($\alpha = 0.05$), then the trend was not considered
 19 detected. Note that an NRC impact level of small (value = 1) was defined as the lowest level of
 20 potential adverse impact.

21 To evaluate whether abundance data were indicative of potential aquatic impacts, staff
 22 standardized all data by subtracting the mean of the first 5 years of data and then dividing by
 23 the standard deviation based on all years of data. The first 5 years (1979–1983) were chosen
 24 as the standard because the CV of abundance either leveled out at $n = 5$, or it was preceded by
 25 a rapid change in direction (Figure H-8). For density and CPUE data, staff compared population
 26 trends between the BSS and FJS to determine if the shift from the epibenthic sled to the beam
 27 trawl in 1985 was influencing the shape of the response. If the FJS data had standardized
 28 observations consistently less than the standardized BSS data after 1985, then the FJS data
 29 were split into pre- and post-1985 for analysis.

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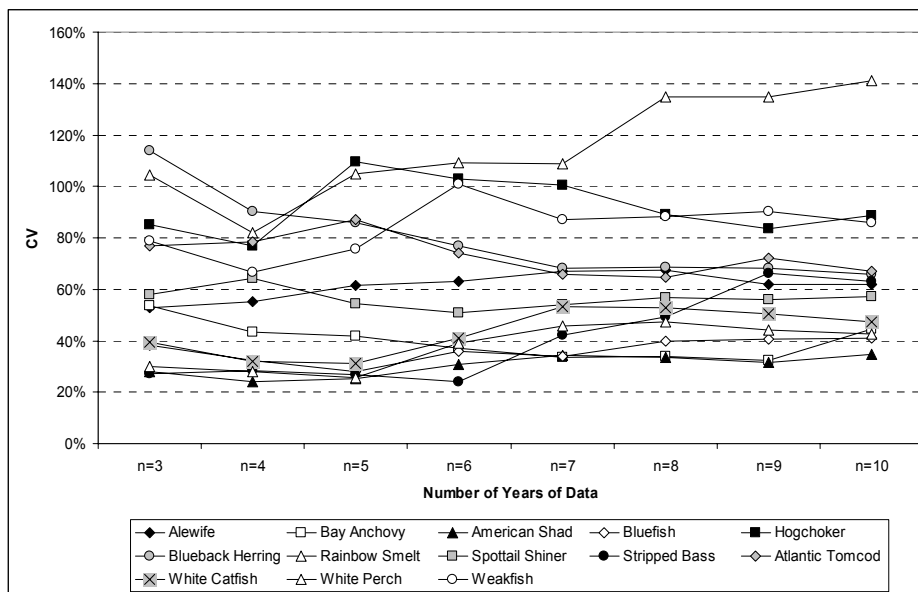


Figure H-8 Coefficient of variation of the abundance index for an increasing number of data points (data from Entergy 2007b)

An assessment of adverse impact was only supported if greater than 40 percent of the standardized observations were outside the bounds of ± 1 . For a normal bell-shaped distribution with a mean of zero and a standard deviation of one, 32 percent of the observations are outside the bounds of ± 1 standard deviation (Snedecor and Cochran 1980). Thus, observations outside the boundaries of ± 1 standard deviation from the mean of the first 5 years were considered outside of the natural variability (noise). If greater than 40 percent of the standardized observations were outside this defined level of noise, then a potential for adverse impact was considered supported. Table H-11 provides an overview of the eight possible outcomes for the assessment.

Table H-11 Comparison of Possible Outcomes When Assessing Population Trends of RIS in the Hudson River Studies

Best-fit Model	Statistical Outcome		Potential for Impact and Result Score
	Significant Slope(s)	Noise ¹	
Simple Linear Regression	No	No	Small—1
	No	Yes	Moderate—2
	Yes	No	Moderate—2
	Yes	Yes	Large—3
Segmented Regression	Neither	No	Small—1
	Neither	Yes	Moderate—2
	Either or Both	No	Moderate—2
	Either or Both	Yes	Large—3

¹Noise: Absolute values for 40 percent of standardized observations greater than 1.

Statistical Approach to Assessing Strength of Connection: To determine the strength of connection between the operation of the IP2 and IP3 cooling systems and the RIS that exist in the Hudson River near the facility, NRC Staff evaluated the two types of environmental samplers: (1) impingement and entrainment data obtained from the operators of IP2 and IP3 (a stationary environmental sampler along the shore of the Hudson) and (2) long-term aquatic resource studies conducted in the river by power plant operators under the supervision of State agencies (e.g. LRS, FJS, BSS). The null hypothesis was that the proportional representation of RIS obtained from the fishery studies should be equal to the proportional representation evident from the impingement and entrainment samples. The nature of this relationship was explored for each RIS, and the overall strength of connection was evaluated by comparing concordance of ranks as described below.

When evaluating the proportional representation, the focus is on comparing the results obtained from impingement and entrainment samples at the IP2 and IP3 facilities with the representation observed in the aquatic community near the facility. Using entrainment as an example, Table H-12 provides an overview of the three possible outcomes for the comparison.

Table H-12 Comparison of Possible Outcomes When Assessing Proportional Representation of RIS in Cooling System and Fishery Studies

Outcome	Result
$\frac{E_i}{E_{RIS}} = \frac{S_i}{S_{RIS}}$	The proportional representation of a given RIS in the cooling system entrainment samples ($\frac{E_i}{E_{RIS}}$) is equal to the proportional representation obtained from the fishery studies ($\frac{S_i}{S_{RIS}}$), suggesting the RIS is equally represented in both the cooling system samples and fishery studies.
$\frac{E_i}{E_{RIS}} < \frac{S_i}{S_{RIS}}$	The proportional representation in the cooling system entrainment samples is less than the representation observed in the fishery studies, suggesting the cooling system sampler is underrepresenting the Hudson River population near IP2 and IP3.
$\frac{E_i}{E_{RIS}} > \frac{S_i}{S_{RIS}}$	The proportional representation in the cooling system entrainment samples is greater than the representation observed in the fishery studies, suggesting the cooling system sampler is overrepresenting the Hudson River population near IP2 and IP3.

An estimate of the population abundance of a given species (S_i) in the vicinity of IP2 and IP3 was the maximum of the annual density of a given species caught (sum of FJS and BSS 75th percentile of weekly densities) in the river segment near IP2 and IP3 over all years (1975–1990). The estimate of the total RIS community abundance (S_{RIS}) caught in the vicinity of IP2 and IP3 was the sum of the maximum densities of each species. The estimated density of each species impinged or entrained was the 75th percentile of the annual density impinged or entrained over all years and the estimated density of all RIS impinged or entrained was the sum over all species. An estimate of $\frac{E_i}{E_{RIS}}$ was the ratio of the density of an individual species

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collected by the plant to the IP2 and IP3 river-segment CPUE plus the density entrained of that individual species. Because of the error and bias in estimating each of these parameters, only the ranks of each ratio were considered a reliable measure of connection. Thus, to estimate the overall strength of connections between the IP2 and IP3 cooling systems and the RIS in the Hudson River near the facility, the estimates of E_i/E_{RIS} and S_i/S_{RIS} for each species were ranked from 1 to 18, and then the ratio of the ranks was compared to the decision rules.

H.1.3.1. Assessment of Population Trends

Studies Used To Evaluate Population Trends

The Hudson River utilities conducted the LRS from 1974 to 2005 and targeted fish eggs, YSL, and PYSL from the George Washington Bridge (river mile (RM) 12) to the Federal Dam at Troy (RM 152), a total of 140 miles (CHGEC et al. 1999). Sampling was conducted during the spring, summer, and early fall, using a stratified random design based on 13 regions and three strata within each region (channel, shoal, and bottom). A 1-m² Tucker trawl was used to sample the channel strata; an epibenthic sled-mounted 1-m² net similar in design to the Tucker trawl was used to sample the bottom strata, and both gear types were used to sample the shoal strata. Because this survey targeted younger life stages, staff did not use the LRS in this analysis except for YOY Atlantic tomcod data.

The utilities' FJS, also known as the FSS, was conducted from 1974 to 2005 and targeted juveniles, yearlings, and older fish (CHGEC et al. 1999). Samples were collected on alternate weeks from the BSS between Manhattan (RM 0) and the Troy Dam (RM 152) using a stratified random design. Data were used to estimate the abundance of YOY and older fish in offshore habitats. Approximately 200 samples were collected each week from July to December. Between 1974 and 1984, a 1-m² Tucker trawl with a 3-mm mesh was used to sample the channel and a 1-m² epibenthic sled with a 3-mm mesh was used to sample the bottom and shoal strata. From 1985 to 2005, a 3-m beam trawl with a 38-mm mesh on all but the cod-end replaced the epibenthic sled. Bay anchovy, American shad, and weakfish were sampled with less efficiency with the beam trawl (NYPA 1986). Further, the number and volume of samples in the bottom and shoal strata were generally greater than 2.5 times those in the channel. Thus, all data were evaluated to determine if a shift in the gear type was affecting the observed trend. When the standardized FJS data were consistently less than the standardized BSS data after 1985, staff analyzed the pre- and post-1985 data separately.

The utilities' BSS was conducted from 1974 to 2005 and targeted YOY and older fish in the shore-zone (extending from the shore to a depth of 10 ft) (CHGEC et al. 1999). Samples were collected from April to December but generally every other week from mid-June through early October between the George Washington Bridge (RM 12) and the Troy Dam (RM 152). A 100-ft bag beach seine was used to collect 100 samples during each sampling period from beaches selected according to a stratified random design. A completed tow covers an area of approximately 450 m².

NRC Staff obtained coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish from commercial and recreational harvest statistics gathered by the Atlantic States Marine Fisheries Commission (ASMFC). Currently, the ASMFC Interstate Fisheries Management Program coordinates the

conservation and management of 22 Atlantic coastal fish species or species groups. For species that have significant fisheries in both State and Federal waters, the Commission works cooperatively with the relevant East Coast Regional Fishery Management Councils to develop fishery management plans. The Commission also works with the National Marine Fisheries Service to develop compatible regulations for Federal waters. For each of the managed species, the Commission conducts periodic stock assessments. Information on each of the managed species can be found at <http://www.asmfc.org/>.

Data from all three field surveys from the Hudson River Estuary Monitoring Program (LRS, FJS, and BSS) were provided for this analysis. The three data sets included the annual abundance index per taxon and life stage from 1974 through 2005, the annual total catch and volume sampled per taxon from 1974 through 2005, and the weekly total volume sampled, catch density, and total catch for each river segment and life stage for the 17 RIS fish from 1979 through 2005. The weekly volume, total catch, and catch density were the combined results of each gear type. Analysis of the river-segment and riverwide trends provided a measure of potential injury. Assessment of coastal harvest data obtained through the literature was conducted visually, using the same decision rules derived for the Hudson River data.

Metrics Used by NRC Staff To Evaluate Population Trends

Abundance Index

The abundance index for YOY for each species was based on the catch from a selected sampling program and used by the applicant and its contractors to estimate riverwide mean RIS abundances. The selection process considered the expected location of each species in the river, based on life-history characteristics and the observed catch rates from previous sampling. The abundance index was constructed to account for the stratified random sampling design used by each of the surveys. For the LRS and the FSS, sampling within a river segment was further stratified by river depth and sampled with a separate gear type. For blueback herring, alewife, bay anchovy, hogchoker, weakfish, and rainbow smelt, the YOY abundance index was based on the catch from a single gear type.

The LRS (L_A) and the FJS abundance index (F_A) were similarly constructed and provided unbiased estimates of the total and mean riverwide population abundance for selected species, respectively (Cochran 1997). For Atlantic tomcod, weeks 19 through 22 of the LRS samples were used to calculate the abundance index. The L_A is strictly a sum of the weighted average species densities over sampling weeks (w) instead of an average over weeks as for the F_A .

For the FJS and each gear type, F_A is constructed as a weighted mean of the average species density ($\bar{d}_{rs w}$) for a given river segment ($r = 0$ to 12), sampling stratum ($s = 1$ to 3), and week

$$(w = 33 \text{ to } 40), \text{ i.e., } F_A = \frac{1}{n} \sum_w \left(\frac{\sum_r \sum_s v_{rs} \bar{d}_{rs w}}{\sum_r \sum_s v_{rs}} \right) I(0,1) \text{ for } n \text{ equal to the number of weeks}$$

sampled, v_{rs} equal to the volume of the given river segment and strata sampled, and the indicator function $I(0,1)$ equaling 1 if a given week was sampled and 0 otherwise (CHGEC 1999). For the FJS, strata sampled were the channel, bottom, and shoal for a given river segment. Poughkeepsie and West Point river segments had the greatest channel volume, Poughkeepsie and Tappan Zee had the greatest bottom volume, and Tappan Zee had the

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greatest shoal volume. Because the river segment associated with IP2 and IP3 did not have large bottom or shoal volumes, the abundance index would not be sensitive to changes in population trends within the vicinity of IP2 and IP3.

The construction of the BSS abundance index (B_A) provided an unbiased estimate of the mean riverwide population abundance for striped bass, white perch, American shad, bluefish, spottail shiner, and white catfish. A single gear type was used for all years; thus, B_A was constructed as a weighted average density or catch per haul ($\bar{c}_{rw}$) for a given river segment ($r = 0$ to 12) and

week ($w = 33$ to 40), i.e., $B_A = \frac{1}{n} \sum_w \left(\frac{\sum_r W_r \bar{c}_{rw}}{\sum_r W_r} \right) I(0,1)$ for n equal to the number of weeks

sampled, W_r equaled the number of beach segments in the sampling design for a given river segment, and the indicator function $I(0,1)$ equaled 1 if a given week was sampled and 0 otherwise (CHGEC 1999).

Catch-Per-Unit-Effort

NRC Staff used the CPUE to evaluate riverwide and river-segment population trends and was defined for a given species as the sum of the fish caught within a given year divided by the total volume sampled. The CPUE for a given region is a biased (by the ratio of v_s/V) estimate of the population abundance, i.e.,

$$E(\text{CPUE}) = E \left(\frac{\sum_s y_s}{\sum_s v_s} \right) = \sum_s \frac{v_s}{V} \mu_s$$

where y_s is the number of fish caught in a given stratum ($s = 1$ to 3),

μ_s is the mean density of fish in a given stratum,

v_s is the volume sampled in the given stratum, and

V is the total volume sampled).

For the LRS and FJS, a greater fraction of the volume sampled was from the bottom and shoal strata; therefore, the CPUE from each river segment is not sensitive to changes in abundance associated with fish sampled in the channel. For the BSS, there was only one gear type (beach seine); thus, the CPUE from each river segment was equivalent to the density ($\bar{d}_{rsw}$) from the BSS. The river-segment CPUE from the BSS was not used in the analysis.

Staff assumed that the river-segment densities for each of the surveys provided by the applicant were the same average species densities, $\bar{d}_{rsw}$ and $\bar{c}_{rw}$, used to derive the abundance indices.

Because multiple gear types were used in the LRS and FJS, the NRC staff assumes that the densities for each gear type probably represented a weighted average.

Analysis of Population Impacts

1 To assess potential impacts to RIS populations near the IP2 and IP3 facility and within the lower
2 Hudson River, the NRC staff evaluated environmental data from FSS, BSS, and LRS studies,
3 and coastal trends, when available. Detailed information is presented in Appendix I.

4 *River Segment 4*

5 To assess potential impacts to RIS populations near the IP2 and IP3 facilities, the NRC staff
6 evaluated environmental data from FSS, BSS, and LRS studies for River Segment 4, which is
7 located at river kilometers (RKM) 63–76 (RM 39–46) (Figure 2-6 in the main text). The two
8 measurement metrics evaluated using the environmental data were density (estimated number
9 of RIS per given volume of water provided by the applicant) and CPUE (number of RIS captured
10 by the sampler for a given volume of water, derived by the NRC staff). Using these two metrics,
11 the staff determined that potential moderate-to-large adverse population impacts were possible
12 for many RIS, including alewife, bay anchovy, American shad, bluefish, hogchoker, blueback
13 herring, rainbow smelt, spottail shiner, Atlantic tomcod, and white perch (Table H-13). A small
14 potential for adverse population impacts was predicted for striped bass, white catfish, and
15 weakfish. An impact determination for populations of Atlantic menhaden, Atlantic and shortnose
16 sturgeon, gizzard shad, and blue crab could not be made, because these species were not
17 routinely caught in the studies. As described above, the NRC staff defined a large population
18 impact for this river segment and a given RIS as a statistically significant negative slope in
19 population abundance, using regression analyses and an observation of greater than 40 percent
20 of the abundance outside of the defined level of environmental noise, defined as ± 1 standard
21 deviation from the mean of the first 5 years of data. The decision rules for this analysis are
22 found at the beginning of Section H-3; the complete analysis is presented in Appendix I.

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Table H-13 Assessment of Population Impacts for River Segment 4

Lower Hudson River

Species	Density			Catch-per-Unit Effort		River Segment Assessment
	FJS	BSS	LRS	FJS	LRS	
Alewife	Large	Large	N/A ^a	Large	N/A	Large
Bay Anchovy	Large	Small	N/A	Small	N/A	Moderate to Large
American Shad	Large	Large	N/A	Large	N/A	Large
Bluefish	Small	Large	N/A	Large	N/A	Large
Hogchoker	Moderate	Large	N/A	Moderate	N/A	Large
Atlantic Menhaden	N/A	N/A	N/A	N/A	N/A	Unknown
Blueback Herring	Moderate	Moderate	N/A	Moderate	N/A	Moderate to Large
Rainbow Smelt	Moderate	N/A	N/A	Large	N/A	Large
Shortnose Sturgeon	N/A	N/A	N/A	N/A	N/A	Unknown
Spottail Shiner	N/A	Large	N/A	N/A	N/A	Large
Atlantic Sturgeon	N/A	N/A	N/A	N/A	N/A	Unknown
Striped Bass	Small	Small	N/A	Small	N/A	Small
Atlantic Tomcod	Moderate	N/A	Moderate	Small	Moderate	Moderate
White Catfish	Small	N/A	N/A	N/A	N/A	Small
White Perch	Small	Large	N/A	Large	N/A	Large
Weakfish	Small	N/A	N/A	Small	N/A	Small
Gizzard Shad	N/A	N/A	N/A	N/A	N/A	Unknown
Blue Crab	N/A	N/A	N/A	N/A	N/A	Unknown

(a) N/A: not applicable; YOY not present in samples

To assess potential population-level impacts to RIS for the lower Hudson River (RKM 0–245, RM 0–152) (Figure 2-6 in the main text), the NRC staff evaluated abundance index data provided by the applicant and CPUE data obtained from FJS, BSS, and LRS studies. Analysis of abundance index data suggested a large potential for adverse population impacts for three RIS (American shad, white catfish, white perch) and a moderate potential for adverse impacts for bay anchovy, blueback herring, Atlantic tomcod, and weakfish. A small potential for adverse population impacts was predicted for alewife, bluefish, hogchoker, rainbow smelt, spottail shiner, and striped bass (Table H-14). An assessment of impacts could not be made for Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab, because few were caught during the monitoring studies. Assessment of population-level impacts using CPUE predicted a potential for moderate-to-large impacts for most RIS. The exceptions were small impacts for spottail shiner, striped bass, and weakfish (Table H-14). As described above, staff could not determine population-level impacts for five RIS.

Table H-14 Assessment of Population Impacts for the Lower Hudson River

Species	Abundance Index	CPUE			Riverwide Assessment
		FJS	BSS	LRS	
Alewife	Small	Moderate	Moderate	N/A ^a	Moderate
Bay Anchovy	Moderate	Small	Moderate	N/A	Moderate
American Shad	Large	Large	Small	N/A	Large
Bluefish	Small	Large	Moderate	N/A	Large
Hogchoker	Small	Moderate	Moderate	N/A	Moderate
Atlantic Menhaden	N/A	N/A	N/A	N/A	Unknown
Blueback Herring	Moderate	Large	Large	N/A	Large
Rainbow Smelt	Small	N/A	Large	N/A	Large
Shortnose Sturgeon	N/A	N/A	N/A	N/A	Unknown
Spottail Shiner	Small	Small	Small	N/A	Small
Atlantic Sturgeon	N/A	N/A	N/A	N/A	Unknown
Striped Bass	Small	Small	Small	N/A	Small
Atlantic Tomcod	Moderate	Moderate	Large	Moderate	Large
White Catfish	Large	N/A	Large	N/A	Large
White Perch	Large	Large	Large	N/A	Large
Weakfish	Moderate	N/A	Small	N/A	Small to Moderate
Gizzard Shad	N/A	N/A	N/A	N/A	Unknown
Blue Crab	N/A	N/A	N/A	N/A	Unknown

(a) N/A: not applicable; YOY not present in samples

WOE Summary of Population Impacts

To integrate all of the available RIS population data for IP2 and IP3 and the lower Hudson River, the NRC staff used a WOE analysis. An overview of this analysis is presented at the beginning of Section H-3; detailed information is presented in Appendix I. The results for this analysis are presented in Table H-15 and predict a moderate-to-large potential for adverse impacts for 13 of the 18 RIS. For two of these (Atlantic menhaden and Atlantic sturgeon), the moderate-to-large potential impact determination was based on only one LOE (coastal trends). A small potential for adverse population-level impacts is predicted for blue crab, based on only one LOE (coastal trends). An impact conclusion regarding the population impacts could not be reached for shortnose sturgeon because of a lack of available data. As described above, the conclusion of a large population impact is based on the detection of a significant negative slope using regression analyses and the observation that greater than 40 percent of the abundance observations were outside the defined level of noise. The decision rules for these analyses are found at the beginning of Section H-3; the complete analysis is presented in Appendix I.

1 **Table H-15 Weight of Evidence Results for the Population Trend Line of Evidence**

Measurement	River Segment Assessment Score	Riverwide Assessment Score	Coastal Assessment Score	WOE Score ^(b)	Impact Conclusion
Utility Score^(a)	2.4	1.7	1.3		
Alewife	4.0	1.7	2	2.8	Large
Bay Anchovy	2.0	1.7	N/A ^(c)	1.9	Moderate
American Shad	4.0	3.0	4	3.7	Large
Bluefish	3.0	2.3	2	2.5	Large
Hogchoker	2.7	1.7	N/A	2.3	Large
Atlantic Menhaden	Unknown	Unknown	2	2 ^(d)	Moderate to Large
Blueback Herring	2.0	3.3	2	2.4	Large
Rainbow Smelt	3.0	2.5	N/A	2.8	Large
Shortnose Sturgeon	Unknown	Unknown	N/A	Unknown	Unknown
Spottail Shiner	4.0	1.0	N/A	2.8	Large
Atlantic Sturgeon	Unknown	Unknown	4	4 ^(d)	Large
Striped Bass	1.0	1.0	1	1	Small
Atlantic Tomcod	1.8	2.5	N/A	2.1	Large
White Catfish	1.0	4.0	N/A	2.2	Large
White Perch	3.0	4.0	1	2.8	Large
Weakfish	1.0	1.5	2	1.4	Small
Gizzard Shad	Unknown	Unknown	N/A	Unknown	Unknown
Blue Crab	Unknown	Unknown	1	1 ^(d)	Small

(a) Overall Use and Utility Score: Low = < 1.5, Medium = ≥1.5 but ≤ 2.0, High = >2.0

(b) WOE Score: Small = <1.5; Small–Moderate = 1.5; Moderate = >1.5 but <2.0; Moderate–Large = 2.0; Large = >2.0

(c) N/A: Not applicable

(d) Impact assessment based only on coastal trends

H.1.3.2. Analysis of Strength of Connection

To determine whether the operation of the IP2 and IP3 cooling systems had the potential to influence RIS populations near the facility or within the lower Hudson River, the NRC staff conducted a strength-of-connection analysis. A summary of this analysis can be found at the beginning of Section H-3; detailed information on the analysis is presented in Appendix I. The strength-of-connection analysis assumes the IP2 and IP3 cooling systems can affect aquatic resources directly through impingement or entrainment and indirectly by impinging and entraining potential food (prey). By comparing the rank order of RIS caught in the river to the order observed in impingement and entrainment samples, it is possible to evaluate how efficient the IP2 and IP3 cooling systems are at removing RIS from the river (e.g., how strongly it is connected to the RIS of interest). The results of this analysis are presented in Table H-16 and show that a high strength of connection was observed for only two species (bluefish and striped bass). For those species, the IP2 and IP3 cooling systems were removing either the species or its prey at levels that were proportionally higher than those observed in the river studies. This suggests that there is strong evidence that the operation of the cooling systems is affecting these species. For the remaining RIS, the strength of connection ranged from low (minimal evidence of connection) to medium (some evidence of connection). The strength of connection was unknown for five species (Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab, because of a lack of available data (Table H-16).

Table H-16 Weight of Evidence for the Strength-of-Connection Line of Evidence

Measurement	Impingement		Entrainment		WOE Score ^b	Strength of Connection
	RIS	Prey	RIS	Prey		
Use and Utility^a	1.9	2.0	1.6	2.1		
Alewife	2 ^c	1	2	1	1.5	Low to Medium
Bay Anchovy	2	1	2	1	1.5	Low to Medium
American Shad	2	1	2	1	1.5	Low to Medium
Bluefish	4	2	2	2	2.5	High
Hogchoker	4	1	2	1	2.0	Medium to High
Atlantic Menhaden	Unknown	1	Unknown	1	Unknown	Unknown
Blueback Herring	2	1	2	1	1.5	Low to Medium
Rainbow Smelt	2	1	4	1	1.9	Medium
Shortnose Sturgeon	Unknown	1	Unknown	1	Unknown	Unknown
Spottail Shiner	1	2	1	2	1.5	Low to Medium
Atlantic Sturgeon	Unknown	1	Unknown	1	Unknown	Unknown
Striped Bass	2	4	2	2	2.5	High

1

Table H-16 (continued)

Measurement	Impingement		Entrainment		WOE Score ^b	Strength of Connection
	RIS	Prey	RIS	Prey		
Atlantic Tomcod	2	1	2	1	1.5	Low to Medium
White Catfish	2	1	2	1	1.5	Low to Medium
White Perch	2	2	2	2	2.0	Medium to High
Weakfish	2	2	2	2	2.0	Medium to High
Gizzard Shad	Unknown	1	Unknown	1	Unknown	Unknown
Blue Crab	Unknown	1	Unknown	1	Unknown	Unknown

(a) Overall Use and Utility Score: Low = <1.5, Medium = ≥1.5 but ≤2.0, High = >2.0

(b) WOE Score: Low = <1.5; Low-Medium = 1.5; Medium = >1.5 but <2.0; Medium-High = 2.0; High = >2.0

(c) 1 indicates a low strength of connection, 2 indicates a medium potential, and 4 indicates a high potential

2

H.1.3.3. Impingement and Entrainment Impact Summary

3 The final integration of population-level and strength-of-connection LOE is presented in
4 Table H-17. This table shows the final conclusions for both LOE—population trends and
5 strength of connection. Assignment of an NRC level of impact (small, moderate, or large)
6 requires information on both a measurable response in the RIS population and clear evidence
7 that the RIS is influenced by the operation of the IP2 and IP3 cooling systems. Thus, when the
8 strength of connection is low, it is not possible to assign an impact level greater than small,
9 because of little evidence that a relationship between the cooling system and RIS exists.
10 Conversely, for an RIS with a high strength of connection to the IP2 and IP3 cooling system
11 operation but evidence of no population decline, the final determination must be small.

12 Based on the final WOE assessment, a small potential for adverse impacts was predicted for
13 two species (striped bass and weakfish), because there was no evidence of a population
14 decline, even though the strength of connection was medium or high. A small-to-moderate
15 impact was predicted for seven species (alewife, bay anchovy, American shad, blueback
16 herring, spottail shiner, Atlantic tomcod, and white catfish). A moderate impact was predicted
17 for rainbow smelt, and a moderate-to-large impact level was predicted for the hogchoker and
18 white perch. A large impact level was predicted for only one species, the bluefish, based on
19 observed population declines and an apparent high strength of connection to the IP2 and IP3
20 cooling systems. The level of impact could not be restricted to less than the full range of from
21 small to large for Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue
22 crab, because of a lack of data.

Table H-17 Impingement and Entrainment Impact Summary for Hudson River RIS

Species	Population Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and 3 Cooling Systems on Aquatic Resources
Alewife	Large	Low to Medium	Small to Moderate
Bay Anchovy	Moderate	Low to Medium	Small to Moderate
American Shad	Large	Low to Medium	Small to Moderate
Bluefish	Large	High	Large
Hogchoker	Large	Medium to High	Moderate to Large
Atlantic Menhaden	Moderate to Large	Unknown ^(b)	Unknown ^(c)
Blueback Herring	Large	Low to Medium	Small to Moderate
Rainbow Smelt	Large	Medium	Moderate
Shortnose Sturgeon	Unknown ^(a)	Unknown ^(b)	Unknown ^(c)
Spottail Shiner	Large	Low to Medium	Small to Moderate
Atlantic Sturgeon	Large	Unknown ^(b)	Unknown ^(c)
Striped Bass	Small	High	Small
Atlantic Tomcod	Large	Low to Medium	Small to Moderate
White Catfish	Large	Low to Medium	Small to Moderate
White Perch	Large	Medium to High	Moderate to Large
Weakfish	Small	Medium to High	Small
Gizzard Shad	Unknown ^(a)	Unknown ^(b)	Unknown ^(c)
Blue Crab	Small	Unknown ^(b)	Unknown ^(c)

(a) Population LOE could not be established using WOE; therefore, population LOE could range from small to large.

(b) Strength of connection could not be established using WOE; therefore, strength of connection could range from low to high.

(c) Conclusion of impact could not be established using WOE, therefore, impacts could range from small to large.

As described above, an impact determination of moderate, moderate to large, or large was attributed to four species—bluefish, hogchoker, rainbow smelt, and white perch, which are discussed below. What follows is a discussion of the analysis that supports this determination and the potential implications of the small determination of impact for the striped bass, a species believed to be in recovery, caused by fishing restrictions imposed in the mid-1980s.

Bluefish: Large Potential for Adverse Impact

The analysis of YOY bluefish population trends at IP2 and IP3 and the lower Hudson River, using data from FJS and BSS studies and a recent assessment by the National Oceanic and Atmospheric Administration (NOAA) for coastal trends, resulted in a determination of large impact (Table H-15). For the IP2 and IP3 population assessment (Table H-13), the BSS density metric and the FJS CPUE metric suggested a population decline that has persisted through time. For these metrics, a significant negative slope was observed, based on segmented

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1 regression, and more than 40 percent of the observations were outside the defined level of
2 environmental noise (± 1 standard deviation from the mean of the first 5 years of data). Based
3 on the decision rules developed for population data, this was considered a large impact. The
4 only LOE inconsistent with this finding was the small impact associated with FJS density. This
5 LOE predicted a small population impact because there was not a significant negative slope and
6 only a small number of observations (7 percent) were outside the defined level of environmental
7 noise. The population assessment for the lower Hudson River (Table H-14) again showed
8 moderate and large impacts based on BSS and FJS CPUE evaluations and a small potential for
9 impact using the abundance index provided by the applicant. The latter conclusion was based
10 on nonsignificant slopes from the segmented regression and a small number of observations
11 outside the range of environmental noise. Coastal trend data provided by NOAA (Shepherd
12 2006) suggest that recreational catches have declined precipitously since the late 1980s. This
13 appears to be consistent with the population-level impact assessment for the Hudson River
14 conducted by the NRC staff.

15 Based on a comparison of FJS and BSS data with impingement and entrainment samples from
16 IP2 and IP3, the rank-order analyses suggest the cooling system is removing a disproportionate
17 number of bluefish from the Hudson River. Thus, the strength of connection for entrainment
18 and impingement was medium and high, respectively (Table H-16). Juvenile bluefish feed on a
19 variety of other fish, including bay anchovy, Atlantic silverside, striped bass, blueback herring,
20 Atlantic tomcod, and American shad. To evaluate the strength-of-connection LOE, bay anchovy
21 and Atlantic tomcod were assumed to be the primary prey. The rank order of these species in
22 impingement and entrainment samples suggested the cooling system was removing an equally
23 proportional number from the river relative to the proportion observed in the river near IP2 and
24 IP3 that could affect YOY bluefish.

25 Combining the two LOE, the NRC staff arrived at a large potential for adverse impact for
26 Hudson River bluefish from the operation of the IP2 and IP3 cooling systems. This assessment
27 is based, in part, on the losses of bluefish from impingement. Based on the work conducted by
28 Fletcher (1990) on field testing of the Ristroph screen system that was eventually installed at
29 IP2 and IP3 in the early 1990s, impingement survival of bluefish is probably similar to that
30 observed for striped bass (about 9 percent). Because studies to estimate impingement
31 mortality were not conducted after Ristroph screen installation, it is not possible to confirm the
32 assessments of Fletcher (1990). Thus, the staff's conclusion of impact for this species should
33 be considered a conservative assessment.

34 White Perch: Moderate-to-Large Potential for Adverse Impact

35 To assess population-level impacts to the white perch near IP2 and IP3 and for the lower
36 Hudson River, the NRC staff evaluated data from FJS and BSS river studies and coastal trends.
37 For the assessment of the Hudson River population near IP2 and IP3, an analysis of BSS
38 density and FJS CPUE data indicated a large potential for adverse impact (Table H-13). Both
39 metrics produced a significant negative slope using segmented regression analysis. The
40 percentage of observations outside the environmental noise was 70 percent for BSS density
41 and 56 percent for FJS CPUE (Appendix I). The population assessment for the lower Hudson
42 River (Table H-14) showed large impacts based on BSS and FJS CPUE evaluations and the
43 abundance index provided by the applicant. The strength of connection assessment
44 (Table H-16) for white perch indicated a medium-to-high degree of connection for all LOE
45 (impingement and entrainment of YOY, impingement and entrainment of perch prey). This

suggests that the IP2 and IP3 cooling systems are removing both YOY and perch prey items (primarily bay anchovy) at levels that are equally proportional relative to their rank order in FJS and BSS environmental samples near IP2 and IP3. Because there was a large potential for adverse effects at the population level and a medium-to-high level of connection between the resource and the IP2 and IP3 cooling systems, the NRC staff concluded that the overall impact of the IP2 and IP3 cooling systems was moderate to large.

As described above, this assessment is based, in part, on the losses of white perch caused by impingement and entrainment. Based on the work conducted by Fletcher (1990), impingement survival of white perch was estimated to be 14 percent based on field-testing of the Ristroph screen system that was eventually installed at IP2 and IP3 in the early 1990s. Work by EA (1989) suggested entrainment mortality of white perch PYSL ranged from 30–92 percent (Table H-5). Because studies to estimate impingement mortality were not conducted after the Ristroph screen installation, it is not possible to confirm the assessments of Fletcher (1990). Thus, the staff's conclusion of impact for this species should be considered a conservative assessment.

Hogchoker: Moderate-to-Large Potential for Adverse Impact

Analysis of population data for YOY hogchoker near IP2 and IP3 (Table H-13) indicated a large potential for adverse impact. River-segment BSS density data had a significant negative slope, based on segmented regression and 78 percent of observations outside the defined level of environmental noise (Appendix I). River-segment FJS density and CPUE data suggested a moderate potential for adverse impact, based on the presence of a significant negative slope from the segmented regression and less than 40 percent of the observations outside the defined level of environmental noise (15 percent for both metrics). As described above, the environmental noise was defined as (+/- 1 standard deviation from the mean of the first 5 years of data). Trend analyses for the lower Hudson River produced a less pronounced effect in YOY populations, resulting in a moderate potential for impact based on Hudson River studies (Table H-14). Coastal trend data were not available.

The strength-of-connection analysis for hogchoker, using the rank order technique, indicated the proportion impinged by the IP2 and IP3 cooling systems was higher than would be expected, based on the densities observed in FJS and BSS studies (Table H-16). The proportion entrained was estimated to be equally proportional to the rank order in FJS and BSS environmental samples near IP2 and IP3. This resulted in an assessment of a medium-to-high strength of connection to the IP2 and IP3 cooling systems. Because hogchokers feed primarily on benthic invertebrates for which no sampling data are available, there was minimal evidence to suggest a connection between hogchoker prey species and the IP2 and IP3 cooling systems.

In the final analyses, the NRC staff concluded that there was a moderate-to-large potential for adverse impacts to the hogchoker from the operation of the IP2 and IP3 cooling systems. This assessment is due, in part, to the losses of this species from impingement. Work by Fletcher (1990) has suggested that impingement mortality for this species is approximately 13 percent for the Ristroph screen system installed at IP2 and IP3 in the early 1990s. Because studies to estimate impingement mortality were not conducted after Ristroph screen installation, it is not possible to confirm the assessments of Fletcher (1990). Thus, the conclusion of impact for this species should be considered a conservative assessment.

Rainbow Smelt: Moderate Potential for Adverse Impact

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Population data for areas near IP2 and IP3 (River Segment 4) and the lower Hudson River were obtained from the FJS and BSS studies, using density and CPUE metrics and the abundance index provided by the applicant. For the area of the river near the IP2 and IP3 facilities, NRC analysis of FJS YOY data indicated a moderate (FJS density) and large (FJS CPUE) potential for adverse impacts (Table H-13). The moderate impact was determined from a significant negative slope from the segmented regression; however, less than 40 percent of the density observations were outside the defined environmental noise. The large impact observed with the FJS CPUE data was based on both a significant negative slope from the segmented regression and 78 percent of the observations outside the defined level of environmental noise (Appendix I). These findings are consistent with the disappearance of this species from the lower Hudson River beginning in 1995 (Daniels et al. 2005) and the listing of rainbow smelt as a Species of Concern by NOAA (2007). Evaluation of population trends for this species for the lower Hudson River (Table H-14) suggests a large impact based on BSS CPUE and a small impact based on the abundance index. Because the abundance index (derived for this species from the FJS channel data) may be more heavily influenced by population trends from the river segment near Poughkeepsie, because of a 1-to-2 times greater channel volume than other river segments with relatively greater populations of smelt (IP2 and IP3 to Cornwall), the NRC staff considers the CPUE metric to reflect the more biologically relevant result.

The staff finds the strength of connection between rainbow smelt and the IP2 and IP3 cooling systems is moderate for impingement and high for entrainment (Table H-16). Based on a rank-order comparison of catch statistics from FSS and BSS studies with entrainment sampling results, the proportion of rainbow smelt early life stages entrained at IP2 and IP3 is higher than would be expected from the catch statistics. YOY rainbow smelt feed on smaller fish but primarily on copepods, small crustaceans, and benthic invertebrates; thus, a low connection was determined for the impingement and entrainment of prey species. Because there is a large potential for adverse population impacts, coupled with an overall medium strength of connection, the NRC staff concluded that the impacts of the IP2 and IP3 cooling systems on this species are moderate. As described above, this assessment is caused, in part, by losses associated with impingement and entrainment. Fletcher (1990) does not report impingement mortality (Table H-5). Entrainment survival estimates are not available for this species. Because true impingement and entrainment mortality cannot be determined, the conclusion of impact for this species should be considered a conservative assessment.

Striped Bass: Small Potential for Adverse Impact

As described in Section 2 of the main text, striped bass appear to spend extended periods in the Hudson River. Based on concerns related to polychlorinated biphenyls (PCB) body burdens, the Hudson River commercial fishery was closed in 1976 (CHGEC 1999). As a result of commercial restrictions on harvesting supported by the Atlantic Striped Bass Conservation Act (1984), the fishery was declared to be in full recovery by 1995 (ASMFC 2006), and abundance levels have continued to increase in the Atlantic population. Although restrictions on both commercial and recreational fisheries have been relaxed because of the recovery of the population, the fisheries continue to be limited to State waters (within 3 nm of land), and the New York State's commercial fishery remains completely closed. While commercial landings have remained lower than the levels seen in the early 1970s, recreational landings have increased and, in 2004, made up 72 percent of the total weight harvested from the Atlantic stock (Shepherd 2006b).

Based on the above, one would expect that the population of YOY striped bass in the Hudson River would have increased from 1995 to the present. Riverwide analysis of YOY population trend data from FJS and BSS surveys (Table H-14 and Appendix I) indicate that YOY populations have increased only slightly above the environmental noise within the last few years of the studies and resulted in a small level of impact based on a WOE analysis. This trend is not evident elsewhere along the Atlantic seaboard, where YOY striped bass populations have increased since fishing restrictions were established (ASMFC 2006). Although the YOY population trends in the Hudson River do not represent a moderate or large adverse impact, the high strength of connection observed, caused by the impingement and entrainment of this species, and the loss of its prey, suggests that the IP2 and IP3 cooling systems may be inhibiting or limiting the abundance of YOY bass in the Hudson River, despite the apparent increase in adults elsewhere in the region.

H.2 Cumulative Impacts on Aquatic Resources

In addition to the potential impacts associated with the IP2 and IP3 CWIS described in Section H.3, it is possible that other natural or anthropogenic factors unrelated to the relicensing of Indian Point could influence the aquatic resources of the lower Hudson River. In this section, the NRC staff discusses and evaluates potential stressors that could contribute to the total impacts to the aquatic resources during the license renewal period. Potential stressors include other Hudson River facilities that withdraw water, the presence of zebra mussels in the freshwater portions of the river, fishing pressure associated with commercially and recreationally important species, habitat loss, interactions with other invasive species, and impacts associated with changes to water and sediment quality caused by short-term anthropogenic activities or long-term influences associated with global climate change.

Population trends should, in theory, reflect cumulative effects of all impacts on the population. Impacts attributable to the Indian Point cooling systems have already been analyzed. This section of the appendix concentrates on effects associated with the invasion of zebra mussels, using a WOE approach, as discussed in Section H.3. A qualitative assessment of effects associated with fishing pressure was also explored.

The NRC staff evaluated potential population-level impacts to RIS for the lower Hudson River (RKM 0–245, RM 0–152) (Figure 2-6 in the main text) in Section H.3.1. Riverwide data used in the analysis included the abundance index provided by the applicant and CPUE data obtained from FJS, BSS, and LRS studies. The results of this analysis were presented in Table H-14 and showed a large potential for adverse impacts for 7 of the 18 RIS caused by the CWIS.

An analysis conducted on behalf of Entergy (Barnthouse et al. 2008) used environmental risk-assessment techniques to evaluate the potential for adverse impacts to Hudson River RIS from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 CWIS, fishing pressure, the presence of zebra mussels, predation by striped bass, and water temperature. Barnthouse et al. (2008) concluded that the Indian Point CWIS had no effect on all seven of the RIS included in their study. Instead, the authors hypothesized that observed population declines in selected RIS were influenced by striped bass predation, mortality imposed by fishing, water temperature, and zebra mussel invasion.

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Strayer et al. (2004) concluded that the abundance of juvenile American shad and white perch declined following the zebra mussel invasion. Further, the authors found that juvenile alewife abundance increased following the zebra mussel invasion. The NRC Staff's analysis follows.

Zebra Mussels

To evaluate the effects of zebra mussels, the NRC staff applied a WOE approach. It is important to note, however, that the Hudson River monitoring surveys used in these analyses were designed to evaluate the population abundance of selected species. They were not designed to evaluate competing and confounded factors affecting population abundance. Coincident measures of zebra mussel abundance through time, water quality, changes to thermal discharges, changes in fishing pressure, and predator-prey interactions would be a minimal requirement to begin to rank stressor effects on each population. These measures are not available, and so the remaining analyses should be viewed as the development of hypotheses of potential impacts associated with zebra mussels.

The NRC staff analyzed the impact of zebra mussels on RIS populations that were caught in River Segment 12 (Albany). The NRC staff analyzed the 75th percentile of the weekly FJS and BSS density and CPUE data from this river segment and used this information to evaluate the population trend LOE for these species. Data for white perch, blueback herring, alewife, American shad, white catfish, spottail shiner, and striped bass were used in the analysis because all have high densities of YOY within this region. Only weeks 27 to 43 were used in the analysis for the FJS and weeks 22 to 43 for the BSS survey so that most years contained observations from the months July through October and June through October for each survey, respectively. Effects associated with changes in gear type for the FJS (1985) were also considered. Details of the analysis are presented in Appendix I.

Simple linear regression and segmented regression with a single join point were fit to the annual measure of abundance for each RIS, as described in Section H.3. If the estimated slope from the linear regression or either slope from the segmented regression, whichever was determined to be the better fitting model, was significantly less than zero, then an adverse population impact was considered detected. An assessment of adverse impact was only supported if more than 40 percent of the standardized observations were outside the bounds of ± 1 standard deviation.

The strength of connection to a potential impact associated with a zebra mussel invasion was determined by the temporality of the observed change in population trends and the year associated with invasion of the zebra mussels in the Hudson River (1991) based on work by Strayer et al. (2004). For any stressor to be considered a potential cause of an impact, the stress must occur before the response (Adams 2003). For the assessment of the observed response, the year associated with a change in population trend was estimated by the join point from the segmented regression or was considered pre-1991, if the linear model was the better fit to the density and CPUE data collected from Region 12 (Albany area). If the join point was before 1991, then the strength of connection was defined as low. If the segmented regression did not converge or was not the better fitting model, the linear regression was used to suggest that there was no change in slope following invasion; thus, the strength of connection was low. If the join point from the segmented regression was after 1991, then the strength of connection was defined as high.

Based on the WOE analysis (see Appendix I for details) and the decision rules presented in Section H.3, the NRC staff determined potential moderate-to-large population impacts within

River Segment 12 (Albany) were possible for many RIS, including American shad, blueback herring, spottail shiner, white catfish, and white perch (Table H-18). A small potential for adverse population impacts was predicted for alewife and striped bass. The data tables for which the results of the strength of connection between adverse population impacts and the zebra mussel invasion are drawn are presented in Appendix I. None of the RIS evaluated had a statistically significant increase in population abundance in River Segment 12. The strength-of-connection analysis assumes that zebra mussels can affect aquatic resources indirectly by reducing potential food resources (prey) or by altering habitat (e.g. shelter). The results of the strength-of-connection analysis are presented in Table H-19 and show that a medium-to-high strength of connection was observed for all fish except white catfish.

Table H-18 Population Trends Postinvasion of Zebra Mussels in 1991 for Density and CPUE of YOY Collected from River Segment 12 (Albany)

Species	FJS Density	BSS Density	FJS CPUE	WOE	Hypothesized Level of Impact to Population Trend
Alewife	1	2	1	1.3	Small
American Shad	2	4	2	2.7	Large
Blueback Herring	2	2	2	2.0	Moderate to Large
Spottail Shiner	2	1	2	1.7	Moderate
Striped Bass	1	1	1	1.0	Small
White Catfish	1	N/A	4	2.5	Large
White Perch	2	2	2	2.0	Moderate to Large

N/A is not applicable; YOY are not present in samples.

Table H-19 Strength of Connection between Population Trends and Zebra Mussel Invasion

Species	FJS Density	BSS Density	FJS CPUE	WOE	Hypothesized Strength of Connection
Alewife	1	1	4	2.0	Medium to High
American Shad	4	1	1	2.0	Medium to High
Blueback Herring	1	4	1	2.0	Medium to High
Spottail Shiner	4	1	1	2.0	Medium to High
Striped Bass	1	1	4	2.0	Medium to High
White Catfish	1	N/A	1	1.0	Low
White Perch	1	4	1	2.0	Medium to High

N/A is not applicable; YOY are not present in samples.

The final integration of population-level and strength-of-connection LOE is presented in Table H-20. This table shows the final conclusions for both LOE—population trends and strength of connection. For an adverse impact to occur, there needs to be a measurable response in the RIS population and clear evidence that the RIS is influenced by the zebra mussel invasion. When the strength of connection is low, it is not possible to arrive at an impact level greater than small, because there is little evidence that a relationship between the mussel invasion and population trends exists. Conversely, for an RIS with a high strength of connection

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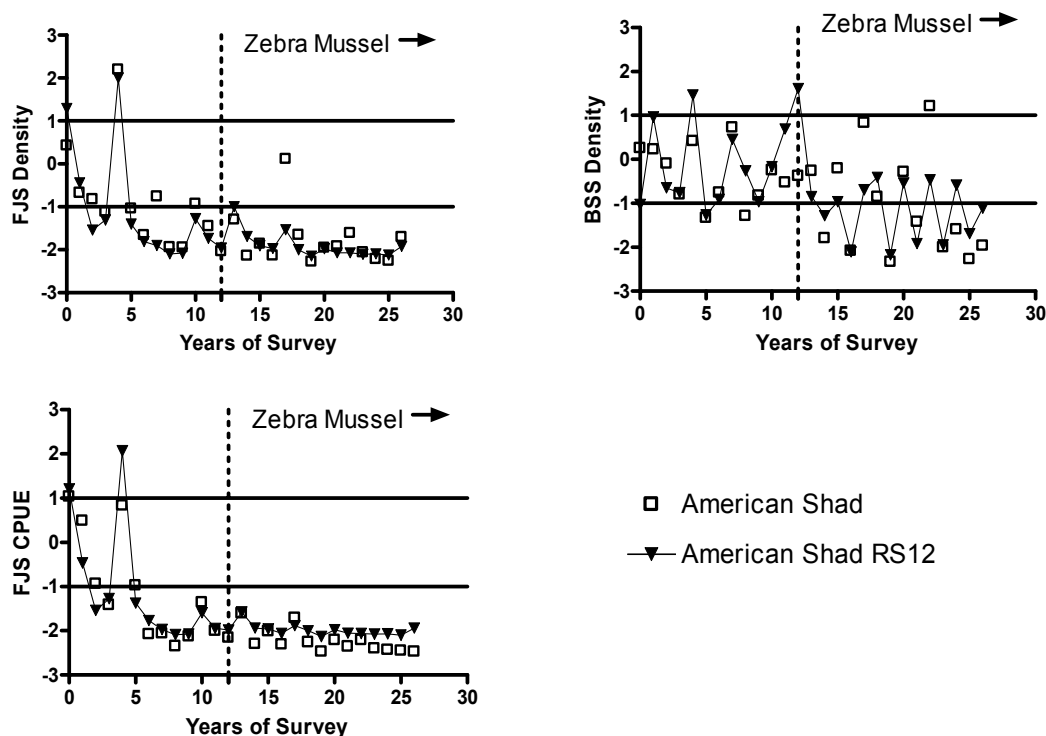
to the zebra mussel invasion but evidence of no population decline, the final determination must be small.

Based on the final WOE assessment, a small potential for adverse impacts from the zebra mussel invasion was predicted for three species (alewife, striped bass, and white catfish). Alewife and striped bass had no evidence of a population decline, even though the strength of connection was medium to high, while white catfish displayed a population decline but had a low strength of connection. A moderate or moderate-to-large impact was predicted for the remaining species (American shad, blueback herring, spottail shiner, and white perch).

Table H-20 Weight of Evidence Associated with Potential Negative Impacts on Population Trends from Zebra Mussel Invasion

Species	Hypothesized Level of Impact to Population Trends	Hypothesized Strength of Connection	Hypothesized Impact to Population Trends from Zebra Mussel
Alewife	Small	Medium to High	Small
American Shad	Large	Medium to High	Moderate to Large
Blueback Herring	Moderate to Large	Medium to High	Moderate to Large
Spottail Shiner	Moderate	Medium to High	Moderate
Striped Bass	Small	Medium to High	Small
White Catfish	Large	Low	Small
White Perch	Moderate to Large	Medium to High	Moderate to Large

The NRC staff analysis predicted a moderate-to-large potential adverse impact on the decline in American shad associated with the zebra mussel invasion. The NRC staff WOE analysis was based on the post-1985 FJS data, since the catch efficiency of the beam trawl for YOY American shad was less than the epibenthic sled. Based on the riverwide abundance index, Strayer et al. (2004) also concluded that the abundance of American shad was affected by zebra mussels. Much of the decline in population abundance, however, was observed before the mussel invasion (Figure H-9). Unlike both the NRC staff and Strayer et al. (2004), Barnthouse et al. (2008) rejected the hypothesis that zebra mussels were a potential cause of the decline.

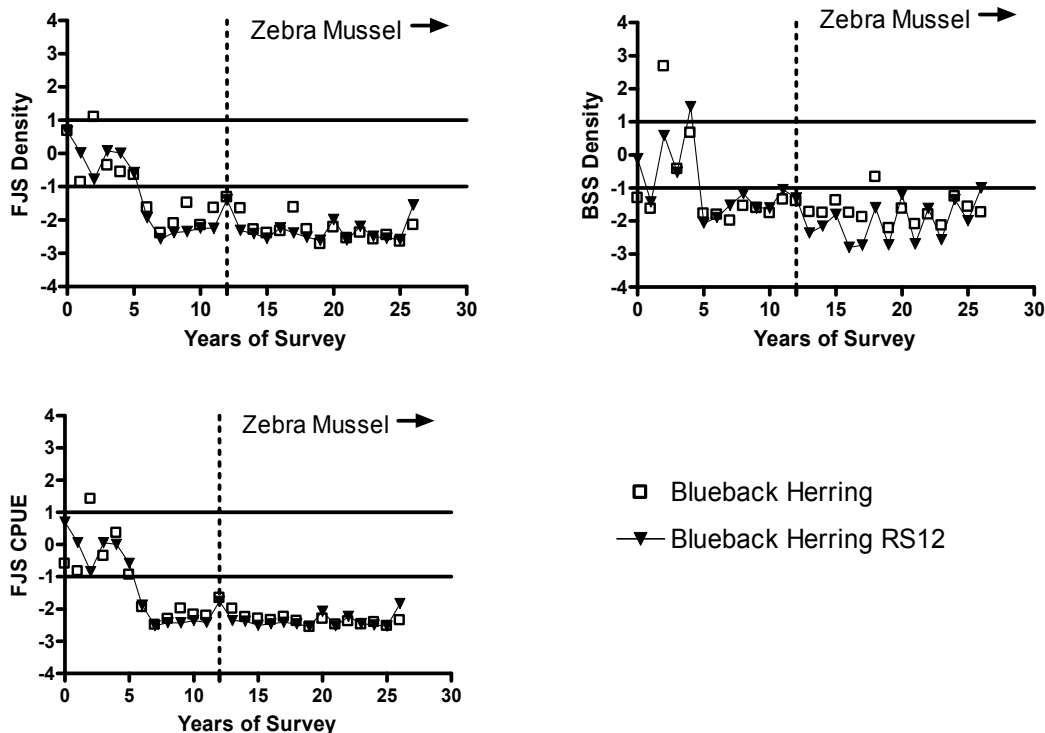


1 Source: Normandeau 2008

2 **Figure H-9 American shad standardized population trend data for the Riverwide and**
 3 **River Segment 12 (RS12), Fall Juvenile, and Beach Seine Surveys (Normandeau 2008)**

4 The NRC staff analysis predicted a moderate-to-large potential adverse impact to juvenile
 5 blueback herring abundance associated with the zebra mussel invasion. Again, unlike both the
 6 NRC staff and Strayer et al. (2004), Barnthouse et al. (2008) rejected the hypothesis that zebra
 7 mussels were a potential cause in the decline of blueback herring. The relative population
 8 response between the effect of the zebra mussel invasion and the combined riverwide impacts
 9 are presented in Figure H-10. Population trend data for River Segment 12 tend to be slightly
 10 below the riverwide observations and, for the BSS density, suggest a further decrease following
 11 the mussel invasion. This suggests to NRC Staff that the relative effects of the zebra mussel
 12 invasion may be slightly greater than the riverwide effects.

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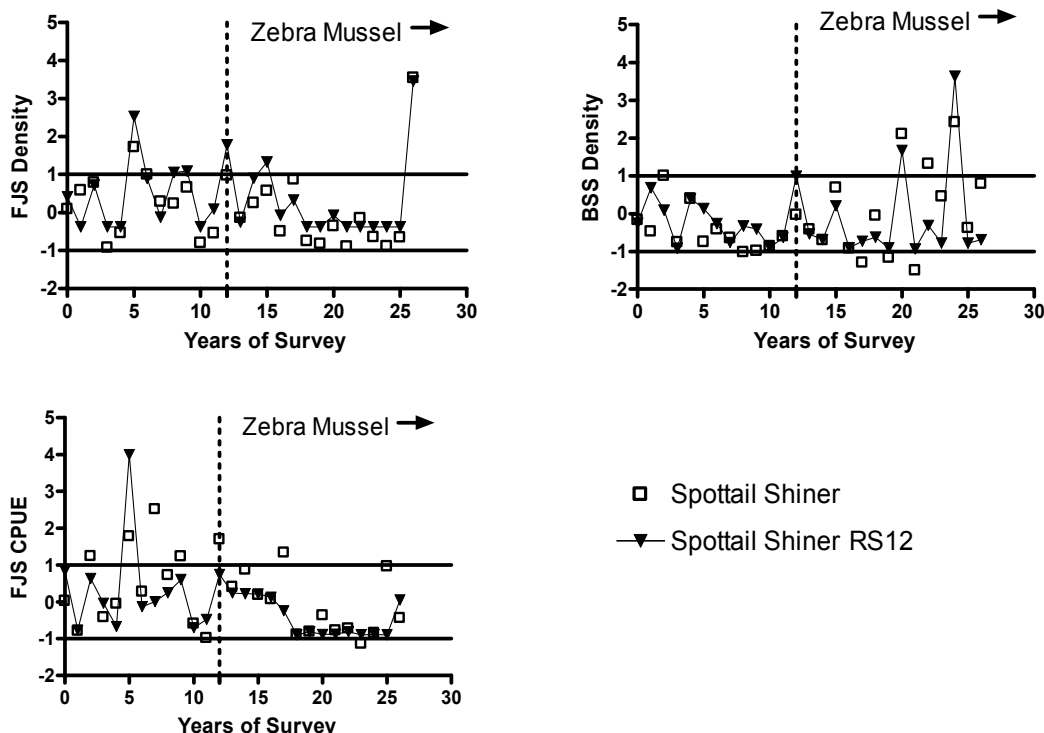


1 Source: Normandeau 2008

2 **Figure H-10 Blueback herring standardized population trend data for the Riverwide and**
 3 **River Segment 12 (RS12), Fall Juvenile, and Beach Seine Surveys**

4 The NRC staff analysis predicted a moderate potential adverse impact to juvenile spottail shiner
 5 abundance associated with the zebra mussel invasion. Strayer et al. (2004) concluded that
 6 there was no change in spottail shiner abundance, and Barnthouse et al. (2008) did not
 7 evaluate spottail shiner population trends. The relative population response between the effect
 8 of the zebra mussel invasion and the combined riverwide impacts is presented in Figure H-11.

9 The impact on white perch population trends from zebra mussels was estimated to be moderate
 10 to large. Figure H-12 presents white perch riverwide density and CPUE for River Segment 12.
 11 White perch population trends obtained from the FJS were not affected by gear changes (year 6
 12 of the survey) and yet, an early decline in fish density and CPUE in River Segment 12 can be
 13 observed from both the FJS and the BSS. For the BSS density, riverwide and each river-
 14 segment population trend overlap. Overall, the riverwide and River Segment 12 data overlap
 15 often and show a decline from the early population abundance. This suggests to NRC Staff that
 16 a combination of stressors acting on the riverwide population is associated with a relatively
 17 greater adverse impact than the impact from the zebra mussel invasion.



1 Source: Normandeau 2008

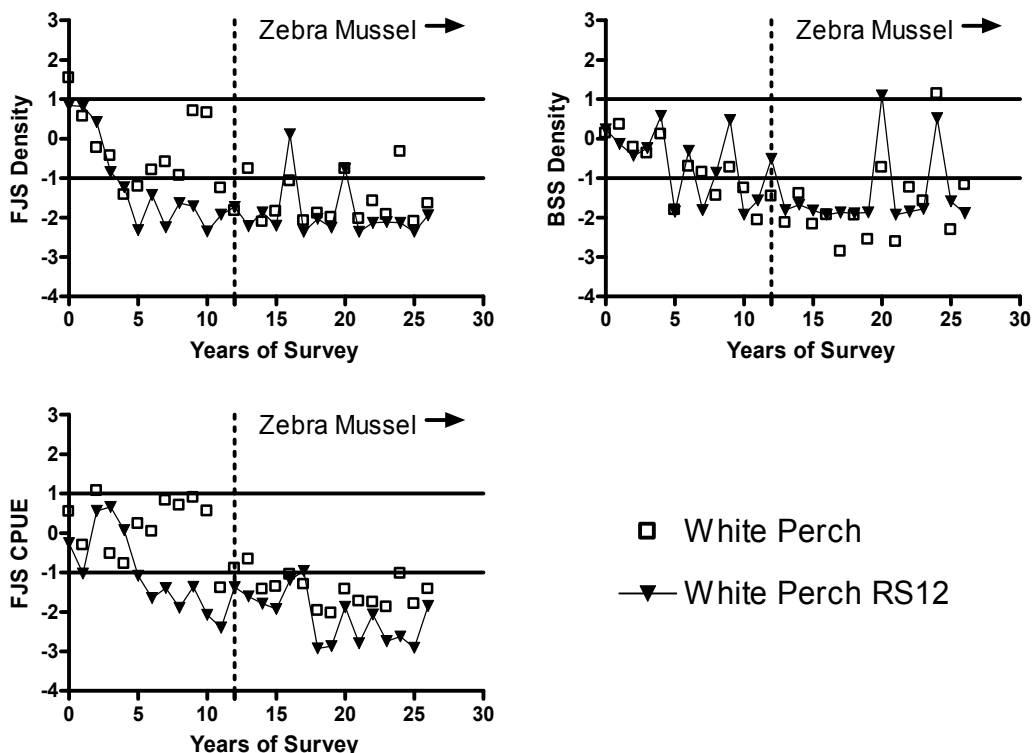
2 **Figure H-11 Spottail Shiner standardized population trend data for the Riverwide and**
 3 **River Segment 12 (RS12), Fall Juvenile, and Beach Seine Surveys**

4 Water Quality and Climate Change

5 *Sewage Treatment System Upgrades*

As discussed in Section 2.2.5, the increasing populations along the river and within the watershed resulted in an increased discharge of sewage into the Hudson River and an overall degradation of water quality. Beginning in 1906 with the creation of the Metropolitan Sewerage Commission of New York, a series of studies were conducted to formulate plans to improve water quality within the region (Brosnan and O'Shea 1996). In the freshwater portion of the lower Hudson River, the most dramatic improvements in wastewater treatment were made between 1974 and 1985, resulting in a decrease in the discharge of suspended solids by 56 percent. Improvements in the brackish portion of the river were even greater. In the New York City area, the construction and upgrading of water treatment plants reduced the discharge of untreated wastewater from 450 million gallons per day (mgd) in 1970 to less than 5 mgd in 1988 (CHGEC 1999). The discharge of raw sewage was further reduced between 1989 and 1993, caused by the implementation of additional treatment programs (Brosnan and O'Shea 1996).

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1 Source: Normandeau 2008

2 **Figure H-12 White perch standardized population trend data for the Riverwide and River**
 3 **Segment 12 (RS12), Fall Juvenile, and Beach Seine Surveys**

4 During the 1990s, three municipal treatment plants located in the lower Hudson River converted
 5 to full secondary treatment—North River (1991), North Bergen MUA-Woodcliff (1991), and
 6 North Hudson Sewerage Authority West New York (1992). In addition, the North Hudson
 7 Sewerage Authority-Hoboken plant, located on the western bank of the Hudson River opposite
 8 Manhattan Island, went to full secondary treatment in 1994 (CHGEC 1999). Upgrades to the
 9 Yonkers Joint Treatment Plant in 1988 and the Rockland County Sewer District #1 in 1989 also
 10 resulted in improvements in water quality in the brackish portion of the Hudson River. In the
 11 mid-1990s, the Rockland County Sewer District #1 and Orangetown Sewer District plants were
 12 also upgraded. (CHGEC 1999)

13 *Trends in Dissolved Oxygen*

14 A review of long-term trends in dissolved oxygen (DO) and total coliform bacteria concentrations
 15 by Brosnan and O'Shea (1996) has shown that improvements to water treatment facilities have
 16 improved water quality. The authors noted that, between the 1970s and 1990s, DO
 17 concentrations in the Hudson River generally increased. The increases coincided with the

upgrading of the 170 million mgd North River plant to secondary treatment in the spring of 1991. DO, expressed as the average percent saturation, exceeded 80 percent in surface waters and 60 percent in bottom waters during summer in the early 1990s. DO minimums also increased from less than 1.5 milligrams per liter (mg/L) in the early 1970s to more than 3.0 mg/L in the 1990s, and the duration of low DO (hypoxia) events was also reduced (Brosnan and O'Shea 1996). Similar trends showing improvements in DO were noted by Abood et al. (2006) from an examination of two long-term data sets collected by NYCDEP in the lower reaches of the river. Brosnan and O'Shea (1996) also noted a strong decline in total coliform bacteria concentrations that began in the 1970s and continued into the 1990s, coinciding with sewage treatment plant upgrades.

Chemical Contaminants

As discussed in Section 2.2.5, the lower Hudson River currently appears on the EPA 303-d list as an impaired waterway, because of the presence of PCBs and the need for fishing restrictions (EPA 2004). Contamination of the sediment, water, and biota of the Hudson River estuary resulted from the manufacture of capacitors and other electronic equipment in the towns of Fort Edward and Hudson Falls, New York, from the 1940s to the 1970s. Investigations conducted by the EPA and others over the past 25 years have delineated the extent and magnitude of contamination, and numerous cleanup plans have been devised and implemented. Recently, EPA Region 2 released a "Fact Sheet" describing a remedial dredging program designed to remove over 1.5 million cubic yards of contaminated sediment covering 400 acres, extending from the Fort Edwards Dam to the Federal Dam at Troy (EPA 2008). Concentrations of PCBs in river sediments below the Troy Dam are much lower. Work summarized by Steinberg et al. (2004) suggests the sediment-bound concentrations of PCBs and dioxins have generally declined in the lower Hudson River since the 1970s and are now at or below ER-M limits.

Chemical contaminants present in the tissues of fish in the Hudson River estuary have been extensively studied for many years and resulted in the posting of consumption advisories by the States of New York and New Jersey. Current information summarized in Steinberg et al. (2004) suggests that many recreationally and important fish and shellfish still contain levels of metals, pesticides, PCBs, and dioxins above the Food and Drug Administration (FDA) guidance values for commercial sales. Tissue concentrations of mercury were of concern only for striped bass; other fish, and shellfish, including flounder, perch, eels, blue crab, and lobster, contained concentrations of mercury in their tissues well below the FDA limit of 2 parts per million (ppm) for commercial sale. Concentrations of chlordane in white perch, American eels, and the hepatopancreas (green gland) of blue crabs were also above FDA guidelines. DDT concentrations in the tissues of most recreationally and commercially valuable fish and shellfish in the estuary were below the 2 ppm FDA limit with the exception of American eel. Unfortunately, the concentrations of 2,3,7,8-TCDD (a dioxin compound) and total PCBs in fish and shellfish tissues were often above FDA guidance limits, suggesting fish and shellfish obtained from some locations within the estuary should be eaten in moderation or not at all.

The results described above suggest that, although a wide variety of contaminants still exist in sediment, water, and biota in the lower Hudson River, the overall levels appear to be decreasing because of the imposition of strict discharge controls by Federal and State regulatory agencies and improvements in wastewater treatment. These trends appear to be confirmed, based on the results of a NOAA-sponsored toxicological evaluation of the estuary in 1991, as described in Wolfe et al. (1996). There is continuing concern, however, that legacy PCB waste may still

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pose a threat to invertebrate, fish, and human populations. A study by Achman et al. (1996) suggested that PCB concentrations in sediment measured at several locations in the lower Hudson River from the mouth to Haverstraw Bay are above equilibrium with overlying water and may be available for transfer within the food web. The implications of this study are that, in some locations within the lower river, the sediments could act as a source of PCBs and pose a long-term chronic threat. The authors concluded, however, that fate and transport modeling would be required to fully understand the implications of this potential contaminant source.

Based on the above information, it appears that the overall water quality in the lower Hudson River is generally improving, although the presence of legacy contaminants still presents a concern to regulatory agencies. Based on the information reviewed, the NRC staff concludes that the cumulative impact of water quality on RIS should decline if efforts continue to address point- and non-point pollution and legacy waste removal and treatment.

Climate Change

The potential cumulative effects of climate change on Hudson River RIS could result in a variety of fundamental changes to watersheds that would affect aquatic resources. The environmental factors of significance identified by Kennedy (1990) that would affect estuarine systems included sea level rise, temperature increase, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects on nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes to marsh communities, and influences to wetland areas adjacent to nearshore systems. Water temperature increases could affect spawning patterns or success, or influence the distribution of key RIS when cold-water species move poleward while warm-water species become established in new habitats. Changes to river salinity and the presence of the salt front could influence the spawning and distribution of RIS, and the range of exotic or nuisance species. Fundamental changes in precipitation could profoundly influence water circulation and change the nature of allochthonous and autochthonous inputs to the system. This could result in fundamental changes to primary production and influence the estuarine food web on many levels. Kennedy (1990) also concluded that some fisheries and aquaculture enterprises and communities might benefit from the results of climate change, while others would suffer extensive economic losses that could lead to population shifts.

The extent and magnitude of climate change impacts to the aquatic resources of the lower Hudson River are an important component of the cumulative assessment analyses. This assessment is beyond the scope of this review and will need to be explored and evaluated by others. A minimal evaluation of shifts in the distribution of RIS standardized mean density for 1979 to 1983 and for 2001 to 2005 was explored in Appendix H. Several RIS (striped bass, alewife, spottail shiner, hogchoker, and white perch) may be shifting their distribution slightly upriver while bay anchovies may be shifting their distribution seaward. This analysis attempts only to explore hypotheses about potential redistribution of fish; definitive statements cannot be made because of data limitations. Thus, the NRC staff has concluded that the cumulative effects of climate change cannot be determined.

H.3 References

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2 Domestic Licensing and Related Regulatory Functions," Part 51, Chapter 1, Title 10, "Energy."
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Appendix I

Statistical Analyses Conducted for Chapter 4 Aquatic Resources and Appendix H

Appendix I

Statistical Analyses Conducted for Chapter 4 Aquatic Resources and Appendix H

Supporting analyses and data tables are presented by section as referenced in the Aquatic Resources sections of Appendix H. Major section headings are maintained to allow mapping between appendices. This appendix includes supporting information for the U.S. Nuclear Regulatory Commission (NRC) staff assessment of impingement impacts (Appendix H, Section 1.3), the assessment of population trends (Appendix H, Section 3.1), the analysis of strength of connection (Appendix H, Section 3.2), and the cumulative impacts on aquatic resources (Appendix H, Section 4).

I.1 Impingement of Fish and Shellfish

I.1.1. NRC Staff Assessment of Impingement Impacts

Staff conducted simple linear regression over years on the number of days of operation and the combined volume of water discharged for Indian Point Nuclear Generating Station Unit Nos. 2 and 3 (IP2 and IP3) between 1975 and 1990 (Table I-1). Days of operation from 1975 to 1981 were obtained from impingement data provided by Entergy Nuclear Operations, Inc. (the applicant) (Entergy 2007b). Days of operation for the remaining years and the combined volume discharged were compiled from the annual reports for the Hudson River Ecological Study in the area of IP2 and IP3 (Con Edison 1980; Con Edison 1984, 1986–1991). The number of days of operation at IP2 and IP3 had a general increase of 8 days per year for IP2 and 5 days per year for IP3 (linear regression, $p = 0.004$ and $p = 0.286$ for IP2 and IP3, respectively). The total volume circulated at IP2 and IP3 combined also had a general increase of 26.2×10^6 cubic meters (m^3 ; linear regression, $p = 0.164$).

Table I-1 Number of Days of Operation at IP2 and IP3 and Combined Discharge

Year	Days of Operation		Combined Volume (millions m ³)
	IP2	IP3	
1975	307		1119
1976	176	239	1329
1977	265	259	2159
1978	234	270	2030
1979	246	227	1935
1980	263	261	1822
1981	276	297	1617
1982	304	135	1273
1983	340	48	1286
1984	238	306	1710
1985	365	266	1977
1986	285	357	1892
1987	346	265	1815
1988	357	352	2322
1989	302	301	1748
1990	365	272	1902

Source: Days of Operation: Entergy 2007b; Con Edison 1984, 1986–1991
Volume Discharged: Con Edison 1980, 1991

I.2 Combine Effects of Impingement and Entrainment

I.2.1. Assessment of Population Trends

Studies Used To Evaluate Population Trends

The Hudson River utilities conducted the Fall Juvenile Shoals Survey (FSS) from 1974 to 2005 and targeted juveniles, yearlings, and older fish. Between 1974 and 1984, a 1-square meter (m²) Tucker trawl with a 3-millimeter (mm) mesh was used to sample the channel and a 1-m² epibenthic sled with a 3-mm mesh was used to sample the bottom and shoal strata. From 1985 to 2005, a 3-meter (m) beam trawl with a 38-mm mesh on all but the cod-end replaced the epibenthic sled. Size selectivity and relative catch efficiency between gear types was tested during nocturnal samplings between August and September 1984. Bay anchovy, American shad, and weakfish were sampled with less efficiency with the beam trawl (Table I-2) (NYPA 1986). Further, the number and volume of samples in the bottom and shoal strata were generally greater than 2.5 times those in the channel (Table I-3).

The Beach Seine Survey (BSS) was conducted from 1974 to 2005 and targeted young of the year (YOY) and older fish in the shore-zone (extending from the shore to a depth of 10 feet (ft)). Samples were collected from April to December but generally every other week from mid-June through early October (Table I-4). For all years, a 100-ft bag beach seine was used to collect 100 samples during each sampling period from beaches selected according to a stratified

random design. Even though the catch-per-unit-effort (CPUE) for representative important species (RIS) differed in magnitude between the BSS and FSS (Table I-5), standardizing the data (observed CPUE minus the mean CPUE and divided by the standard deviation across years) allowed a comparison of the shape of the data over time. Thus, NRC staff conducted a visual comparison of the standardized BSS and FSS data determine if a shift in gear types was affecting the observed FSS trend. When the standardized FSS data were consistently less than the standardized BSS data after 1985, the pre- and post-1985 data were evaluated separately.

**Table I-2 Catch by Gear or Gear Efficiency (catch per 1000 m²)
from August to September 1984**

Species	Young of the Year				Yearling and Older			
	3-m Beam Trawl (n = 257)		1-m ² Epibenthic Sled (n = 322)		3-m Beam Trawl (n = 257)		1-m ² Epibenthic Sled (n = 322)	
	Mean Density	Standard Error	Mean Density	Standard Error	Mean Density	Standard Error	Mean Density	Standard Error
Bay Anchovy	29.0	3.0	1261	61.9	0.6	0.1	11.2	1.2
American Shad	0.4	0.1	4.4	3.0	0.0	0.0	0.0	0.0
Bluefish	0.1	<0.1	0.3	0.1	0.0	0.0	0.0	0.0
Hogchoker	0.1	<0.1	0.1	<0.1	5.4	0.4	1.5	0.2
Striped Bass	13.3	0.8	3.4	0.4	0.2	<0.1	0.1	<0.1
White Catfish	0.0	0.0	0.0	0.0	1.6	0.2	1.0	0.1
White Perch	1.3	0.2	0.1	<0.1	22.1	1.6	6.4	1.3
Weakfish	0.7	0.1	1.9	0.3	0.0	0.0	0.0	0.0

Source: NYPA 1986

Appendix I

1 **Table I-3 Changes to the Design and Gear Used During the Fall Juvenile Survey**

Year	Volume (m ³)	Number of Samples	Samples per Gear			Sample Collection Dates
			Epibenthic Sled	Tucker Trawl	Beam Trawl	
1974	728083	1690	100/wk			Weekly, Aug–Dec
1975	317749	901	100/wk			Biweekly, Aug–Dec
1976	365903	881	100/wk			Biweekly, Aug–Dec
1977	368134	826	100/wk			Biweekly, Aug–Dec
1978	352420	900	100/wk			Biweekly, Aug–Dec
1979	1,006,411	2387	150/wk	50/wk		Biweekly, July–Dec
1980	771291	2103	150/wk	50/wk		Biweekly, July–Dec
1981	479591	1199	150/wk	50/wk		Biweekly, Aug–Oct
1982	400969	1000	150/wk	50/wk		Biweekly, Aug–Oct
1983	477057	1199	150/wk	50/wk		Biweekly, Aug–Oct
1984	601459	1601	150/wk	50/wk		Biweekly, July–Oct
1985	1886754	1802		~500	~1,500	Biweekly, July–Nov
1986	2,298,395	2098		549	1,549	Biweekly, July–Dec
1987	2035472	1891		495	1,396	Biweekly, July–Nov
1988	1826692	1680		440	1,240	Biweekly, July–Oct
1989	1590118	1679		439	1,240	Biweekly, July–Oct
1990	1252994	1680		439	1,241	Biweekly, July–Oct
1991	1707319	1678		440	1,238	Biweekly, July–Oct
1992	1865451	1680		440	1,240	Biweekly, July–Oct
1993	2010222	1680		440	1,240	Biweekly, July–Oct
1994	2018494	1681		440	1,241	Biweekly, July–Oct
1995	1782199	1680		440	1,240	Biweekly, July–Oct
1996	1824802	1669		484	1,185	Biweekly, July–Oct
1997	1995519	2015		826	1,189	Biweekly, July–Nov
1998	2214707	2130		825	1,305	Biweekly, July–Dec
1999	2160009	2085		823	1,262	Biweekly, July–Dec
2000	2174896	2113		816	1,297	Biweekly, July–Nov
2001	2097877	2084		818	1,266	Biweekly, July–Oct
2002	2105272	2128		821	1,307	Biweekly, July–Dec
2003	1891135	2131		825	1,306	Biweekly, July–Dec
2004	2106874	2128		823	1,305	Biweekly, July–Dec
2005	2063654	2128		824	1,304	Biweekly, July–Dec

2 Note: Compiled from the annual Year Class Reports for the Hudson River Estuary Monitoring Program; ASA 1999,
3 2001a, 2001b, 2003, 2004a, 2004b, 2005–2007; Battelle 1983; ConEd undated a, undated b, 1996; EA 1990, 1995,
4 1991; LMS 1989, 1991, 1996; MMES 1983; Versar 1987; TI 1977–1981; NAI 1985a, 1985b, 2007.

There were four basic combinations of sampling intensities, duration, and gear types used during the FSS (Table I-3). Likewise, there were roughly three levels of sampling intensity used during the BSS (Table I-4). Thus, for data provided on a weekly basis, only weeks 27 to 43 were used in the analysis for the FSS and weeks 22 to 43 for the BSS survey, so that most years contained observations from the months of July through October and June through October for each survey, respectively.

Table I-4 Number of Weeks Sampled Each Month During the BSS

Year	April	May	June	July	August	September	October	November	December
1974	4	4	4	5	4	5	4	4	3
1975	5	4	4	5	4	5	4	4	3
1976	5	4	4	5	4	5	4	4	2
1977	4	4	4	5	4	5	4	4	3
1978	4	4	4	5	4	5	4	4	4
1979	5	4	4	5	4	5	4	4	2
1980	5	4	4	5	4	2	2	2	1
1981	0	0	0	0	2	3	2	0	0
1982	0	0	0	0	1	3	1	0	0
1983	0	0	0	0	2	3	1	0	0
1984	0	0	0	1	2	2	2	1	0
1985	0	0	0	2	2	2	2	2	0
1986	0	0	0	2	2	2	2	2	0
1987	0	0	1	2	2	3	2	1	0
1988	0	0	1	3	2	2	2	1	0
1989	0	0	1	3	2	2	2	1	0
1990	0	0	1	3	2	2	2	0	0
1991	0	0	1	2	2	3	2	0	0
1992	0	0	1	2	2	3	2	0	0
1993	0	0	0	3	2	2	2	1	0
1994	0	0	0	3	2	2	2	1	0
1995	0	0	1	2	2	3	2	0	0
1996	0	0	1	3	2	2	2	0	0
1997	0	0	1	3	2	2	2	0	0
1998	0	0	1	3	2	2	2	0	0
1999	0	0	1	3	2	2	2	0	0
2000	0	0	1	3	2	2	2	0	0
2001	0	0	1	3	2	2	2	0	0
2002	0	0	1	3	2	2	2	0	0
2003	0	0	1	3	2	2	2	0	0
2004	0	0	1	3	2	2	2	0	0
2005	0	0	1	3	2	2	2	0	0

Source: NRC Request for Sampling Effort and Abundance Data from Three Hudson River Sampling Programs for 16 Selected Fish Species from 1974 through 2005, Normandeau Associates Inc., February 25, 2008

Appendix I

Metrics Used To Evaluate Population Trends

Abundance Index

The abundance index for YOY for each species was based on the catch from a selected sampling program and used by the applicant and its contractors to estimate riverwide mean RIS abundances. The selection process considered the expected location of each species in the river, based on life-history characteristics and the observed catch rates from previous sampling. The abundance index was constructed to account for the stratified random sampling design used by each of the surveys. For the Long River Survey (LRS) and the FSS, sampling within a river segment was further stratified by river depth and sampled with separate gear types. For blueback herring, alewife, bay anchovy, hogchoker, weakfish, and rainbow smelt, the YOY abundance index was based on the catch from a single gear type (Table I-5).

The construction of the LRS (L_A) and the FSS abundance index (F_A) were similar and provided an unbiased estimate of the total and mean riverwide population abundance for selected species, respectively (Cochran 1997). For the FSS and each gear type, F_A was constructed as a weighted mean of the average species density with weight given by the volume of each stratum for a given river segment. For the FSS, strata sampled were the channel, bottom, and shoal for a given river segment. Poughkeepsie and West Point river segments had the greatest channel volume, Poughkeepsie and Tappan Zee had the greatest bottom volume, and Tappan Zee had the greatest shoal volume (Table I-6). Because the river segment associated with IP2 and IP3 did not have large bottom or shoal volumes, the abundance index was not sensitive to changes in population trends within the vicinity of IP2 and IP3.

Table I-5 Sampling Program Used To Calculate the Abundance Index for YOY and Yearling Fish and the Median Catch-per-Unit-Effort Over Time

Species	Sampling Program	Riverwide FSS Median YOY Catch-per- Unit-Effort	Riverwide BSS Median YOY Catch- per-Unit-Effort
Alewife	FSS-Channel	4.35E-04	1.05
Bay Anchovy	FSS-Channel	2.61E-02	6.70
American Shad	BSS	8.12E-04	9.17
Bluefish	BSS	3.18E-05	3.36E-01
Hogchoker	FSS-Bottom	1.03E-02	2.30E-01
Blueback Herring	FSS-Channel	1.12E-02	2.86E+01
Rainbow Smelt	FSS-Channel	N/A ^a	< 0.0001
Spottail Shiner	FSS-Channel	1.10E-04	7.25
Stripped Bass	BSS	2.47E-03	6.47
Atlantic Tomcod	LRS	2.69E-03	6.70E-02
White Catfish	BSS	N/A	2.50E-02
White Perch	BSS	5.89E-03	10.4
Weakfish	FSS-Channel	N/A	5.00E-03

^a N/A = not applicable; YOY not present in samples
Source: CHGE 1999

Table I-6 Volume of Sampling Strata by River Segment

Region	River Segment	Volume (m ³)			Region	Area (m ²) Shore Zone
		Channel	Bottom	Shoal		
Battery	0	141,809,822	48,455,129	18,747,833	209,012,784	N/A
Yonkers	1	143,452,543	59,312,978	26,654,767	229,420,288	3,389,000
Tappan Zee	2	138,000,768	62,125,705	121,684,992	321,811,465	20,446,000
Croton-Haverstraw	3	61,309,016	32,517,633	53,910,105	147,736,754	12,101,000
Indian Point	4	162,269,471	33,418,632	12,648,163	208,336,266	4,147,000
West Point	5	178,830,022	25,977,862	2,647,885	207,455,769	1,186,000
Cornwall	6	94,882,267	36,768,629	8,140,123	139,791,019	4,793,000
Poughkeepsie	7	228,975,052	63,168,132	5,990,260	298,133,444	3,193,000
Hyde Park	8	131,165,041	32,012,000	2,307,625	165,484,666	558,000
Kingston	9	93,657,021	35,479,990	12,332,868	141,469,879	3,874,000
Saugerties	10	113,143,296	42,845,077	20,307,338	176,295,711	7,900,000
Catskill	11	83,924,081	42,281,206	34,526,456	160,731,743	8,854,000
Albany	12	32,025,080	13,517,183	25,606,842	71,149,105	6,114,000

N/A – not applicable. Data from Entergy 2007b.

Analysis of Population Impacts

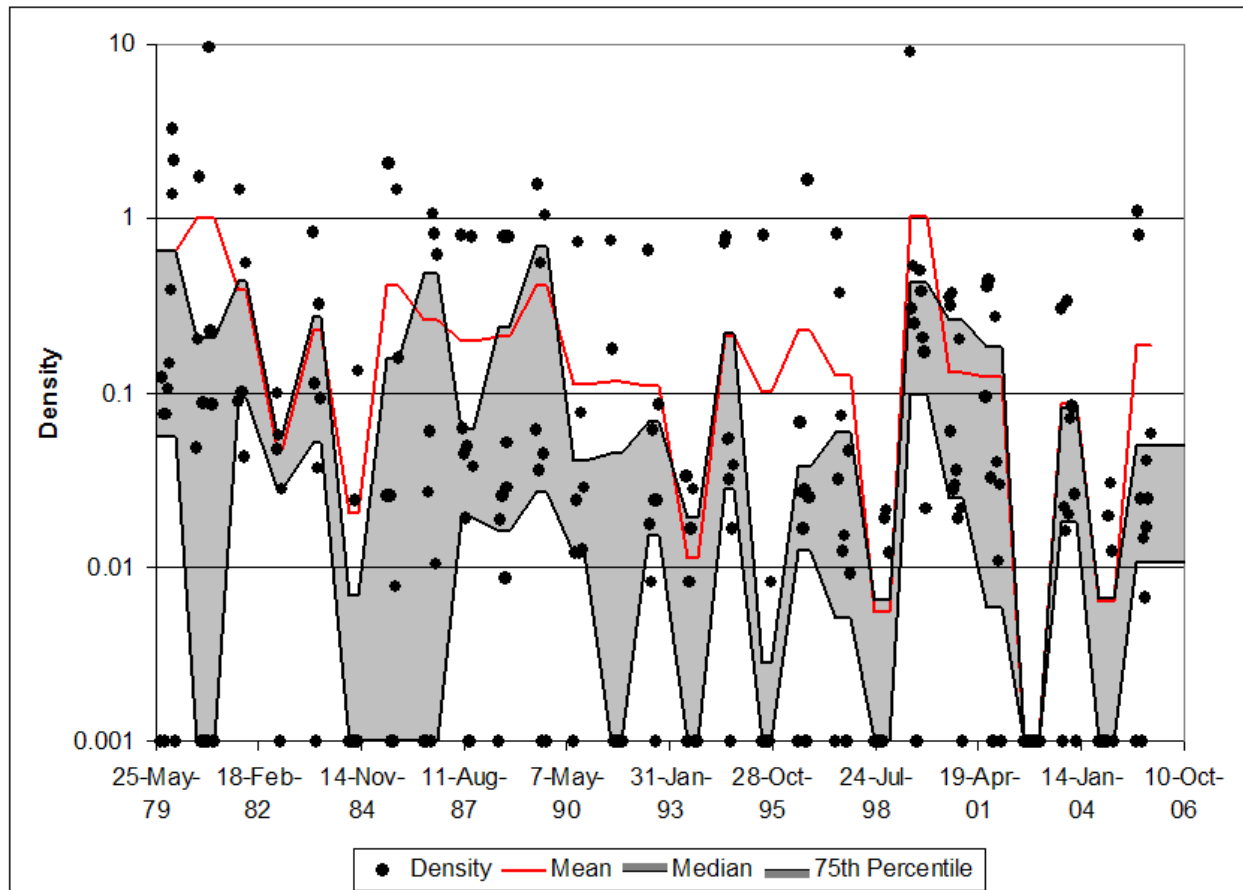
As discussed in Section H.3, the analysis was based on YOY fish to assess the population trends. For the river-segment analysis, the median and the 75th percentile of the densities of YOY caught within a given year in the vicinity of IP2 and IP3 (River Segment 4) were used to bound population trends for a visual representation. The median and 75th percentile are less sensitive to extreme values than the mean. Fish population sizes and the chance of catching fish were highly variable, and a few large catches can influence the mean and potentially distort a trend analysis. For example, the mean density for alewives caught during the FSS in the vicinity of IP2 and IP3 tended to be equal to or greater than the 75th percentile of the density for most years because of the relatively fewer large observations (Figure I-1). Further, seasonal and interannual differences in the salt front position may influence the pattern of trends in total or mean abundance between river segments. Evaluating the 75th percentile of the weekly data removed the influence from any given week associated with potentially extreme environmental characteristics.

River-segment data collected from 1979–2005 (n = 27 for each RIS) was standardized by subtracting the first 5-year mean and dividing by the standard deviation based on all years. Because of the large variability between years (coefficients of variation (CVs) ranging from 67 to 247 percent), a 3-year moving average was used to smooth the river-segment data before the trend analysis. Two competing models, simple linear regression and segmented regression with a single join point, were statistically fit to the smoothed and standardized 75th percentile of the annual observed densities for each taxon. The model with the smallest mean square error (MSE) was chosen as the better fitting model and used to determine the level of potential injury. Extreme outliers (values greater than 2 standard deviations from the mean) were removed from the analysis if the segmented regression was unable to converge; results with and without outliers were recorded. All data (1979–2005) from the FSS were compared to the BSS to determine if changes in the gear type affected the observed trend. When the standardized FSS

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data were consistently less than the standardized BSS data after 1985, the pre- and post-1985 data were evaluated separately.

Figure I-1 Relationship among the mean, the median, and the 75th percentile of the fish density for alewives caught during the FSS in River Segment 4



Note: The value 0.001 was added to all numbers so that the log scale could be used for plotting.

For the riverwide data collected from 1979–2005 ($n = 27$ for each RIS), the FSS CPUE, the BSS CPUE, and the abundance index for the YOY were used to assess the population trends. Riverwide data consisted of a single number per year for a given taxon and life stage. CVs ranged from 60 percent to 154 percent for the FSS, 41 percent to 302 percent for the BSS, and 49 percent to 319 percent for the abundance index. Simple linear regression and segmented regression with a single join point were fit to the standardized data (using the first 5-year mean and the standard deviation based on all years). Extreme outliers were removed from the analysis if the segmented regression was unable to converge; results with and without outliers were recorded. The model with the smallest MSE was chosen as the best-fit model and used to determine the level of potential injury. All data (1979–2005) from the FSS were compared to the BSS to determine if changes in the gear type affected the observed trend. When the

1 standardized FSS data were consistently less than the standardized BSS data after 1985, NRC
2 staff evaluated the pre- and post-1985 data separately.

3 The FSS density and CPUE for a given RIS can be highly correlated when nearly all of the fish
4 are caught from a single habitat (channel, shoal, or bottom) for the majority of sampling events.
5 For these RIS, the weight-of-evidence (WOE) analysis was conducted both with and without the
6 FSS CPUE results. Because of the slight variation in response between the two measures of
7 population trend, different result scores can occur. However, for all RIS, the final determination
8 of the level of impact associated with the IP2 and IP3 cooling systems was the same by either
9 method. Thus, the correlation between measures was ignored.

10 For each data set, the results of the linear and segmented regression were presented in a
11 series of two tables and a figure if a conclusion of potential large impact to any RIS population
12 was made. The statistics displayed in the first table included the MSE for each model; the
13 estimate of the linear slope and associated 95 percent confidence interval; the p-value
14 associated with the significance test of the null hypothesis that the slope (S) associated with the
15 simple linear model equals zero; the 95 percent confidence interval (CI) of the two slopes from
16 the segmented regression (Slope 1=S1 and Slope 2=S2); and the estimated join point. For the
17 segmented regression, slopes were defined as significant if the CI did not include zero.

18 The best-fit model (defined as the model with the smaller MSE) was then characterized in a
19 second table, based on the general trend depicted by the direction of the estimated slopes. If
20 the slope was significantly different from 0, the trend was represented by either the statement
21 $S > 0$ for a positive slope or $S < 0$ for a negative slope. If the slope was not significant, the
22 statement depicting the lack of a trend was $S = 0$. This table also included the assessment of
23 the percentage of observations outside the defined level of environmental noise, defined as
24 ± 1 standard deviation from the mean. A percentage greater than 40 percent outside this
25 defined level of noise was assumed to provide support for a potential impact, based on the
26 assumption that the proportion of extreme observations was a measure of stability. A level of
27 potential negative impact was then determined, based on the decision rules presented in
28 Section 4.1 of the draft Supplemental Environmental Impact Statement (SEIS). If a large
29 potential for a negative impact was concluded for any RIS, a figure of the data and the best-fit
30 model was presented.

31 *IP2 and IP3 River Segment 4*

32 As stated above, there were two different gear types used during the FSS to sample the bottom
33 and shoal habitats. From 1979 to 1984, an epibenthic sled was used, and from 1985 to 2005, a
34 beam trawl was used. Because there were not enough annual observations from the 1979–
35 1984 time period to conduct a segmented regression, a simple linear regression was conducted
36 to assess the slope of the density of fish near IP2 and IP3. These data were standardized to
37 the average of the first 2 years and divided by the standard deviation of all six observations.
38 Only white perch had a significant negative slope ($n = 6$, $p = 0.01$; Figure I-2). Hogchoker and
39 rainbow smelt appeared to have negative trends, but they were not significant ($p = 0.15$ and 0.33
40 respectively). Rainbow smelt and white perch had 67 percent of their observations less than -1 .

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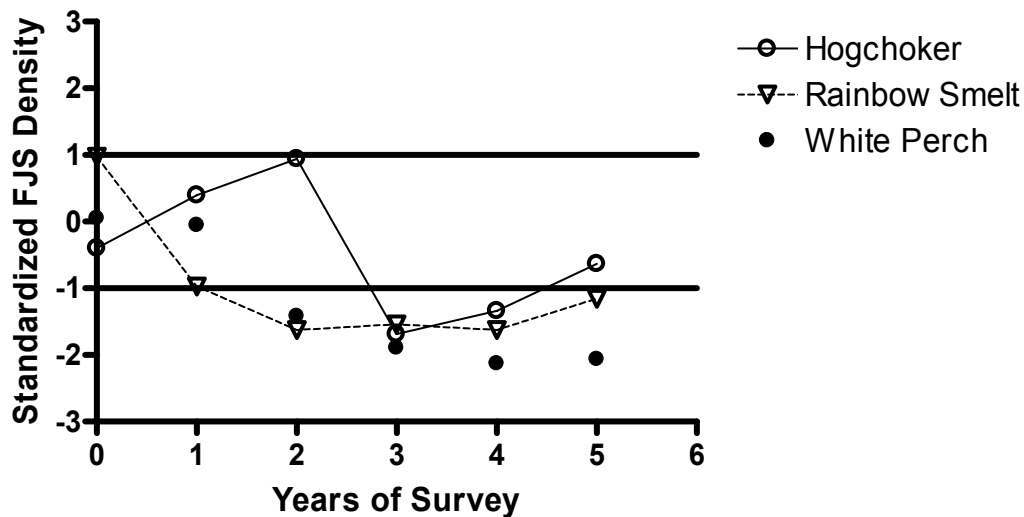
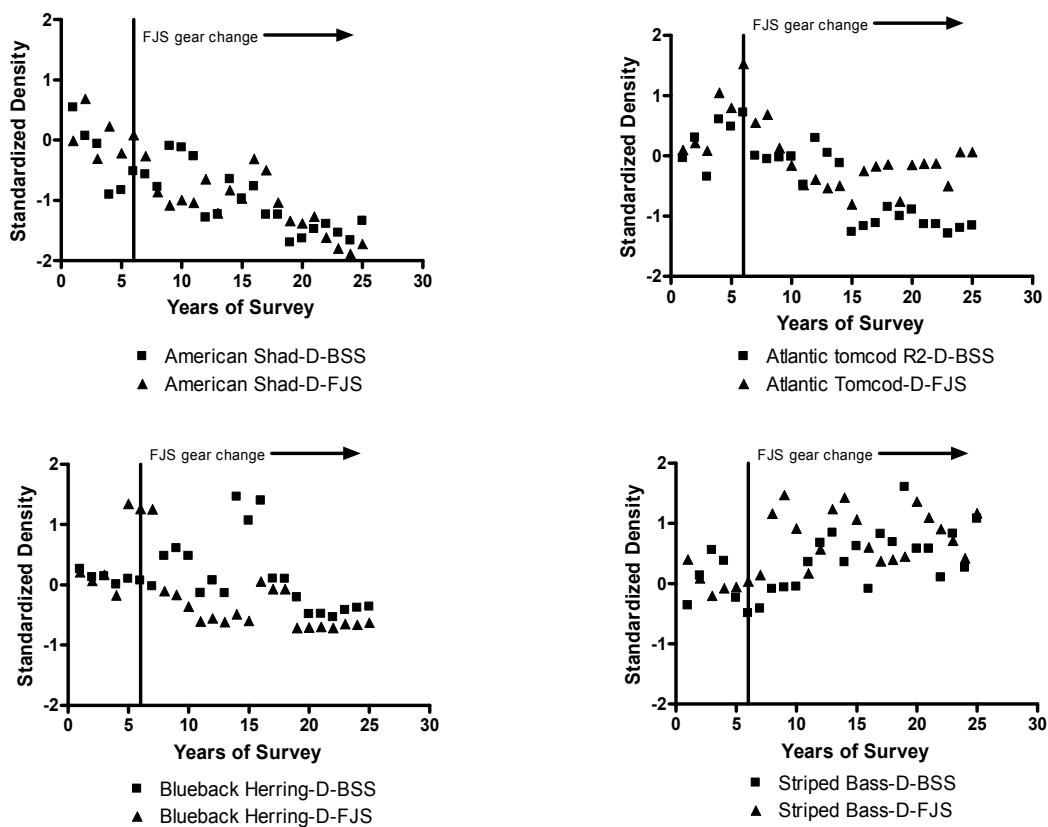


Figure I-2 River Segment 4 population trends based on the first 6 years (1979–1984) of FSS standardized density data for selected RIS

Data collected between 1985 and 2005 were temporally disconnected from the mid-1970s, when operation began at IP2 and IP3. There was a potential that fish populations responded earlier and stabilized to a lower abundance level. For this analysis, data were standardized with the average of 1985 to 1989 and the standard deviation of all data between 1985 and 2005. This analysis was used only when the observed response from all data was biologically different from the BSS population density trend and had a decline associated with the gear change.

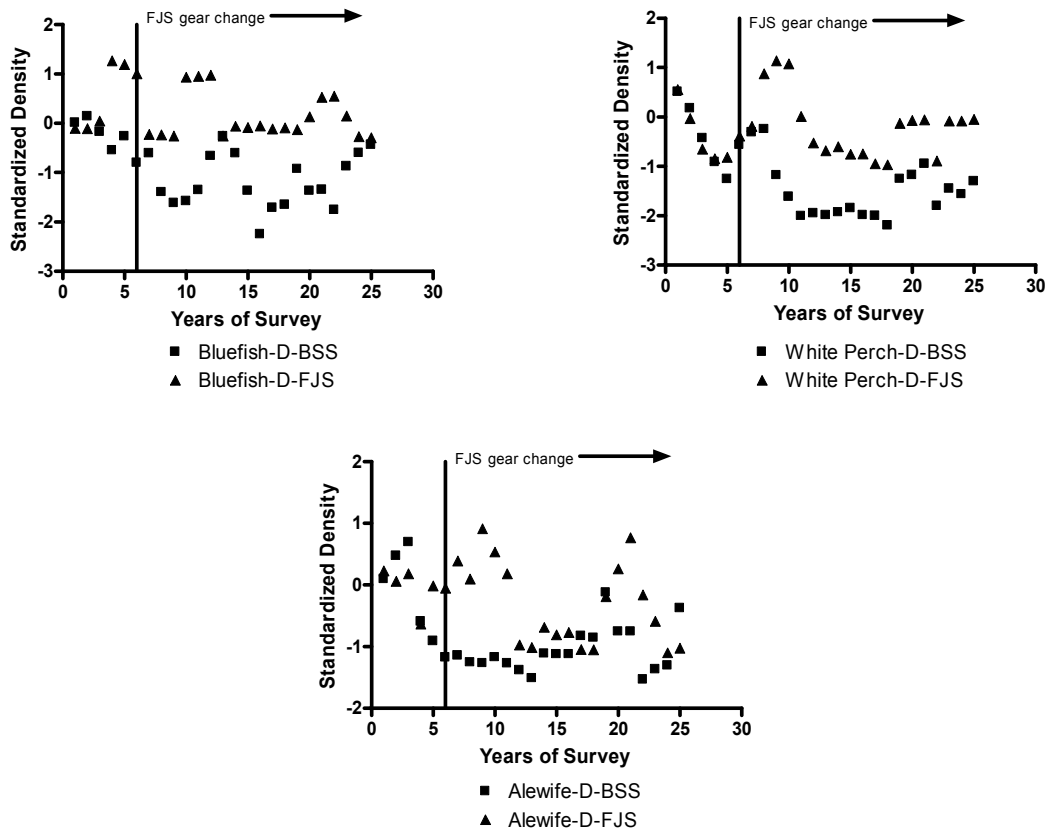
A visual comparison of the river-segment FSS standardized density with the BSS standardized density suggested that the trends were not biologically different for American shad, Atlantic tomcod, blueback herring, and striped bass (Figure I-3). Observations from the two surveys overlap and cross over each other. The post-1985 FSS observations for bluefish, white perch, and alewife were greater than the BSS observations and did not show a decline associated with the gear change (Figure I-4). Thus, for these RIS, all of the FSS data (1979–2005) were used in the regression analysis. The FSS density data for bay anchovy and weakfish, however, did show a potential gear effect (Figure I-5), and a pre- and post-1985 analysis was conducted.



1 Note: All data were used in WOE analysis; R2 = River Segment 2, Yonkers

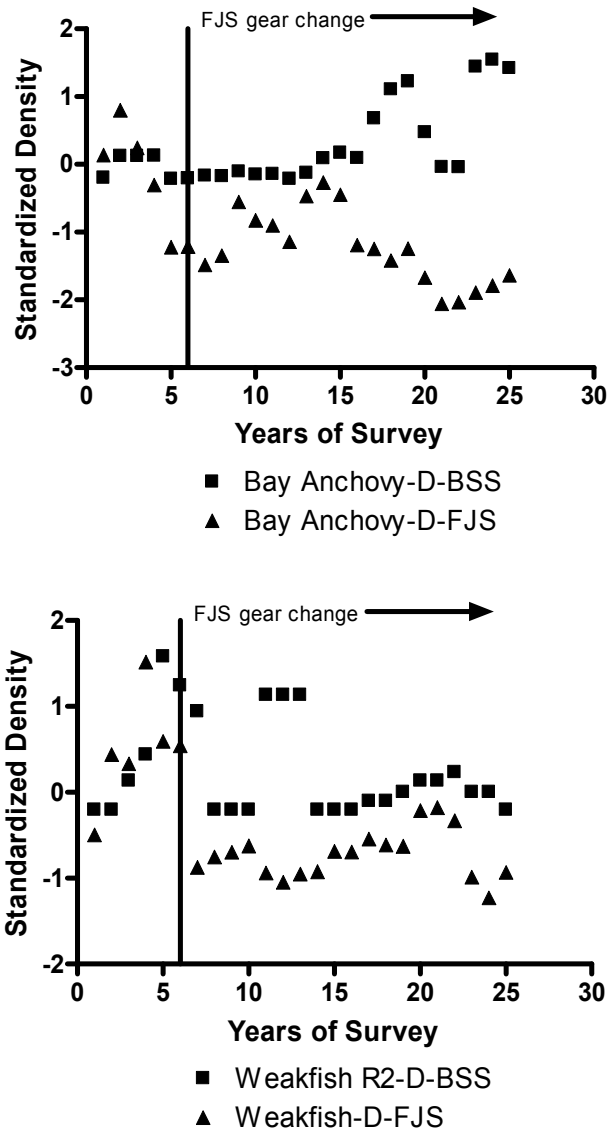
2 **Figure I-3 River Segment 4 population trends based on the BSS and FSS standardized**
 3 **density (D) not considered biologically different**

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1 Note: All data were used in WOE analysis.

2 **Figure I-4 River Segment 4 population trends based on the BSS and FSS standardized**
 3 **density (D) for which the FSS density is greater**



1 Note: All years were analyzed separately for WOE analysis; R2 = River Segment 2, Yonkers

2 **Figure I-5 River Segment 4 population trends based on the BSS and FSS standardized**
 3 **density (D) for which the FSS may indicate a gear difference**

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1 The following tables are the intermediate analyses for the assessment of population trends
2 associated with fish density sampled from River Segment 4. Results of these river-segment
3 trend analyses are compiled in Table H-13 in Section H.3 of the draft SEIS. The data used in
4 this analysis, in order of appearance, were the standardized 75th percentile of the weekly fish
5 density for a given year collected from the FSS (Table I-7, Table I-8, and Figure I-6), BSS
6 (Table I-9, Table I-10, and Figure I-7), and LRS for Atlantic tomcod only (Table I-11 and Table I-
7 12).

8 Two FSS alewife density observations, not extreme outliers, were removed from the regression
9 analysis to allow the segmented regression to converge (Tables I-7 and I-8). These
10 observations corresponded to the peaks in two sporadic increases. Three FSS white catfish
11 density observations, also not extreme outliers, were removed from the regression analysis to
12 allow the segmented regression to converge. The results of both regression models with the
13 observations removed were considered more conservative and were used for the trend
14 analysis.

Table I-7 Competing Models Used To Characterize the Standardized River Segment 4 FSS Population Trends of YOY Fish Density Using a 3-Year Moving Average

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife (All data)	0.58	-0.035 ± 0.016	0.040	Did Not Converge			
Alewife (2 values removed)	0.47	-0.041 ± 0.014	0.007	0.50	-0.070 to -0.007	2004	-3.93e+008 to 3.93e+008
Bay Anchovy 1979-1984	1.10	-0.102 ± 0.262	0.716	Not Fit			
Bay Anchovy 1985-2005	0.96	-0.058 ± 0.035	0.113	0.91	-0.174 to 0.473	1986	-0.285 to -0.002
American Shad (All data)	0.35	-0.079 ± 0.010	< 0.001	0.36	-0.106 to -0.031	1997	-0.226 to 0.008
Bluefish (All data)	0.52	-0.019 ± 0.014	0.194	0.54	-0.081 to 0.039	1996	-0.178 to 0.153
Hogchoker (All data)	0.58	-0.034 ± 0.016	0.047	0.43	0.038 to 0.268	1988	-0.150 to -0.053
Blueback Herring (All data)	0.49	-0.055 ± 0.014	0.001	0.51	-0.154 to 0.002	1992	-0.120 to 0.056
Rainbow Smelt (All data)	0.52	0.036 ± 0.028	0.220	0.35	0.041 to 0.167	1993	-0.793 to -0.119
Striped Bass (All data)	0.46	0.034 ± 0.013	0.013	0.44	-0.014 to 0.241	1988	-0.045 to 0.053
Atlantic Tomcod (All data)	0.49	-0.040 ± 0.014	0.007	0.49	-0.510 to 0.691	1983	-0.085 to -0.012
White Catfish (All data)	0.57	0.014 ± 0.016	0.37	Did Not Converge			
White Catfish (3 values removed)	0.10	0.007 ± 0.003	0.030	0.10	-0.025 to 0.070	1986	-0.006 to 0.013
White Perch (All data)	0.62	-0.014 ± 0.017	0.413	0.63	-2.43 to 1.27	1981	-0.047 to 0.035
Weakfish 1979-1984	0.88	0.328 ± 0.211	0.195	Not Fit			
Weakfish 1985-2005	1.02	0.013 ± 0.037	0.732	1.07	-11.6 to 10.1	1980	-0.071 to 0.117

CI = confidence interval

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Table I-8 River Segment Assessment of the Level of Potential Negative Impact Based on the Standardized FSS Density Using a 3-Year Moving Average

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Alewife (All data)	LR	S < 0	48	Yes	4
Alewife (2 values removed)	LR	S < 0	48	Yes	4
Bay Anchovy 1979–1984	LR	S = 0	50	Yes	4
Bay Anchovy 1985–2005	SR	S1 = 0 S2 < 0	43		
American Shad	LR	S < 0	56	Yes	4
Bluefish	LR	S = 0	7	No	1
Hogchoker (All data)	SR	S1 > 0 S2 < 0	15	No	2
Blueback Herring	LR	S < 0	11	No	2
Rainbow Smelt (All data)	SR	S1 > 0 S2 < 0	7	No	2
Striped Bass	SR	S1 = 0 S2 = 0	26	No	1
Atlantic Tomcod	LR	S < 0	15	No	2
White Catfish (All data)	LR	S = 0	4	No	1
White Catfish (3 values removed)	LR	S > 0	4	No	1
White Perch	LR	S = 0	19	No	1
Weakfish 1979–1984	LR	S = 0	33	No	1
Weakfish 1985–2005	LR	S = 0	29		

LR = Linear Regression; SR = Segmented Regression

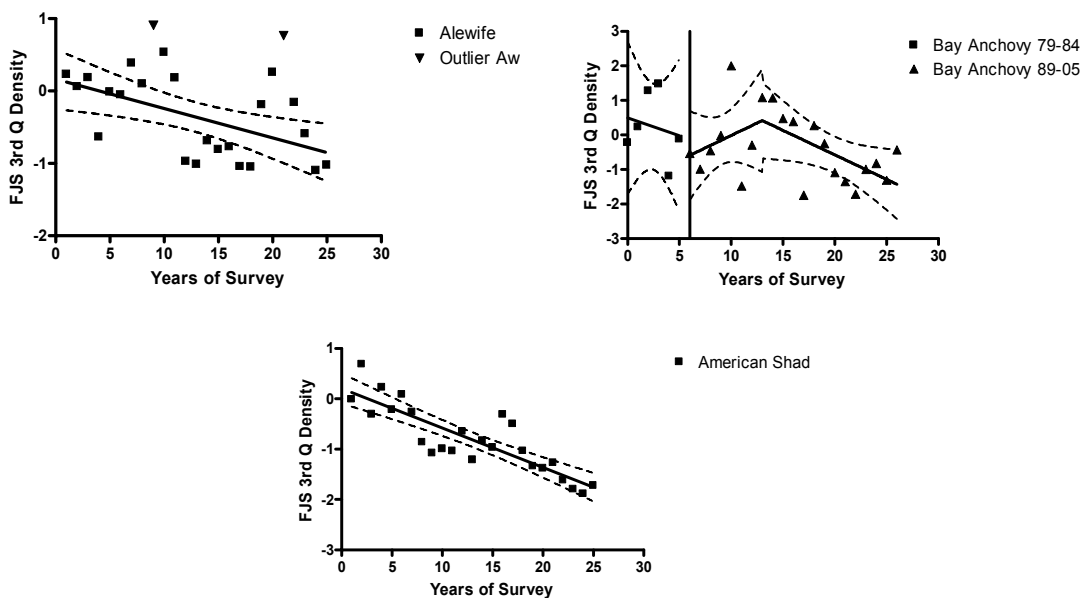


Figure I-6 River Segment 4 population trends based on the FSS standardized density assigned a large level of potential negative impact

Table I-9 Competing Models Used To Characterize the Standardized River Segment 4 BSS Population Trends of YOY Fish Density Using a 3-Year Moving Average

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife	0.57	-0.030 ± 0.016	0.065	0.39	-0.459 to -0.156	1986	-0.010 to 0.063
Bay Anchovy	0.44	0.056 ± 0.012	0.000	0.39	-0.095 to 0.058	1991	0.055 to 0.161
American Shad	0.35	-0.069 ± 0.010	< 0.001	0.34	-0.724 to 0.270	1983	-0.083 to -0.036
Bluefish	0.58	-0.038 ± 0.016	0.027	0.48	-0.146 to -0.047	1996	-0.021 to 0.287
Hogchoker	0.52	-0.059 ± 0.014	< 0.001	0.40	-0.250 to -0.092	1991	-0.034 to 0.076
Blueback Herring	0.53	-0.024 ± 0.015	0.120	0.42	-0.005 to 0.100	1994	-0.235 to -0.042
Spottail Shiner	0.43	-0.017 ± 0.012	0.176	0.35	-0.469 to -0.004	1985	-0.014 to 0.043
Striped Bass	0.42	0.040 ± 0.012	0.002	0.43	-0.287 to 0.221	1985	0.013 to 0.087
White Perch	0.61	-0.062 ± 0.017	0.001	0.40	-0.247 to -0.122	1992	-0.007 to 0.133

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1 **Table I-10 River Segment 4 Assessment of the Level of Potential Negative Impact Based**
 2 **on the Standardized BSS Density Using a 3-Year Moving Average**

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Final Decision
Alewife	SR	S1 < 0 S2 = 0	74	Yes	4
Bay Anchovy	SR	S1 = 0 S2 > 0	11	No	1
American Shad	SR	S1 = 0 S2 < 0	63	Yes	4
Bluefish	SR	S1 < 0 S2 = 0	52	Yes	4
Hogchoker	SR	S1 < 0 S2 = 0	78	Yes	4
Blueback Herring	SR	S1 = 0 S2 < 0	11	No	2
Spottail Shiner	SR	S1 < 0 S2 = 0	74	Yes	4
Striped Bass	LR	S > 0	30	No	1
White Perch	SR	S1 < 0 S2 = 0	70	Yes	4

3 LR = Linear Regression; SR = Segmented Regression

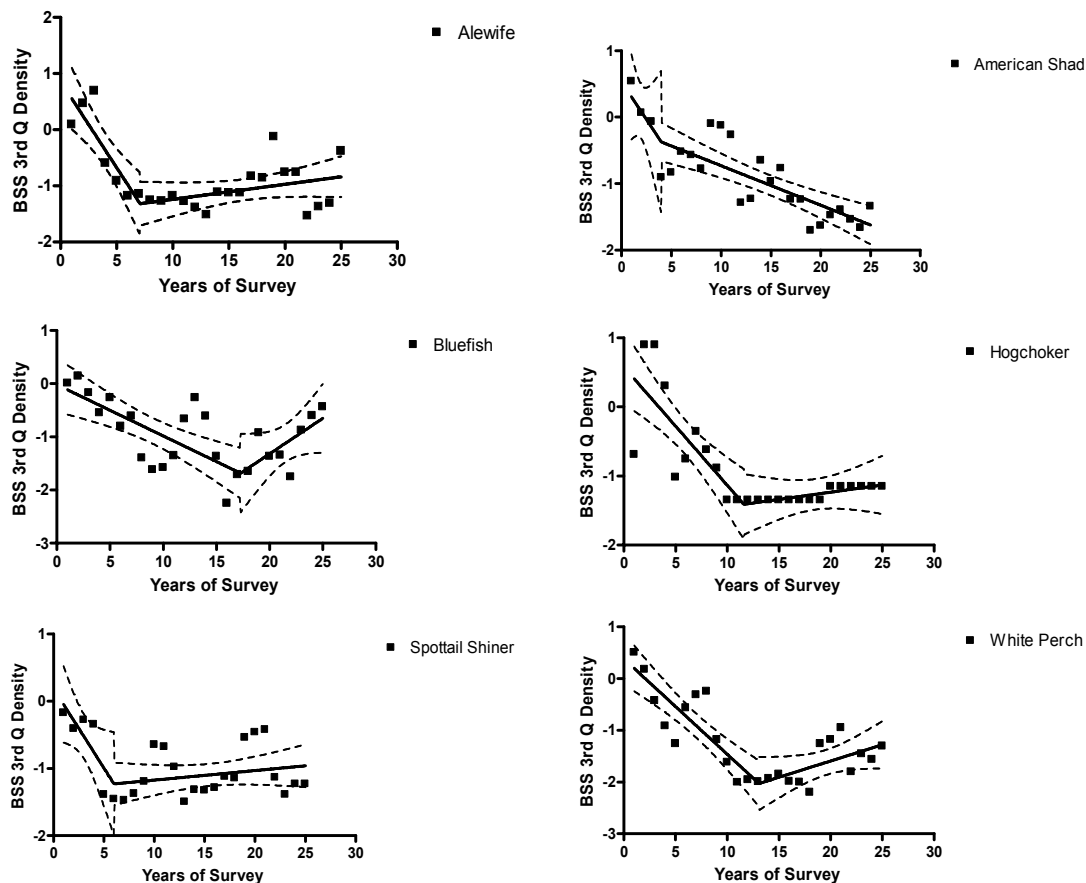


Figure I-7 River Segment 4 population trends based on the BSS standardized density assigned a large level of potential negative impact

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Table I-11 Competing Models Used To Characterize the Standardized River Segment 4 LRS Population Trends of YOY Atlantic Tomcod Density Using a 3-Year Moving Average

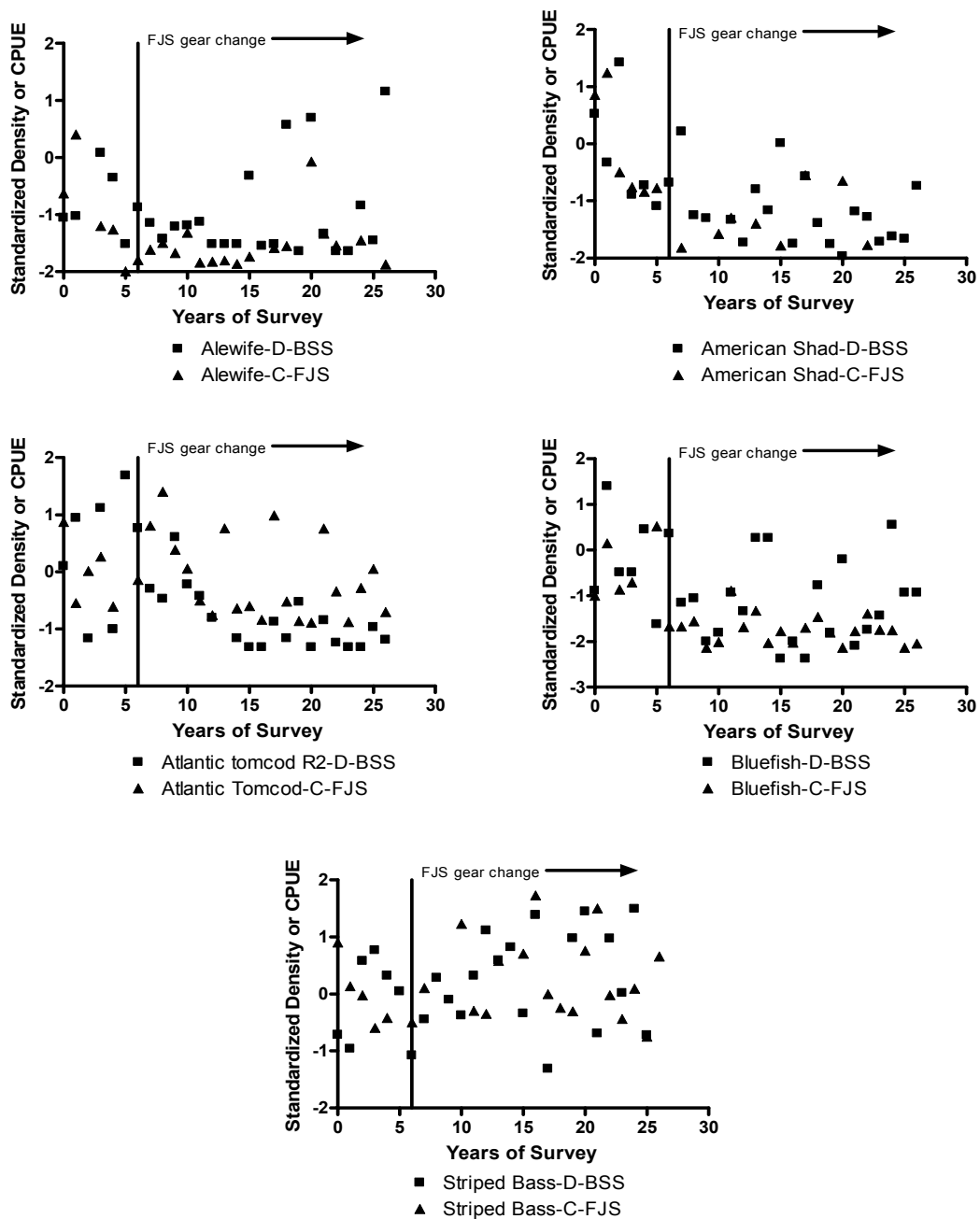
Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Atlantic Tomcod	0.53	-0.074 ± 0.015	< 0.001	0.49	-0.187 to -0.067	1982	-0.098 to 0.124

Table I-12 River Segment 4 Assessment of the Level of Potential Negative Impact Based on the Standardized LRS Atlantic Tomcod YOY Density Using a 3-Year Moving Average

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Atlantic Tomcod	SR	S1 < 0 S2 = 0	33	No	2

SR = Segmented Regression

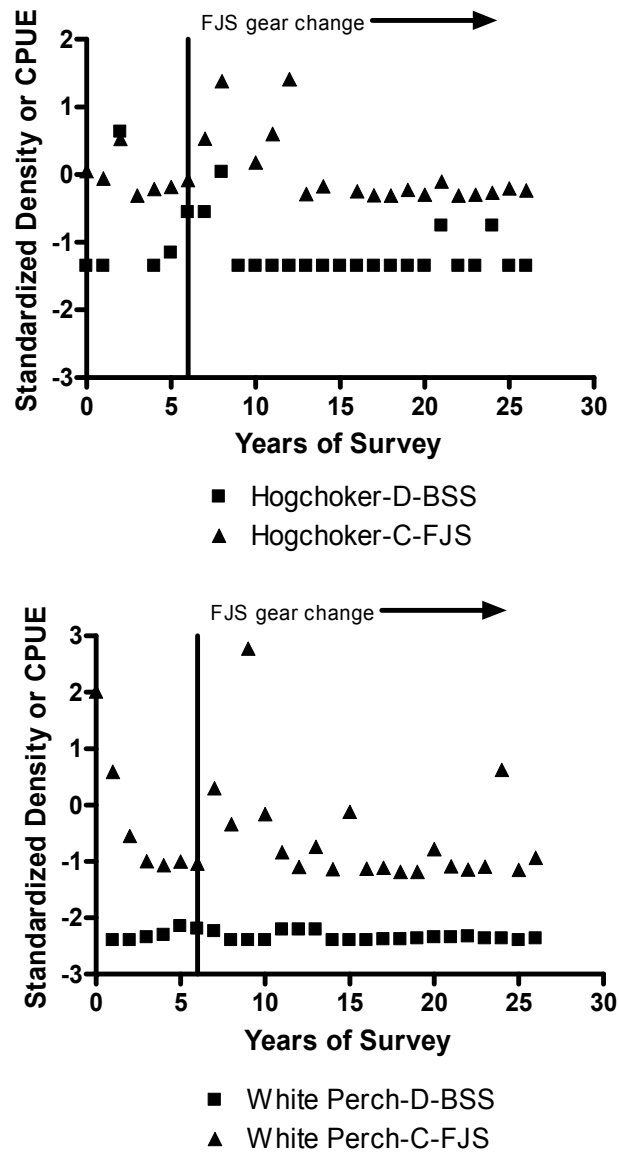
A visual comparison of the river-segment FSS standardized CPUE with the BSS standardized density suggested that the trends for alewife, American shad, Atlantic tomcod, bluefish, and striped bass were not biologically different (Figure I-8). Observations from both surveys overlap and cross over each other. The post-1985 FSS CPUE observations for hogchoker and white perch were greater than the BSS observations and did not show a decline associated with the gear change (Figure I-9). Thus, for these RIS, all of the FSS CPUE data (1979–2005) were used in the regression analysis. The FSS density data for bay anchovy, blueback herring, and weakfish, however, did show a potential gear effect (Figure I-10), and a pre- and post-1985 analysis was conducted.



1 Note: All data were used in WOE analysis; R2 = River Segment 2, Yonkers.

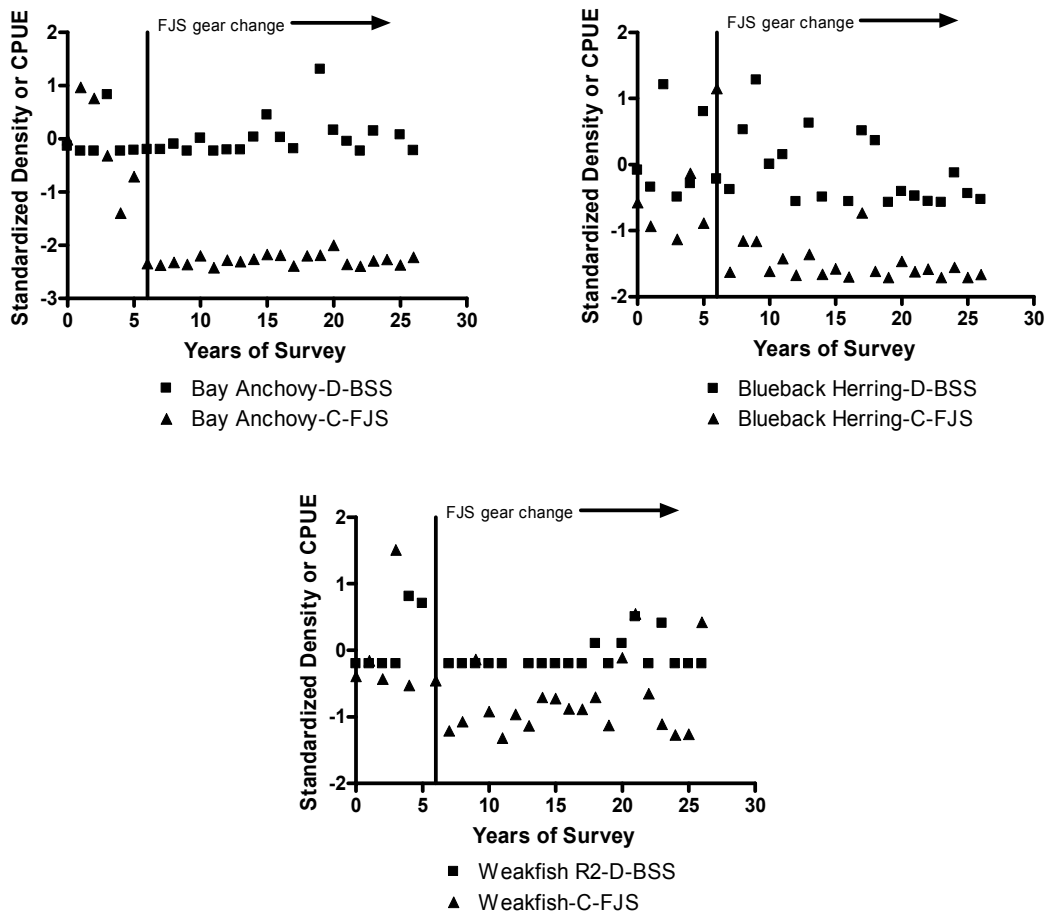
2 **Figure I-8 River Segment 4 population trends based on the FSS standardized CPUE (C)**
 3 **and BSS density (D) not considered biologically different**

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1 Note: All data were used in WOE analysis.

2 **Figure I-9 River Segment 4 population trends based on the FSS standardized CPUE (C)**
 3 **and BSS density (D) for which the FSS density is greater**



1 Note: Years were analyzed separately for WOE analysis; R2 = River Segment 2, Yonkers.

2 **Figure I-10 River Segment 4 population trends based on the FSS standardized CPUE (C)**
 3 **and BSS density (D) for which the FSS may indicate a gear difference**

4 The following tables were the intermediate analyses for the assessment of population trends
 5 associated with fish CPUE sampled from River Segment 4 (IP2 and IP3). Results of these river-
 6 segment trend analyses were compiled in Table H-13 in Section H.3 of the draft SEIS (Entergy
 7 2007). The data used in this analysis, in order of appearance, were the standardized
 8 75th percentile of the weekly fish CPUE for a given year collected from the FSS (Table I-13,
 9 Table I-14, and Figure I-11) and LRS for Atlantic tomcod only (Table I-15 and Table I-16).

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Table I-13 Competing Models Used To Characterize the Standardized River Segment 4, FSS Population Trends of YOY Fish CPUE

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife	0.92	-0.055 ± 0.023	0.022	0.79	-0.839 to -0.058	1984	-0.058 to 0.060
Bay Anchovy 1979–1984	0.80	-0.373 ± 0.191	0.123	Not Fit			
Bay Anchovy 1985–2005	1.00	0.034 ± 0.036	0.360	0.96	-0.022 to 0.248	1999	-0.596 to 0.172
American Shad	0.76	-0.085 ± 0.019	< 0.001	0.57	-0.717 to -0.159	1985	-0.067 to 0.018
Bluefish	0.84	-0.072 ± 0.021	0.002	0.82	-0.374 to -0.002	1988	-0.106 to 0.061
Hogchoker (All data)	1.00	-0.025 ± 0.025	0.332	0.92	-0.101 to 0.368	1988	-0.184 to 0.000
Hogchoker (2 outliers removed)	0.47	-0.021 ± 0.012	0.087	0.44	-0.049 to 0.211	1987	-0.097 to -0.008
Blueback Herring 1979–1984	1.11	-0.059 ± 0.266	0.835	Not Fit			
Blueback Herring 1985–2005	0.38	-0.022 ± 0.015	0.152	Did Not Converge			
Rainbow Smelt (All data)	0.89	-0.062 ± 0.022	0.009	0.45	-4.95 to -2.33	1980	-0.049 to 0.002
Striped Bass	1.01	-0.013 ± 0.025	0.599	1.00	-0.089 to 0.178	1993	-0.259 to 0.076
Atlantic Tomcod (All data)	0.95	-0.046 ± 0.024	0.063	0.99	-6.78 to 6.63	1980	-0.102 to 0.012
Atlantic Tomcod (1 outlier removed)	0.66	-0.028 ± 0.017	0.106	Did Not Converge			
White Perch (All data)	0.95	-0.047 ± 0.023	0.055	0.87	-3.97 to 1.12	1981	-0.071 to 0.029
White Perch (1 outlier removed)	0.72	-0.047 ± 0.024	0.038	0.51	-2.02 to -0.538	1981	-0.037 to 0.026
Weakfish 1979–1984	0.83	0.357 ± 0.199	0.148	Not Fit			
Weakfish 1985–2005 (All data)	1.00	0.035 ± 0.036	0.349	1.03	-4.66 e+007 to 4.66e+007	1986	-0.036 to 0.133
Weakfish 1985–2005 (3 values removed)	0.62	-0.003 ± 0.025	0.892	Did Not Converge			

Two extreme outliers (both values greater than 3 standard deviations from the mean) were removed from the FSS hogchoker CPUE regression analysis because of their influence on the regression (Tables I-13 and I-14). One extreme outlier (value greater than 3 standard deviations from the mean) was removed from the FSS Atlantic tomcod CPUE regression analysis, and one extreme outlier (value greater than 2 standard deviations from the mean) was

removed from the FSS white perch CPUE regression analysis. These extreme outliers had a great influence on the regression results. One value (not an extreme outlier) and two extreme outliers (both greater than 2 standard deviations from the mean) were removed from the FSS weakfish CPUE regression analysis because of the influence these data had on the regression results. The results of the regression models with the observations removed were more conservative and were used for the trend analysis.

Table I-14 River Segment 4 Assessment of the Level of Potential Negative Impact Based on the Standardized FSS CPUE

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Alewife	SR	$S1 < 0$ $S2 = 0$	89	Yes	4
Bay Anchovy 1979–1984	LR	$S = 0$	33	No	1
Bay Anchovy 1985–2005	SR	$S1 = 0$ $S2 = 0$	33		
American Shad	SR	$S1 < 0$ $S2 = 0$	74	Yes	4
Bluefish	SR	$S1 < 0$ $S2 = 0$	78	Yes	4
Hogchoker (All data)	SR	$S1 = 0$ $S2 = 0$	15	No	1
Hogchoker (2 outliers removed)	SR	$S1 = 0$ $S2 < 0$	15	No	2
Blueback Herring 1979–1984	LR	$S = 0$	17	Yes	2
Blueback Herring 1985–2005	LR	$S = 0$	71		
Rainbow Smelt (All data)	SR	$S1 < 0$ $S2 = 0$	78	Yes	4
Striped Bass	SR	$S1 = 0$ $S2 = 0$	26	No	1
Atlantic Tomcod (All data)	LR	$S = 0$	7	No	1
Atlantic Tomcod (1 outlier removed)	LR	$S = 0$	7	No	1
White Perch (All data)	SR	$S1 = 0$ $S2 = 0$	56	Yes	2
White Perch (1 outlier removed)	SR	$S1 < 0$ $S2 = 0$	56	Yes	4
Weakfish 1979–1984	LR	$S = 0$	33	No	1
Weakfish 1985–2005 (All data)	LR	$S = 0$	24		
Weakfish 1985–2005 (3 values removed)	LR	$S = 0$	24		

LR = Linear Regression; SR = Segmented Regression

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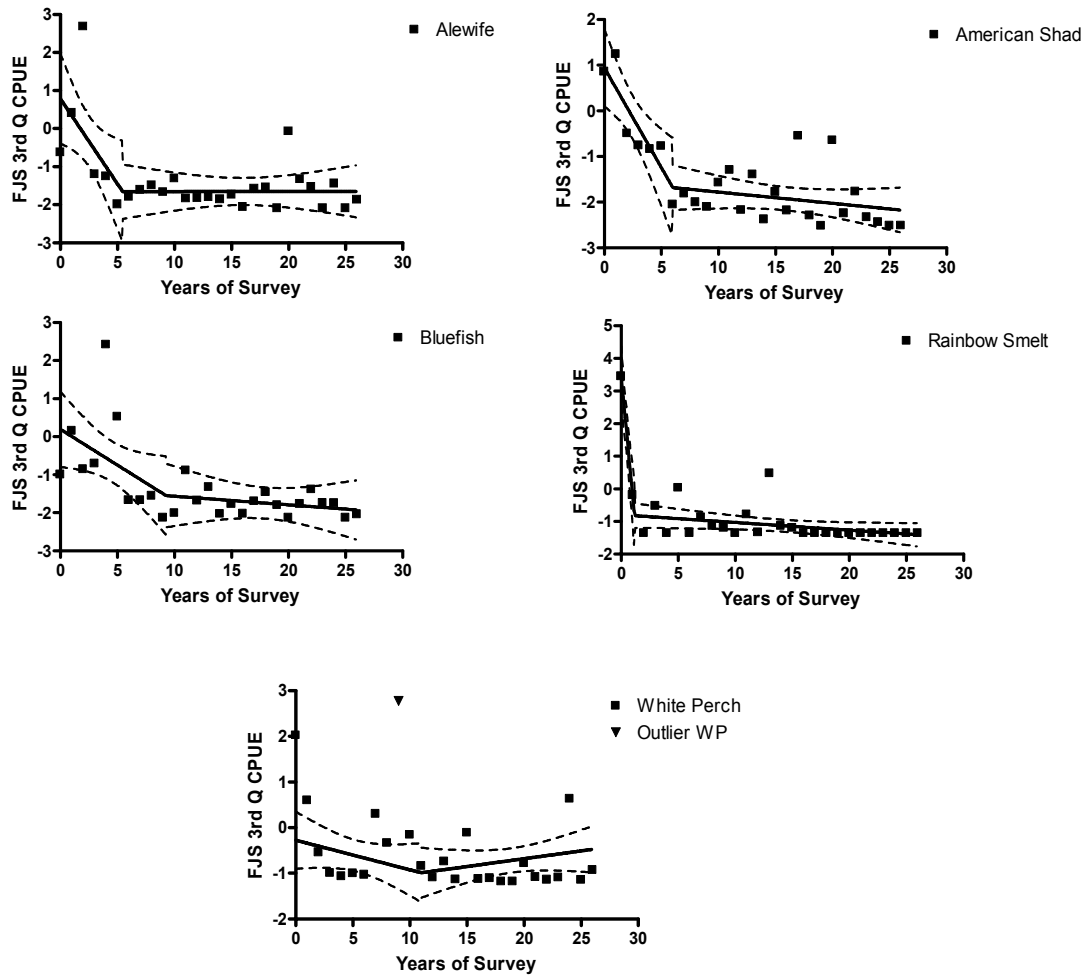


Figure I-11 River Segment 4 population trends based on the FSS standardized CPUE assigned a large level of potential negative impact

Table I-15 Competing Models Used To Characterize the Standardized River Segment 4 LRS Population Trends of YOY Atlantic Tomcod CPUE Using a 3-Year Moving Average

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Atlantic Tomcod	0.57	-0.069 ± 0.022	0.006	0.28	-0.873 to -0.338	1989	-0.031 to 0.034

Table I-16 River Segment 4 Assessment of the Level of Potential Negative Impact Based on the Standardized LRS Atlantic Tomcod YOY CPUE Using a 3-Year Moving Average

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Atlantic Tomcod	SR	S1 < 0 S2 = 0	22	No	2

SR = Segmented Regression

The results of the two measurement metrics—density (estimated number of RIS per given volume of water provided by the applicant) and CPUE (number of RIS captured by the sampler for a given volume of water derived by the NRC staff) were combined for the assessment of population impacts potentially associated with the IP2 and IP3 cooling systems. Table I-17 presents the numeric results compiled from Tables I-8, I-10, I-12, I-14, and I-16 above and used to derive Table H-13 in Section H.3 in the draft SEIS.

Table I-17 Assessment of Population Impacts for IP2 and IP3 River Segment 4

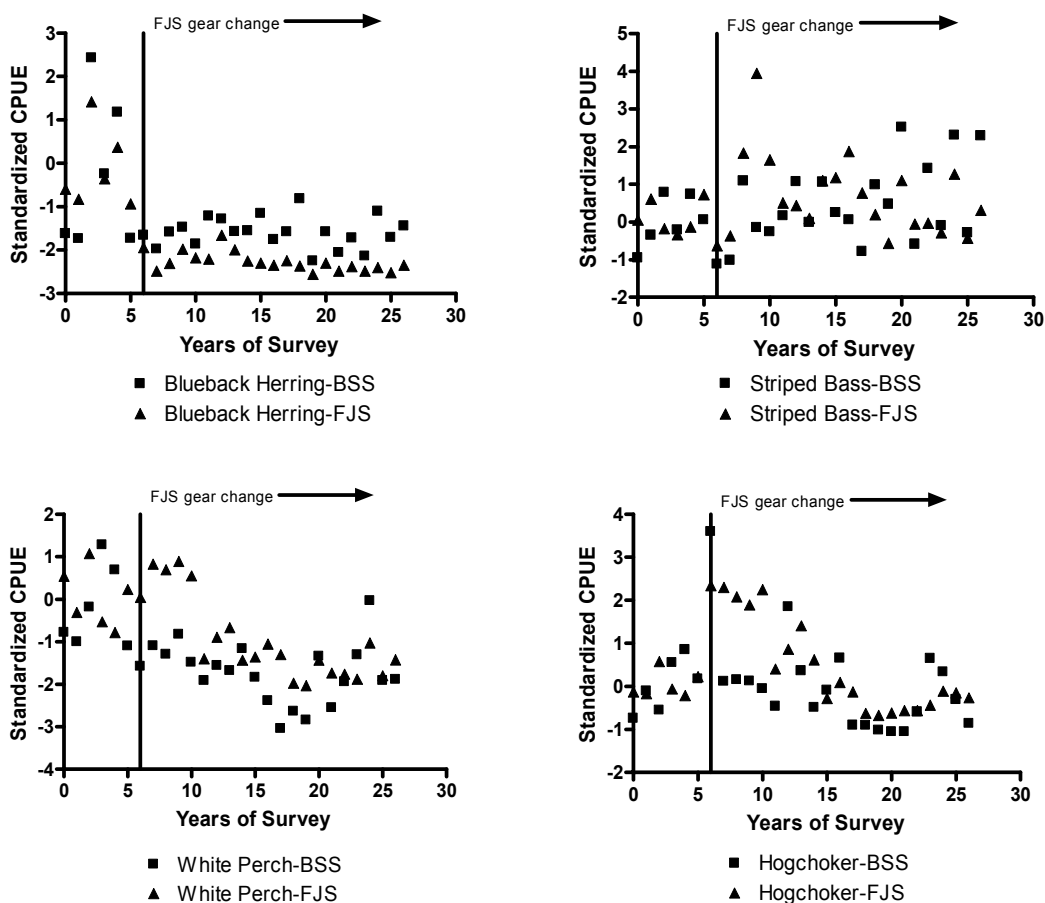
Species	Density			CPUE		River-Segment Assessment
	FSS	BSS	LRS	FSS	LRS	
Alewife	4	4	N/A ^a	4	N/A	4.0
Bay Anchovy	4	1	N/A	1	N/A	2.0
American Shad	4	4	N/A	4	N/A	4.0
Bluefish	1	4	N/A	4	N/A	3.0
Hogchoker	2	4	N/A	2	N/A	2.7
Atlantic Menhaden	N/A	N/A	N/A	N/A	N/A	Unknown
Blueback Herring	2	2	N/A	2	N/A	2.0
Rainbow Smelt	2	N/A	N/A	4	N/A	3.0
Shortnose Sturgeon	N/A	N/A	N/A	N/A	N/A	Unknown
Spottail Shiner	N/A	4	N/A	N/A	N/A	4.0
Atlantic Sturgeon	N/A	N/A	N/A	N/A	N/A	Unknown
Striped Bass	1	1	N/A	1	N/A	1.0
Atlantic Tomcod	2	N/A	2	1	2	1.8
White Catfish	1	N/A	N/A	N/A	N/A	1.0
White Perch	1	4	N/A	4	N/A	3.0
Weakfish	1	N/A	N/A	1	N/A	1.0
Gizzard Shad	N/A	N/A	N/A	N/A	N/A	Unknown
Blue Crab	N/A	N/A	N/A	N/A	N/A	Unknown

(a) N/A: not applicable; YOY not present in samples

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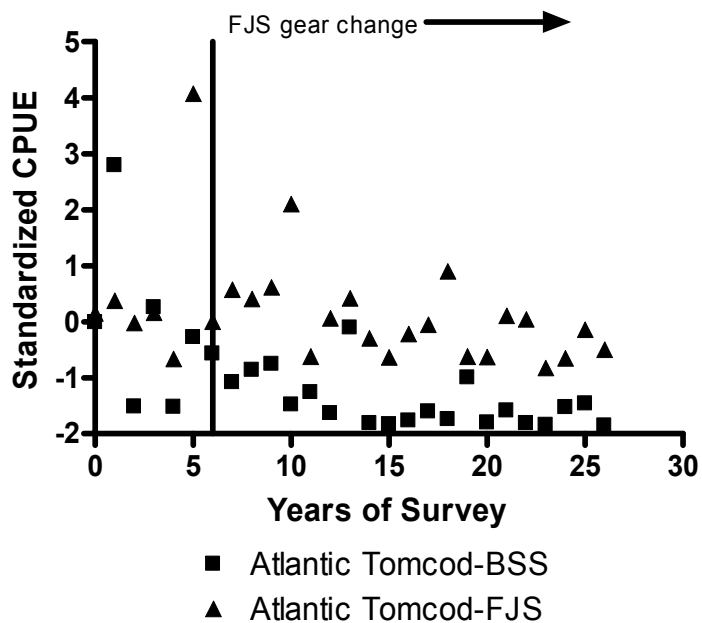
1 Lower Hudson River

2 A visual comparison of the riverwide FSS standardized CPUE with the BSS standardized CPUE
3 suggested that the trends were not biologically different for blueback herring, striped bass, white
4 perch, and hogchoker (Figure I-12). Observations from both surveys overlap and cross over
5 each other. The post-1985 FSS observations for Atlantic tomcod were greater than the BSS
6 observations and did not show a decline associated with the gear change (Figure I-13). For
7 these RIS, all of the FSS data (1979–2005) were used in the regression analysis. The FSS
8 density data for alewife, American shad, bay anchovy, and bluefish, however, did show a
9 potential gear effect (Figure I-14), and a pre- and post-1985 analysis was conducted.



10 Note: All data were used in WOE analysis.

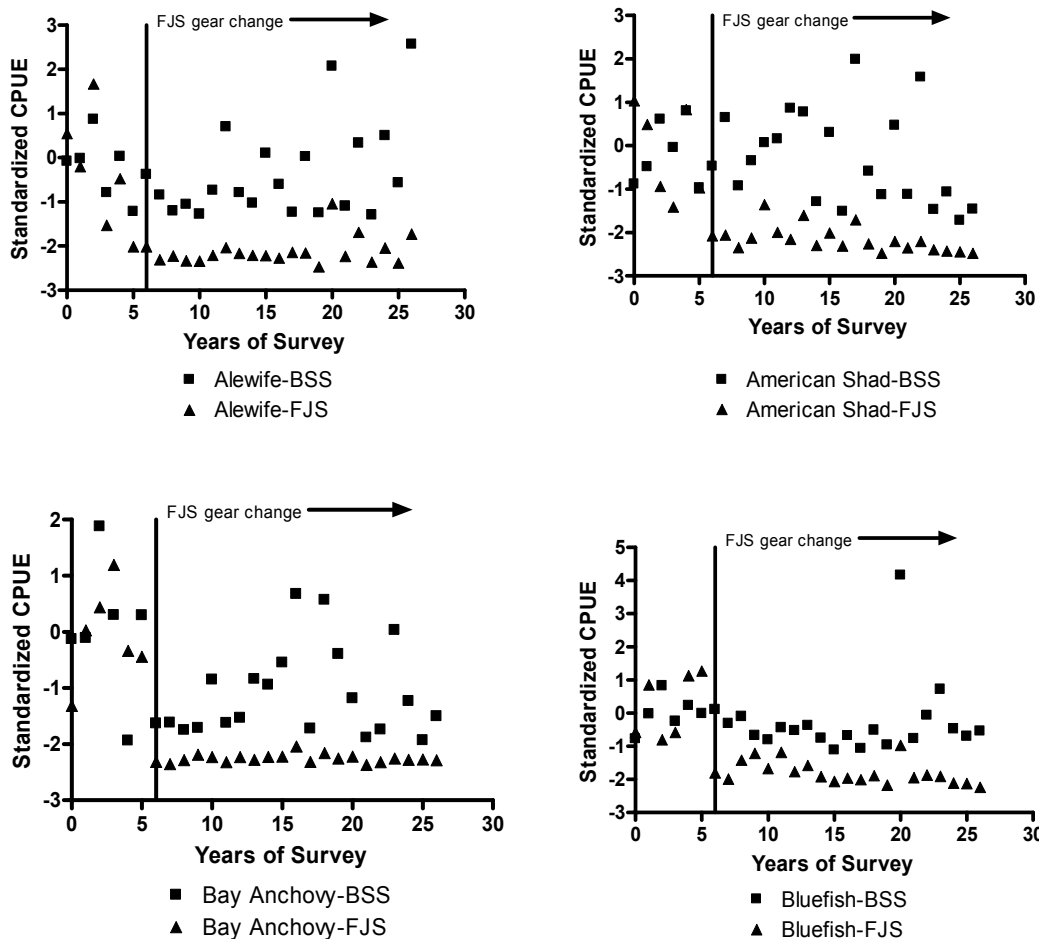
11 **Figure I-12 Riverwide population trends based on the FSS and BSS standardized CPUE**
12 **not considered biologically different**



1 Note: All data were used in WOE analysis.

2 **Figure I-13 Riverwide population trends based on the FSS and BSS standardized CPUE**
 3 **for which the FSS density is greater**

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1 Note: Years were analyzed separately for WOE analysis.

2 **Figure I-14 Riverwide population trends based on the FSS and BSS standardized CPUE**
 3 **for which the FSS may indicate a gear difference**

4 The following tables are the intermediate analyses for the riverwide assessment of population
 5 trends associated with annual fish CPUE and the abundance index. Results of these riverwide
 6 trend analyses are compiled in Table H-14 in Section H.3 of the draft SEIS. The data used in
 7 this analysis, in order of appearance, were the standardized annual fish CPUE for a given year
 8 collected from the FSS (Table I-18, Table I-19, and Figure I-15), BSS (Table I-20, Table I-21,
 9 and Figure I-16), LRS for Atlantic tomcod only (Table I-22 and Table I-23), and the annual fish
 10 abundance index (Table I-24, Table I-25, and Figure H-17).

11 One extreme outlier (value greater than 4 standard deviations away from the mean) was
 12 removed from the abundance index for the bluefish regression analysis (Tables I-24 and I-25).

One extreme outlier was also removed from the abundance index for both the rainbow smelt (value greater than 5 standard deviations away from the mean) regression analysis and the white catfish (value greater than 2 standard deviations away from the mean) regression analysis, because of the influence these data had on the regression results. The results of the regression models with the observations removed were more conservative and were used for the trend analysis.

Table I-18 Competing Models Used To Characterize the Standardized Riverwide FSS Population Trends of YOY Fish CPUE

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife 1979–1984	0.833	-0.357 ± 0.199	0.148	Not Fit			
Alewife 1985–2005	0.628	0.025 ± 0.023	0.286	0.633	-1.90e+007 to 1.90e+007	1986	-0.015 to 0.090
Bay Anchovy 1979–1984	1.08	0.135 ± 0.259	0.629	Not Fit			
Bay Anchovy 1985–2005	0.764	-0.002 ± 0.028	0.949	0.749	-0.082 to 0.328	1993	-0.216 to 0.073
American Shad 1979–1984	0.983	-0.254 ± 0.235	0.340	Not Fit			
American Shad 1985–2005	0.873	-0.085 ± 0.031	0.015	0.831	-0.362 to 0.746	1989	-0.222 to -0.031
Bluefish 1979–1984	0.918	0.305 ± 0.219	0.236	Not Fit			
Bluefish 1985–2005	0.915	-0.073 ± 0.033	0.039	0.899	-0.778 to 1.90	1987	-0.193 to -0.021
Hogchoker	0.916	-0.055 ± 0.023	0.022	0.645	0.114 to 0.526	1986	-0.198 to -0.086
Blueback Herring	0.704	-0.091 ± 0.017	< 0.001	0.563	-0.454 to -0.153	1987	-0.079 to 0.027
Spottail Shiner (All data)	0.875	-0.035 ± 0.022	0.125	0.859	-0.295 to 0.675	1984	-0.132 to 0.003
Striped Bass	1.019	-0.003 ± 0.025	0.902	0.931	-0.085 to 0.389	1988	-0.162 to 0.025
Atlantic Tomcod	0.607	-0.028 ± 0.015	0.083	0.595	-0.089 to 0.183	1989	-0.124 to -0.002
White Perch	0.647	-0.097 ± 0.016	< 0.001	Did Not Converge			

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Table I-19 Riverwide Assessment of the Level of Potential Negative Impact Based on the Standardized FSS CPUE

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Final Decision
Alewife 1979–1984	LR	S = 0	50	Yes	2
Alewife 1985–2005	LR	S = 0	14		
Bay Anchovy 1979–1984	LR	S = 0	33	No	1
Bay Anchovy 1985–2005	SR	S1 = 0 S2 = 0	24		
American Shad 1979–1984	LR	S = 0	50	Yes	4
American Shad 1985–2005	SR	S1 = 0 S2 < 0	52		
Bluefish 1979–1984	LR	S = 0	33	Yes	4
Bluefish 1985–2005	SR	S1 = 0 S2 < 0	48		
Hogchoker	SR	S1 > 0 S2 < 0	22	No	2
Blueback Herring	SR	S1 < 0 S2 = 0	81	Yes	4
Spottail Shiner	SR	S1 = 0 S2 = 0	26	No	1
Striped Bass	SR	S1 = 0 S2 = 0	30	No	1
Atlantic Tomcod	SR	S1 = 0 S2 < 0	7	No	2
White Perch	LR	S < 0	56	Yes	4

LR = Linear Regression; SR = Segmented Regression

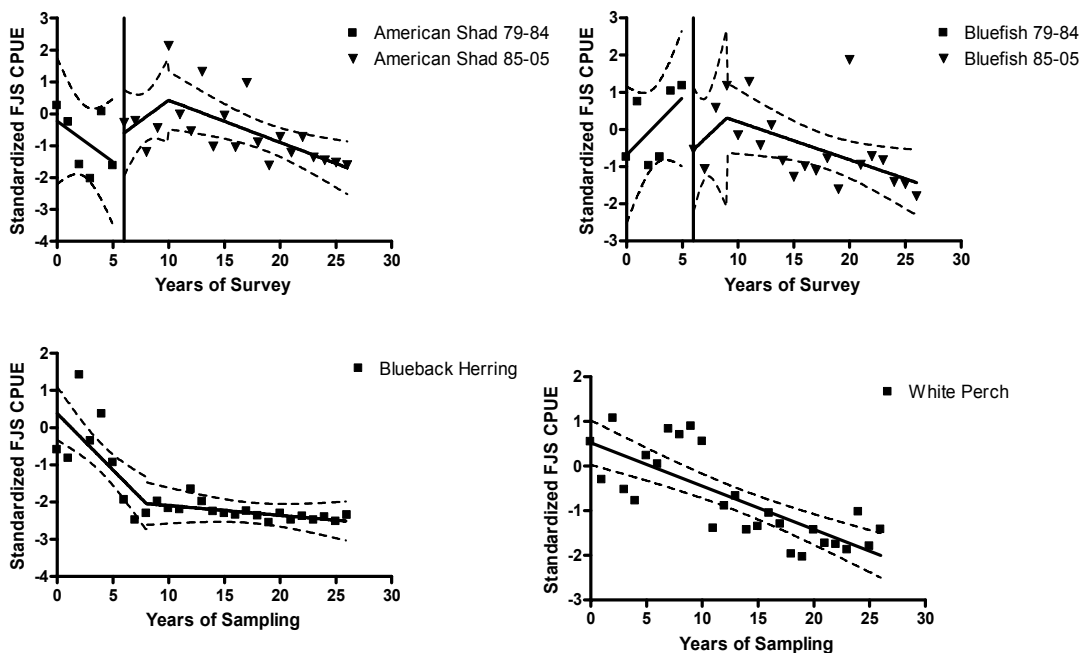


Figure I-15 Riverwide population trend based on the FSS standardized CPUE assigned a large level of potential negative impact

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Table I-20 Competing Models Used To Characterize the Standardized Riverwide BSS Population Trends of YOY Fish CPUE

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife	0.996	0.027 ± 0.025	0.281	0.944	-0.417 to 0.087	1987	-0.001 to 0.177
Bay Anchovy	0.971	-0.038 ± 0.024	0.123	0.927	-0.631 to 0.094	1986	-0.063 to 0.085
American Shad	0.991	-0.030 ± 0.025	0.235	0.981	-0.103 to 0.198	1992	-0.240 to 0.029
Bluefish	0.478	-0.019 ± 0.012	0.121	0.439	-0.103 to -0.013	1995	-0.038 to 0.165
Hogchoker	0.969	-0.039 ± 0.024	0.113	0.913	-0.212 to 0.983	1983	-0.141 to -0.014
Blueback Herring	0.937	-0.050 ± 0.023	0.042	0.940	-0.429 to 0.091	1987	-0.101 to 0.075
Spottail Shiner	0.965	0.041 ± 0.024	0.101	0.928	-0.448 to 0.145	1987	0.012 to 0.172
Striped Bass	0.908	0.057 ± 0.022	0.017	0.941	-0.347 to 0.373	1986	-0.010 to 0.147
Atlantic Tomcod	0.802	-0.078 ± 0.020	0.001	0.787	-0.232 to -0.038	1993	-0.135 to 0.137
White Perch	0.859	-0.068 ± 0.021	0.004	0.737	-0.208 to -0.070	1997	-0.036 to 0.358
Rainbow Smelt	0.875	-0.065 ± 0.022	0.006	0.327	-1.54 to -0.939	1982	-0.022 to 0.021
White Catfish	0.642	-0.098 ± 0.016	< 0.001	0.668	-2.02 to 1.89	1980	-0.138 to -0.061
Weakfish	1.01	-0.021 ± 0.025	0.407	0.996	-0.514 to 1.33	1982	-0.111 to 0.018

**Table I-21 Riverwide Assessment of the Level of Potential Negative Impact
Based on the BSS CPUE**

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Final Decision
Alewife	SR	S1 = 0 S2 = 0	41	Yes	2
Bay Anchovy	SR	S1 = 0 S2 = 0	56	Yes	2
American Shad	SR	S1 = 0 S2 = 0	37	No	1
Bluefish	SR	S1 < 0 S2 = 0	11	No	2
Hogchoker	SR	S1 = 0 S2 < 0	19	No	2
Blueback Herring	LR	S < 0	93	Yes	4
Spottail Shiner	SR	S1 = 0 S2 > 0	26	No	1
Striped Bass	LR	S > 0	33	No	1
Atlantic Tomcod	SR	S1 < 0 S2 = 0	74	Yes	4
White Perch	SR	S1 < 0 S2 = 0	81	Yes	4
Rainbow Smelt	SR	S1 < 0 S2 = 0	96	Yes	4
White Catfish	LR	S < 0	67	Yes	4
Weakfish	SR	S1 = 0 S2 = 0	11	No	1

LR = Linear Regression; SR = Segmented Regression

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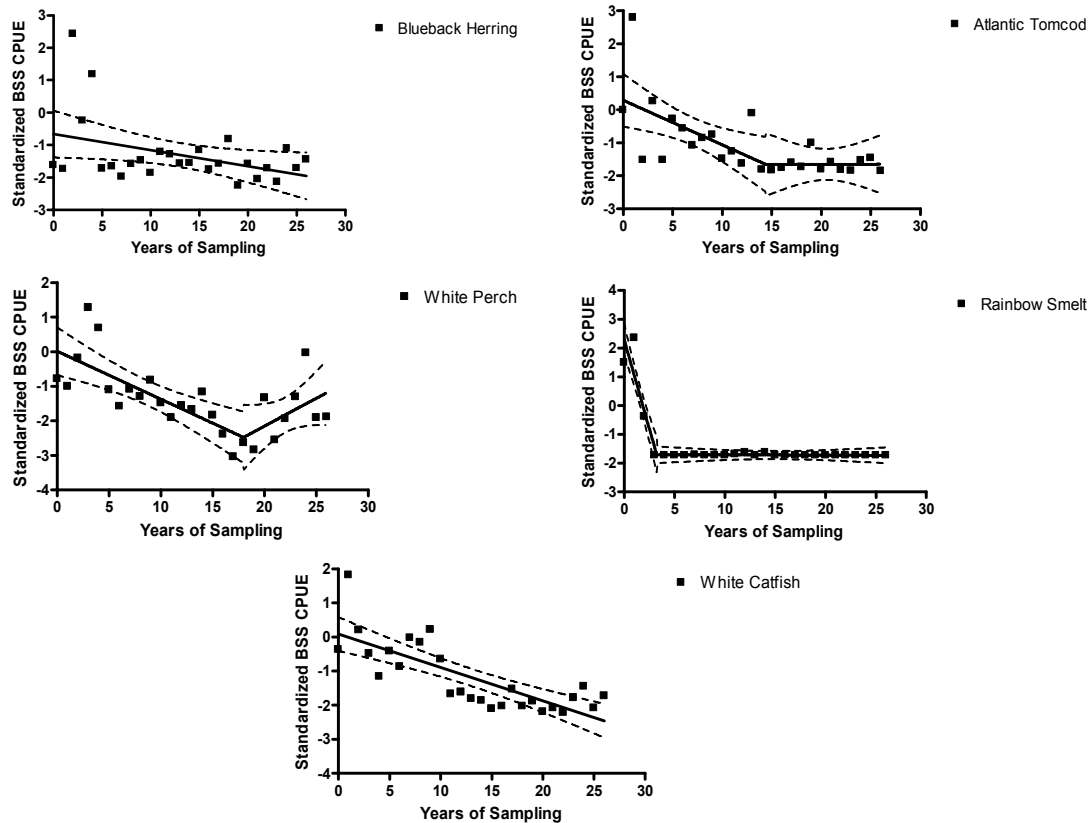


Figure I-16 Riverwide population trends based on the BSS standardized CPUE assigned a large level of potential negative impact

Table I-22 Competing Models Used To Characterize the Standardized Riverwide LRS Population Trend of YOY Atlantic Tomcod CPUE

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Atlantic Tomcod	1.02	-0.006 ± 0.025	0.826	0.96	-2.38 to 0.439	1980	-0.037 to 0.081

Table I-23 Riverwide Assessment of the Level of Potential Negative Impact Based on the Standardized LRS CPUE of Atlantic Tomcod

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise	Support for Possible Negative Impact	Final Decision
Atlantic Tomcod	SR	S1 = 0 S2 = 0	44	Yes	2

SR = Segmented Regression

Table I-24 Competing Models Used To Characterize the Standardized Riverwide YOY Abundance Index Trends

Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife	1.00	-0.024 ± 0.025	0.334	1.03	-0.200 to 0.075	1993	-0.149 to 0.195
Bay Anchovy	0.952	-0.045 ± 0.024	0.067	0.890	-0.137 to 0.317	1988	-0.192 to -0.014
American Shad	0.924	-0.053 ± 0.023	0.028	0.934	-0.163 to 0.221	1989	-0.199 to 0.010
Bluefish (All data)	1.00	0.023 ± 0.025	0.355	1.03	-0.274 to 0.195	1989	-0.053 to 0.158
Bluefish (1 outlier removed)	0.378	0.003 ± 0.009	0.775	0.359	-0.074 to 0.015	1994	-0.014 to 0.111
Hogchoker	0.992	-0.029 ± 0.025	0.244	0.964	-0.143 to 0.349	1988	-0.179 to 0.015
Blueback Herring	0.978	-0.036 ± 0.024	0.152	0.896	-0.077 to 0.380	1988	-0.200 to -0.020
Rainbow Smelt (All data)	1.02	-0.008 ± 0.025	0.759	Did Not Converge			
Rainbow Smelt (1 outlier removed)	0.269	-0.008 ± 0.007	0.253	0.265	-0.038 to 0.104	1987	-0.047 to 0.004
Spottail Shiner	0.972	0.038 ± 0.024	0.125	0.960	-0.164 to 0.100	1993	-0.025 to 0.270
Striped Bass	0.952	0.045 ± 0.024	0.067	0.970	-0.081 to 0.114	1996	-0.126 to 0.369
Atlantic Tomcod	0.969	-0.039 ± 0.024	0.112	0.852	-0.051 to 0.323	1989	-0.223 to -0.036
White Catfish (All data)	0.854	-0.069 ± 0.021	0.003	Did Not Converge			
White Catfish (1 outlier removed)	0.495	-0.062 ± 0.012	< 0.001	Did Not Converge			
White Perch	0.964	-0.041 ± 0.024	0.096	0.795	-0.286 to -0.068	1993	-0.007 to 0.237
Weakfish	0.900	-0.059 ± 0.022	0.013	0.854	-0.329 to 0.689	1984	-0.153 to -0.028

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Table I-25 Riverwide Assessment of the Level of Potential Negative Impact Based on the Abundance Index

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Final Decision
Alewife	LR	S = 0	33	No	1
Bay Anchovy	SR	S1 = 0 S2 < 0	30	No	2
American Shad	LR	S < 0	52	Yes	4
Bluefish (All data)	LR	S = 0	7	No	1
Bluefish (1 outlier removed)	SR	S1 = 0 S2 = 0	7	No	1
Hogchoker	SR	S1 = 0 S2 = 0	15	No	1
Blueback Herring	SR	S1 = 0 S2 < 0	19	No	2
Rainbow Smelt (All data)	LR	S = 0	4	No	1
Rainbow Smelt (1 outlier removed)	SR	S1 = 0 S2 = 0	4	No	1
Spottail Shiner	SR	S1 = 0 S2 = 0	26	No	1
Striped Bass	LR	S = 0	30	No	1
Atlantic Tomcod	SR	S1 = 0 S2 < 0	19	No	2
White Catfish (All data)	LR	S < 0	63	Yes	4
White Catfish (1 outlier removed)	LR	S < 0	63	Yes	4
White Perch	SR	S1 < 0 S2 = 0	70	Yes	4
Weakfish	SR	S1 = 0 S2 < 0	15	No	2

LR = Linear Regression; SR = Segmented Regression

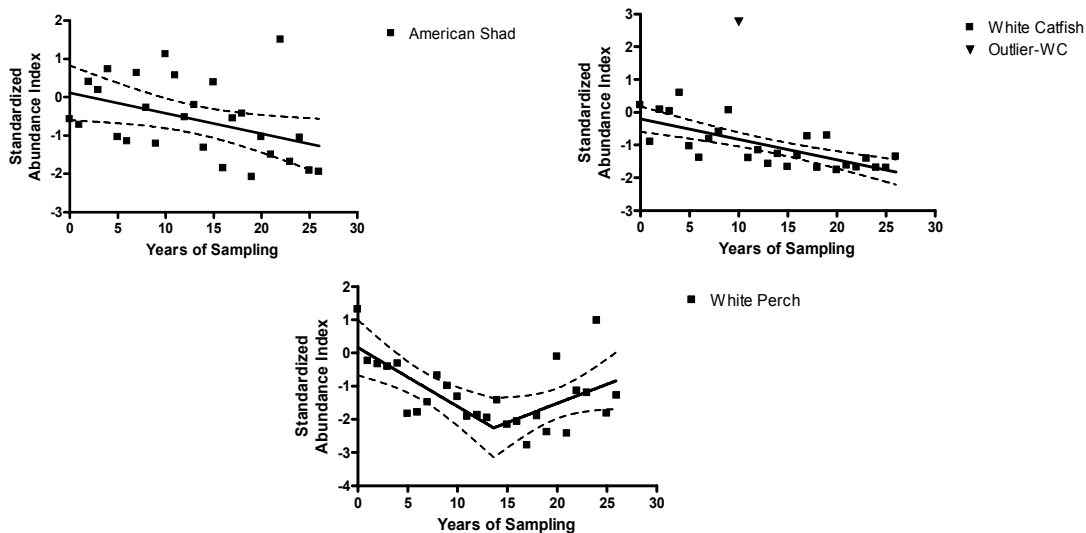


Figure I-17 Riverwide population trends based on the abundance index assigned a large level of potential negative impact

The results of the two measurement metrics—CPUE (number of RIS captured by the sampler for a given volume of water derived by the NRC staff) and the abundance index provided by the applicant—were combined for the assessment of riverwide population impacts. Table I-26 presents the numeric results compiled from Tables I-19, I-21, I-23, and I-25 above and used to derive Table H-14 in Section H.3 in the draft SEIS.

1

Table I-26 Assessment of Riverwide Population Impacts

Species	CPUE			Abundance Index	Riverwide Assessment
	FSS	BSS	LRS		
Alewife	2	2	N/A ^a	1	1.7
Bay Anchovy	1	2	N/A	2	1.7
American Shad	4	1	N/A	4	3.0
Bluefish	4	2	N/A	1	2.3
Hogchoker	2	2	N/A	1	1.7
Atlantic Menhaden	N/A	N/A	N/A	N/A	Unknown
Blueback Herring	4	4	N/A	2	3.3
Rainbow Smelt	N/A	4	N/A	1	2.5
Shortnose Sturgeon	N/A	N/A	N/A	N/A	Unknown
Spottail Shiner	1	1	N/A	1	1.0
Atlantic Sturgeon	N/A	N/A	N/A	N/A	Unknown
Striped Bass	1	1	N/A	1	1.0
Atlantic Tomcod	2	4	2	2	2.5
White Catfish	N/A	4	N/A	4	4.0
White Perch	4	4	N/A	4	4.0
Weakfish	N/A	1	N/A	2	1.5
Gizzard Shad	N/A	N/A	N/A	N/A	Unknown
Blue Crab	N/A	N/A	N/A	N/A	Unknown

2 I.2.2. Analysis of Strength of Connection

3 To determine whether the operation of the IP2 and IP3 cooling systems has the potential to
 4 influence RIS populations near the facilities or within the lower Hudson River, the NRC staff
 5 conducted a strength-of-connection analysis. Measurements used for this analysis include
 6 monitoring data at IP2 and IP3 from 1975–1990 that provide information on impingement and
 7 entrainment rates for RIS and prey of RIS, as well as River Segment 4 (IP2 and IP3) population-
 8 density data from the FSS and BSS.

9 The analysis of effects of impingement was based on the concordance of ranked proportions of
 10 the number of YOY and yearling fish of each species impinged in relation to the sum of all fish
 11 impinged and the ranked proportions of each species abundance in the river near IP2 and IP3
 12 relative to the total abundance of the 18 RIS. Likewise, the effects of entrainment were based
 13 on the concordance of ranked proportions of the estimated number entrained for all life stages
 14 for a given species in relation to the abundance of all fish entrained and the ranked proportion of
 15 each species abundance in the river near IP2 and IP3 relative to the total abundance of the RIS.

16 An estimate of the population abundance (S_i) for a given species in the vicinity of IP2 and IP3
 17 was estimated as the maximum over all years (1979–1990) of the annual 75th percentile of
 18 weekly density measures from all habitats. Thus, S_i for each species was the maximum annual
 19 sum of the FSS and BSS 75th percentile of weekly densities from the river segment near IP2

and IP3 (Table I-27). The estimate of the total RIS community abundance (S_{RIS}) caught in the vicinity of IP2 and IP3 was the sum of the maximum densities of each species.

The density of each species impinged (Imp_i) was estimated by the 75th percentile of the annual (1975–1990) density impinged at IP2. IP2 typically had 2.8 times more fish impinged than IP3. The annual density impinged was the sum of the seasonal (January–March, April–June, July–September, October–December) densities calculated as the estimated number impinged divided by the number of samples taken (Table I-28). The estimate of the total density of RIS impinged (Imp_{RIS}) was the 75th percentile of the annual sum of all RIS densities impinged at IP2.

The estimate of $\frac{Imp_i}{Imp_{RIS}}$ was the ratio of the density of an individual species impinged to the total RIS density.

The density of each species entrained for a given season and year (1981–1987) was calculated as the mean number entrained divided by the number of samples taken (Table I-29). Density estimates were based on the combined entrainment from IP2 and IP3. The estimate of $\frac{E_i}{E_{RIS}}$ was the maximum over years of the ratio of the density of an individual species entrained to the total RIS density.

Because of the error and bias in estimation of each of these parameters, only the ranks of each ratio were considered a reliable measure of connection. Thus, to estimate the overall strengths of connection between the IP2 and IP3 cooling systems and the RIS in the Hudson River near the facilities, the estimates of $\frac{Imp_i}{Imp_{RIS}}$, $\frac{E_i}{E_{RIS}}$, and $\frac{S_i}{S_{RIS}}$ for each species were ranked from

1 (low proportion) to 18 (high proportion), and then the ratio of the ranks were compared as a measure of the strength of connection for impingement (Table I-30) and entrainment (Table I-31).

Potential food web impacts on RIS associated with the loss of prey caused by impingement or entrainment, based on the relationship presented in the conceptual model (Section 4.1.3 in the main text), were also considered. Indirect impacts on predator fish (bluefish, spottail shiner, striped bass, white perch, and weakfish) were based on the largest observed strength of connection associated with their prey. Thus, for YOY bluefish, which preys on juvenile bay anchovy and Atlantic tomcod, a loss of prey associated with impingement was estimated as 1.33 (the maximum of 0.88 for anchovy and 1.33 for tomcod) (Table I-31). The remaining YOY predator-prey relationships were YOY spottail shiner prey on YOY striped bass; YOY striped bass prey on YOY bay anchovy, hogchoker, Atlantic tomcod, and weakfish; YOY white perch prey on YOY bay anchovy; and YOY weakfish prey on YOY bay anchovy. All remaining YOY RIS eat plankton, zooplankton, benthic invertebrates, and amphipods. These prey were assumed to be unaffected by the cooling systems, and a low strength of connection was concluded. The results of this analysis are presented in Table H-16 in Section H.3 of the draft SEIS and in Table I-32.

Appendix I

1 **Table I-27 Sum of the FSS and BSS 75th Percentiles of the Weekly Density Caught at**
2 **River Segment 4**

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Maximum = Si
Alewife	1.01	0.55	6.94	2.86	2.36	0.21	1.31	1.28	0.36	0.93	1.42	0.87	6.94
Bay Anchovy	96.33	198.05	342.15	391.41	82.03	194.88	106.25	77.11	73.54	153.21	303.60	48.77	391.41
American Shad	5.49	4.90	19.04	8.42	7.77	7.00	6.59	13.68	5.33	4.62	23.27	5.33	23.27
Bluefish	0.52	1.23	1.03	1.06	1.66	1.30	1.41	0.52	0.63	0.20	0.30	1.64	1.66
Hogchoker	0.56	1.31	1.69	1.20	0.16	0.53	0.83	1.94	3.09	4.27	0.44	1.14	4.27
Atlantic Menhaden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback Herring	10.39	3.31	38.43	3.56	8.94	24.15	24.46	5.25	17.82	29.09	8.52	10.71	38.43
Rainbow Smelt	3.12	0.63	0.00	0.12	0.00	0.65	0.00	0.97	0.58	0.39	0.00	1.36	3.12
Shortnose Sturgeon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spottail Shiner	3.20	0.20	0.60	5.80	1.19	0.25	0.20	0.75	0.20	0.73	1.80	3.10	5.80
Atlantic Sturgeon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stripped Bass	4.28	4.60	15.24	15.15	12.47	12.17	3.09	6.83	13.42	12.64	9.15	12.58	15.24
Atlantic Tomcod	2.34	1.12	4.09	3.85	0.67	11.94	1.65	5.68	2.20	2.76	2.04	1.60	11.94
White Catfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03
White Perch	16.51	14.90	18.74	15.69	7.36	8.19	10.82	22.56	13.16	10.83	2.94	4.38	22.56
Weakfish	0.90	1.72	2.21	9.21	1.36	11.11	1.76	0.76	0.45	3.17	1.42	1.00	11.11
Gizzard Shad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table I-28 Annual Density of RIS Impinged at IP2

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Alewife	97.1	23.4	231.5	305.9	40.6	79.2	2300.1	269.4	750.0	148.3	181.1	224.8	441.7	169.7	92.5	221.6
Bay Anchovy	2394.4	304.6	1838.3	2871.8	2308.8	2677.7	47136.1	11429.7	11474.6	242.9	441.8	9285.6	2740.3	2343.0	166.1	1363.5
American Shad	26.2	38.5	52.4	421.7	129.2	331.7	8859.3	191.9	909.3	15.1	36.9	629.5	440.2	122.7	202.8	165.5
Bluefish	37.1	0.8	185.5	32.5	3.0	85.6	399.2	638.2	2599.2	7.9	47.3	762.0	1883.8	501.8	114.4	1031.6
Hogchoker	441.7	149.2	216.0	564.3	469.7	372.4	513.3	6088.4	2200.4	345.2	388.1	4253.9	3835.6	6687.7	4051.7	3071.9
Atlantic Menhaden	1.2	1.6	3.4	4.0	0.6	2.0	244.4	34.2	77.5	4.4	37.3	769.7	352.4	144.0	144.4	166.3
Blueback Herring	2902.9	4213.6	4930.9	5214.0	2157.9	290.2	5193.5	191.3	4361.3	176.9	157.8	395.3	3129.3	689.2	505.1	2424.5
Rainbow Smelt	111.9	59.8	290.7	519.7	390.2	180.4	25.2	274.0	413.3	48.9	82.5	1189.4	832.4	1868.3	50.2	140.7
Shorthead Sturgeon	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.0	5.0	0.0	0.0	0.0
Spottail Shiner	45.4	93.4	67.4	31.2	79.4	45.4	35.6	30.2	93.9	60.3	33.7	23.7	128.4	89.6	218.4	290.6
Atlantic Striped Bass	2.2	0.2	1.2	0.4	1.0	0.2	3.5	21.7	2.5	9.4	5.3	44.0	0.0	0.0	0.0	0.0
Atlantic Tomcod	111.3	110.7	268.3	469.5	828.5	252.5	1439.9	341.7	1048.5	304.3	457.2	827.8	2116.3	3226.0	1021.1	1766.7
White Catfish	175.9	202.1	148.4	41.0	39.0	14.7	36.1	101.1	139.1	118.2	73.0	159.7	171.8	580.7	255.8	488.7
White Perch	4598.9	6594.8	14043.3	6720.4	25784.8	10473.8	25537.3	25264.5	12479.6	13704.1	6513.9	13729.8	31258.0	33257.3	19242.0	54654.3
Weakfish	225.6	16.5	135.5	369.4	194.0	352.8	2325.6	3487.6	19315.7	47.9	175.4	769.6	290.9	2388.5	997.6	297.9
Gizzard Shad	15.0	30.5	33.1	11.1	12.7	1.2	19.1	25.7	86.8	126.0	34.2	131.9	71.6	206.2	355.9	427.5
RIS Total	12995	12497	33846	22497	33734	20618	101762	62597	69564	15672	10389	47122	209824	53689	27818	80733

Table I-29 Annual Density of RIS Entrained at IP2 and IP3 Combined

Year	1981	1981	1983	1983	1983	1984	1984	1985	1985	1986	1986	1986	1987	1987
Season	Apr-June	July-Sep	Apr-June	July-Sep	July-Sep	Apr-June	July-Sep	Apr-June	July-Sep	Jan-Mar	Apr-June	July-Sep	Apr-June	July-Sep
Herring Family	5.27E+08	3.80E+06	4.01E+09	1.02E+07	2.67E+09	2.03E+05	6.70E+06	--	--	--	7.78E+08	1.02E+05	1.25E+07	--
Blueback Herring	--	1.40E+07	3.58E+05	2.99E+07	2.49E+05	8.25E+05	--	--	6.22E+05	--	4.95E+04	9.93E+04	--	--
Alewife	--	--	--	5.46E+06	1.08E+05	--	--	--	--	--	6.61E+05	--	4.40E+04	--
American Shad	2.68E+07	4.47E+06	9.50E+06	2.36E+05	4.26E+08	2.18E+05	4.87E+05	--	--	--	2.12E+06	--	6.53E+04	9.60E+04
Alosa Species	1.78E+09	1.55E+07	2.99E+09	2.06E+06	4.01E+09	6.57E+05	1.54E+07	--	--	2.14E+06	9.90E+05	--	2.19E+04	--
Atlantic Menhaden	--	--	--	--	--	--	2.48E+06	--	--	--	7.99E+06	--	--	--
Anchovy Family	7.47E+08	7.50E+09	1.95E+06	9.73E+09	1.24E+08	2.11E+09	--	--	--	--	--	--	--	--
Bay Anchovy	1.12E+10	8.30E+10	6.51E+06	1.20E+10	1.79E+09	2.15E+10	1.79E+09	1.37E+10	--	--	1.01E+08	3.81E+09	4.80E+08	5.20E+09
Rainbow Smelt	--	--	2.88E+04	--	1.98E+07	3.59E+06	7.58E+05	1.54E+05	3.49E+08	--	5.06E+07	7.77E+06	8.59E+06	3.25E+06
Spottail Shiner	--	--	--	5.00E+05	--	2.18E+05	--	--	--	--	--	--	--	--
White Catfish	--	--	--	--	--	1.96E+05	--	--	--	5.33E+05	2.37E+04	--	--	--
Atlantic Tomcod	2.15E+08	--	5.18E+06	9.13E+05	1.32E+08	1.34E+07	1.66E+08	5.48E+05	1.84E+08	--	4.48E+07	--	1.48E+07	1.18E+06
White Perch	3.72E+09	7.31E+07	1.43E+09	1.33E+08	6.60E+08	1.10E+08	1.42E+08	9.95E+06	1.27E+07	--	6.77E+08	1.42E+07	8.81E+07	1.80E+07
Striped Bass	5.92E+09	1.22E+07	8.00E+08	1.82E+08	1.04E+09	7.58E+08	2.65E+08	7.15E+05	--	--	7.64E+08	7.54E+06	3.88E+08	1.67E+07
Morone Species	--	--	6.53E+08	4.27E+07	1.33E+08	3.31E+07	6.71E+07	3.29E+05	--	--	7.34E+07	1.02E+06	2.96E+07	9.27E+05
Perch Family	--	--	4.28E+07	--	1.29E+07	--	4.36E+04	--	--	--	5.34E+05	4.96E+04	4.20E+04	--
Bluefish	--	--	--	--	--	2.15E+05	--	1.07E+06	--	--	--	--	--	--
Weakfish	--	2.62E+08	--	2.64E+08	--	5.53E+08	1.96E+06	1.03E+08	--	--	--	1.44E+07	1.52E+05	2.35E+06
Hogchoker	3.32E+06	2.70E+08	5.84E+05	1.37E+08	2.82E+06	4.81E+07	3.45E+04	3.90E+07	--	--	2.35E+04	1.33E+07	1.30E+05	4.61E+06
Total RIS	2.42E+10	9.11E+10	9.95E+09	2.26E+10	1.10E+10	2.51E+10	2.46E+09	1.39E+10	5.48E+08	--	2.50E+09	3.86E+09	1.02E+09	5.25E+09

-- = Not identified in sample

Table I-30 Assessment of Impingement

Species	75th Percentile of Impingement	$\text{Imp}_i / \text{Imp}_{\text{RIS}}$	Rank of Impingement Ratio	Max Density Caught in River	S_i / S_{RIS} (percent)	Rank of Fish Density in River Segment 4	Rank of Impingement : Rank of Fish Density
Alewife	279	0.43 percent	7	6.94	1.30	10	0.70
Bay Anchovy	4475	6.96 percent	15	391.41	73.05	17	0.88
American Shad	426	0.66 percent	8	23.27	4.34	15	0.53
Bluefish	669	1.04 percent	10	1.66	0.31	6	1.67
Hogchoker	3890	6.05 percent	13	4.27	0.80	8	1.63
Atlantic Menhaden	150	0.23 percent	5	0.00	0.00	1	Not Calculable
Blueback Herring	4251	6.61 percent	14	38.43	7.17	16	0.88
Rainbow Smelt	440	0.68 percent	9	3.12	0.58	7	1.29
Shortnose Sturgeon	0	0.00 percent	1	0.00	0.00	1	Not Calculable
Spottail Shiner	94	0.15 percent	3	5.80	1.08	9	0.33
Atlantic Sturgeon	4	0.01 percent	2	0.00	0.00	1	Not Calculable
Striped Bass	1146	1.78 percent	11	15.24	2.84	13	0.85
Atlantic Tomcod	13690	21.28 percent	16	11.94	2.23	12	1.33
White Catfish	182	0.28 percent	6	0.03	0.01	5	1.20
White Perch	25599	39.79 percent	17	22.56	4.21	14	1.21
Weakfish	1330	2.07 percent	12	11.11	2.07	11	1.09
Gizzard Shad	127	0.20 percent	4	0.00	0.00	1	Not Calculable
Total RIS	64339			535.77			

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1

Table I-31 Assessment of Entrainment

Species	E_i / E_{RIS}	Rank of Entrainment Proportion	S_i / S_{RIS} (percent)	Rank of Fish Density in River Segment 4	Rank of Entrainment: Rank of Fish Density
Alewife	40.28 percent	13	1.30	10	1.3
Bay Anchovy	99.10 percent	17	73.05	17	1.0
American Shad	40.28 percent	13	4.34	15	0.9
Bluefish	0.01 percent	5	0.31	6	0.8
Hogchoker	0.61 percent	8	0.80	8	1.0
Atlantic Menhaden	0.32 percent	7	0.00	1	Not Calculable
Blueback Herring	40.28 percent	13	7.17	16	0.8
Rainbow Smelt	63.72 percent	16	0.58	7	2.3
Shortnose Sturgeon	0.00 percent	1	0.00	1	Not Calculable
Spottail Shiner	0.00 percent	4	1.08	9	0.4
Atlantic Sturgeon	0.00 percent	1	0.00	1	Not Calculable
Striped Bass	37.94 percent	11	2.84	13	0.8
Atlantic Tomcod	33.47 percent	10	2.23	12	0.8
White Catfish	0.10 percent	6	0.01	5	1.2
White Perch	37.94 percent	11	4.21	14	0.8
Weakfish	2.20 percent	9	2.07	11	0.8
Gizzard Shad	0.00 percent	1	0.00	1	Not Calculable

Table I-32 Weight of Evidence for the Strength-of-Connection Line of Evidence Based on the Result Scores of Low = 1, Medium = 2, and High = 3

Measurement	Impingement Result Score		Entrainment Result Score		WOE Score ^b	Strength of Connection
	RIS	Prey	RIS	Prey		
Use and Utility^a	1.9	2.0	1.6	2.1		
Alewife	2	1	2	1	1.5	Low to Medium
Bay Anchovy	2	1	2	1	1.5	Low to Medium
American Shad	2	1	2	1	1.5	Low to Medium
Bluefish	4	2	2	2	2.5	High
Hogchoker	4	1	2	1	2.0	Medium to High
Atlantic Menhaden	Unknown	1	Unknown	1	Unknown	Unknown
Blueback Herring	2	1	2	1	1.5	Low to Medium
Rainbow Smelt	2	1	4	1	1.9	Medium
Shortnose Sturgeon	Unknown	1	Unknown	1	Unknown	Unknown
Spottail Shiner	1	2	1	2	1.5	Low to Medium
Atlantic Sturgeon	Unknown	1	Unknown	1	Unknown	Unknown
Striped Bass	2	4	2	2	2.5	High
Atlantic Tomcod	2	1	2	1	1.5	Low to Medium
White Catfish	2	1	2	1	1.5	Low to Medium
White Perch	2	2	2	2	2.0	Medium to High
Weakfish	2	2	2	2	2.0	Medium to High
Gizzard Shad	Unknown	1	Unknown	1	Unknown	Unknown
Blue Crab	Unknown	1	Unknown	1	Unknown	Unknown
(a) Use and Utility: Low = <1.5, Medium = ≥1.5 but ≤2.0, High = >2.0						
(b) WOE Score: Small = <1.5; Small-Moderate = 1.5; Moderate = >1.5 but <2.0; Moderate-Large = 2.0; Large = >2.0						

I.3 Cumulative Impacts on Aquatic Resources

Zebra Mussels

For this analysis, the 75th percentile of the weekly FSS and BSS density and CPUE data from Region 12 (Albany) were used to evaluate the population trend LOE for impacts associated with a zebra mussel invasion. Data for white perch, blueback herring, alewife, American shad, white catfish, spottail shiner, and striped bass were used in the analysis because all have high densities of YOY within this region. The data were standardized based on the first 5-year mean and the standard deviation of all annual results (1979 to 2005). Only weeks 27 to 43 were used in the analysis for the FSS and weeks 22 to 43 for the BSS survey, so that most years contained observations from the months of July through October and June through October for each survey, respectively. Effects associated with changes in gear types for the FSS (1985) were also considered.

Simple linear regression and segmented regression with a single join point were fit to the annual measure of abundance for each RIS, as described in Section H.3. The model with the smallest MSE was chosen as the better fit to the data. If the best-fit model was the simple linear regression and the slope was statistically significantly less than 0 ($\alpha = 0.05$), a negative population trend was considered detected. If the slope was not significantly different from 0,

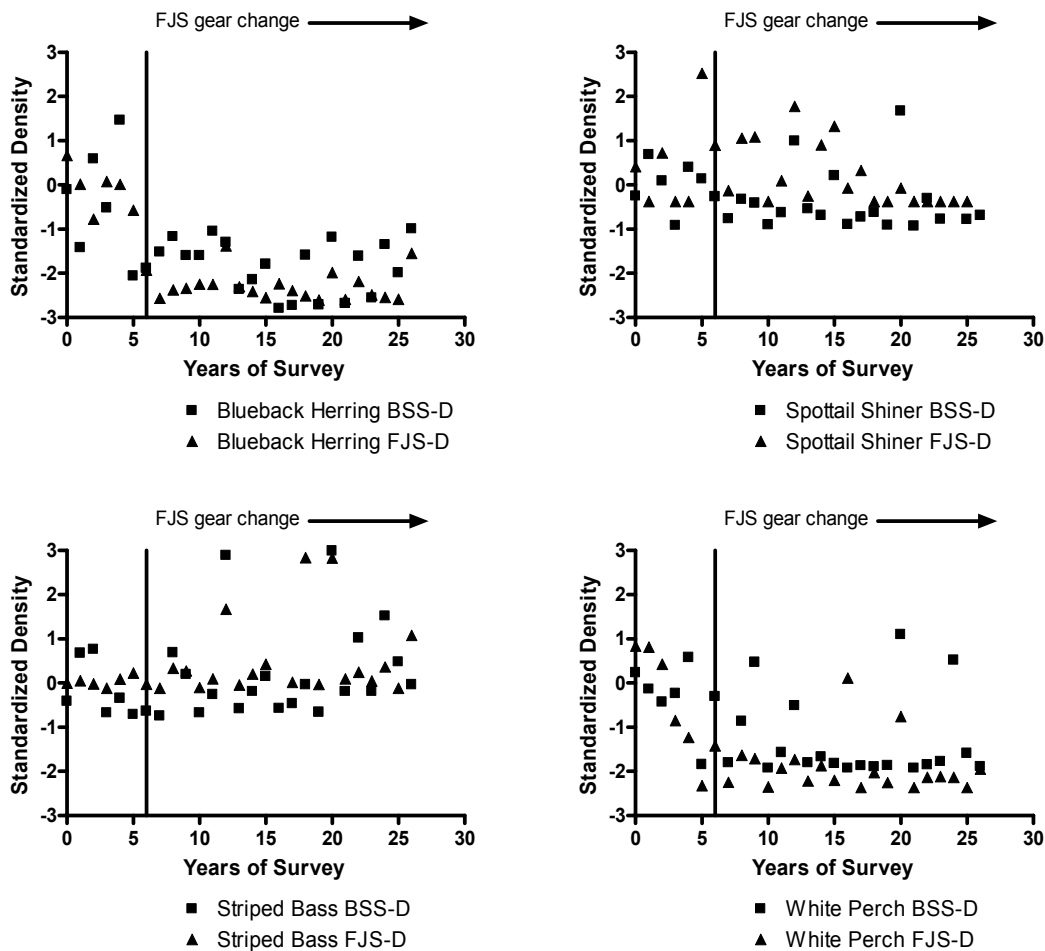
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1 then a population trend was not considered detected. If the best-fit model was the segmented
2 regression and either slope, S_1 or S_2 , was statistically significantly less than 0 ($\alpha = 0.05$), then a
3 negative population trend was considered detected. If both slopes S_1 and S_2 were not
4 significantly different from 0 ($\alpha = 0.05$), then the trend was not considered detected.

5 An assessment of adverse impact was only supported if more than 40 percent of the
6 standardized observations were outside the bounds of ± 1 . For a normal bell-shaped
7 distribution with a mean of 0 and a standard deviation of 1, 32 percent of the observations are
8 outside the bounds of ± 1 standard deviation. Thus, observations outside the boundaries of ± 1
9 standard deviation from the mean of the first 5 years were considered outside the natural
10 variability (noise). If more than 40 percent of the standardized observations were outside this
11 defined level of noise, then a potential for adverse impact was considered supported.

12 Data collected between 1985 and 2005 are not temporally disconnected from the 1991 invasion
13 of zebra mussels. However, because of earlier impacts, there is a potential that fish populations
14 stabilized pre-1985 to a lower abundance level. If changes in gear types have affected the
15 observed population response, only data post-1985 were used. For this analysis, data were
16 standardized with the average of 1985 to 1989 and the standard deviation of all data between
17 1985 and 2005. This analysis was used only when the observed response from all data was
18 biologically different from the BSS population density trend and had a decline associated with
19 the gear change.

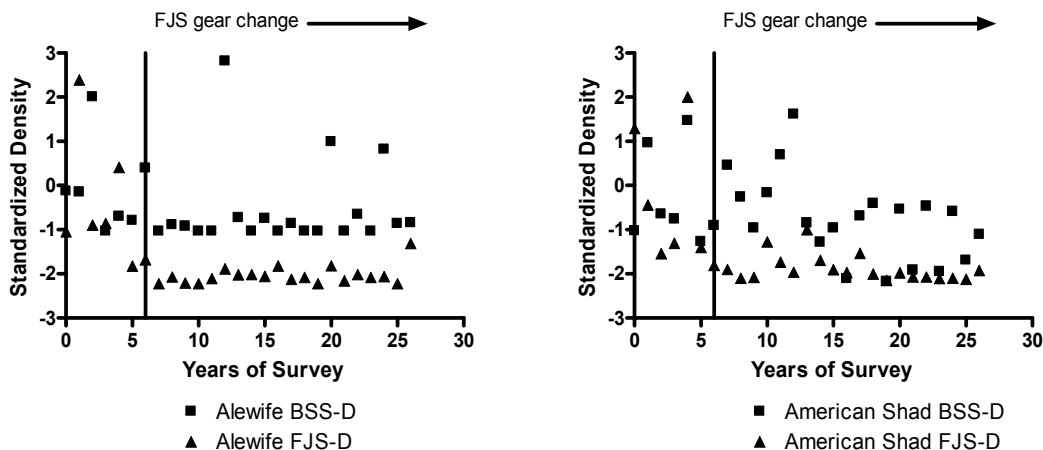
20 A visual comparison of the river-segment FSS standardized density with the BSS standardized
21 density suggested that the trends for blueback herring, spottail shiner, striped bass, and white
22 perch were not biologically different (Figure I-18). Observations from both surveys overlap and
23 cross over each other. Thus, for these RIS, all of the FSS data (1979–2005) were used in the
24 regression analysis. The FSS density data for alewife and American shad, however, did show a
25 potential gear effect (Figure I-19), and a post-1985 analysis was conducted.



1 Note: All data were used in WOE analysis.

2 **Figure I-18 River Segment 12 population trends based on the BSS and FSS standardized**
 3 **density (D) not considered biologically different**

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Note: Post-1985 data were analyzed for WOE analysis.

Figure I-19 River Segment 12 population trends based on the BSS and FSS standardized density (D) for which the FSS may indicate a gear difference

The following tables are the intermediate analyses for the assessment of population trends associated with fish density sampled from River Segment 12 (Albany). Results of these river-segment trend analyses are compiled in Table H-18 in Section H.4 of the draft SEIS. The data used in this analysis, in order of appearance, were the standardized 75th percentile of the weekly fish density for a given year collected from the FSS (Table I-33, Table I-34, and Figure I-20) and BSS (Table I-35, Table I-36, and Figure I-21).

Two extreme outliers (values greater than 2 standard deviations away from the mean) were removed from the FSS spottail shiner density regression analysis (Tables I-33 and I-34). Three extreme outliers were also removed from the FSS striped bass density (values greater than 2 standard deviations away from the mean) regression analysis and one extreme outlier from the FSS white catfish density (value greater than 2 standard deviations away from the mean) regression analysis because of the influence these data had on the regression results. The results of the regression models with the observations removed were more conservative and were used for the trend analysis.

One extreme outlier (value greater than 2 standard deviations away from the mean) was removed from the BSS alewife density regression analysis (Tables I-35 and I-36). One value was also removed from the BSS American shad density (value greater than 1.6 standard deviations away from the mean) regression analysis, one extreme outlier from the BSS spottail shiner density (value greater than 3 standard deviations away from the mean) regression analysis, and two extreme outliers from the BSS striped bass density (values greater than 2 standard deviations away from the mean) regression analysis because of the influence these data had on the regression results. The results of the regression models with the observations removed were more conservative and were used for the trend analysis.

Table I-33 Competing Models Used To Characterize the Standardized River Segment 12 (Albany) Fall Juvenile Survey Population Trends of YOY Fish Density

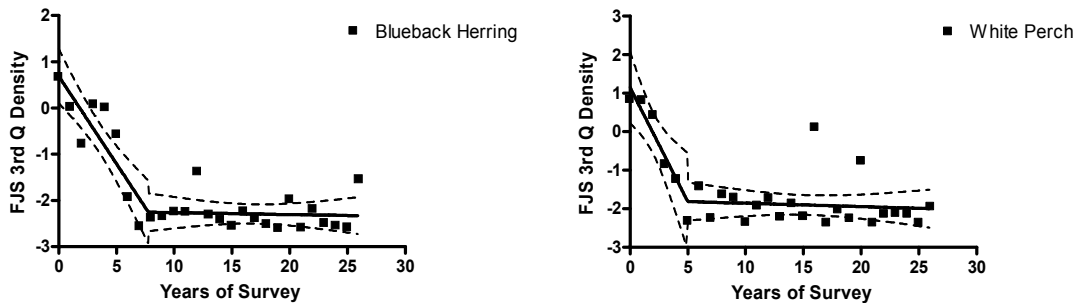
Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife (1985–2005)	1.01	0.031 ± 0.036	0.409	0.95	-5.66 to 2.00	1986	-0.028 to 0.139
American Shad (1985–2005)	0.95	-0.059 ± 0.034	0.102	0.90	-0.216 to 0.475	1992	-0.271 to -0.0001
Blueback Herring	0.73	-0.088 ± 0.018	< 0.001	0.44	-0.520 to -0.238	1987	-0.042 to 0.034
Spottail Shiner (All data)	1.02	-0.007 ± 0.025	0.777	1.05	-0.553 to 0.695	1984	-0.095 to 0.059
Spottail Shiner (2 outliers removed)	0.65	-0.025 ± 0.017	0.158	0.59	-0.041 to 0.160	1991	-0.188 to -0.010
Striped Bass (All data)	0.975	0.037 ± 0.024	0.139	0.94	0.004 to 0.155	1999	-0.568 to 0.171
Striped Bass (3 outliers removed)	0.40	0.012 ± 0.010	0.253	0.42	-1.20 to 1.30	1980	-0.014 to 0.037
White Catfish (All data)	0.982	-0.034 ± 0.024	0.171	1.00	-0.118 to 0.123	1994	-0.283 to 0.096
White Catfish (1 outlier removed)	0.88	-0.022 ± 0.022	0.327	0.92	-1.15e+006 to 1.15e+006	1979	-0.070 to 0.026
White Perch	0.84	-0.071 ± 0.021	0.002	0.58	-0.972 to -0.212	1984	-0.049 to 0.031

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Table I-34 River Segment 12 (Albany) Assessment of the Level of Potential Negative Impact Based on the Standardized FSS Density

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise	Support for Possible Negative Impact	Level of Potential Negative Impact
Alewife	SR	S1 = 0 S2 = 0	19 percent	No	1
American Shad	SR	S1 = 0 S2 < 0	14 percent	No	2
Blueback Herring	SR	S1 < 0 S2 = 0	78 percent	Yes	4
Spottail Shiner (All data)	LR	S = 0	22 percent	No	1
Spottail Shiner (2 outliers removed)	SR	S1 = 0 S2 < 0	22 percent	No	2
Striped Bass (All data)	SR	S1 > 0 S2 = 0	19 percent	No	1
Striped Bass (3 outliers removed)	LR	S = 0	19 percent	No	1
White Catfish (All data)	LR	S = 0	33 percent	No	1
White Catfish (1 outlier removed)	LR	S = 0	33 percent	No	1
White Perch	SR	S1 < 0 S2 = 0	78 percent	Yes	4

LR = Linear Regression; SR = Segmented Regression



Note: Design Restricted

Figure I-20 River Segment 12 (Albany) population trends based on the FSS standardized density assigned a large level of potential negative impact

1 **Table I-35 Competing Models Used To Characterize the Standardized River Segment 12**
 2 **(Albany) Beach Seine Survey Population Trends of YOY Fish Density**

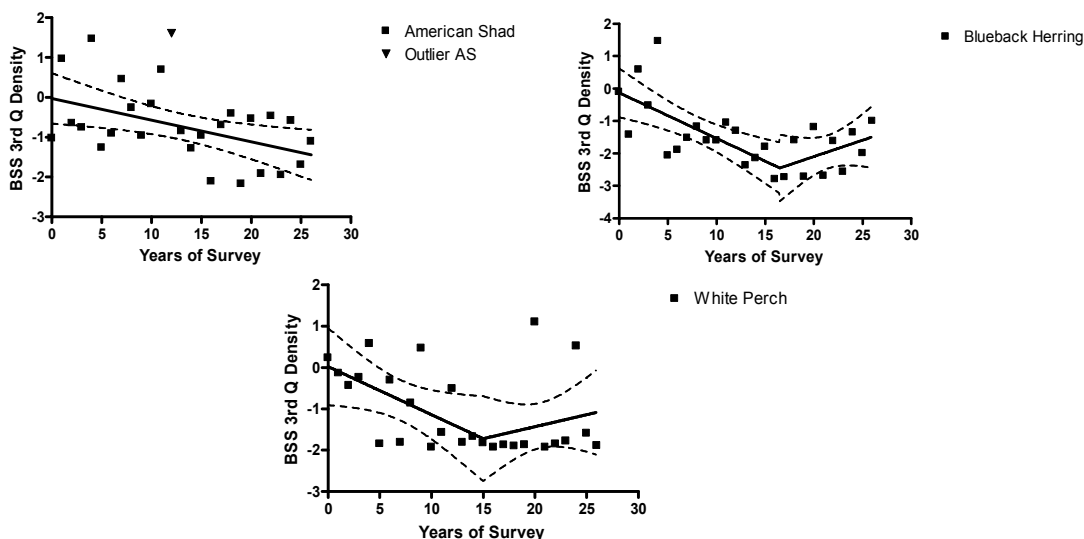
Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife (All data)	1.01	-0.020 ± 0.025	0.440	1.03	-0.877 to 0.472	1984	-0.073 to 0.071
Alewife (1 outlier removed)	0.78	-0.018 ± 0.019	0.373	0.74	-0.310 to 0.027	1989	-0.039 to 0.120
American Shad (All data)	0.91	-0.056 ± 0.023	0.020	Did Not Converge			
American Shad (1 value removed)	0.81	-0.055 ± 0.020	0.012	Did Not Converge			
Blueback Herring	0.87	-0.066 ± 0.022	0.005	0.78	-0.221 to -0.060	1996	-0.078 to 0.279
Spottail Shiner (All data)	1.02	0.007 ± 0.025	0.769	1.05	-1.23 to 0.765	1982	-0.050 to 0.087
Spottail Shiner (1 outlier removed)	0.66	-0.021 ± 0.017	0.232	0.68	-1.06 to 0.704	1982	-0.059 to 0.032
Striped Bass (All data)	0.99	0.030 ± 0.025	0.226	1.02	-0.787 to 0.544	1984	-0.024 to 0.117
Striped Bass (2 outliers removed)	0.61	0.020 ± 0.015	0.211	0.59	-0.483 to 0.148	1984	-0.003 to 0.088
White Perch	0.94	-0.048 ± 0.023	0.048	0.92	-0.229 to -0.003	1994	-0.100 to 0.216

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Table I-36 River Segment 12 (Albany) Assessment of the Level of Potential Negative Impact Based on the Standardized BSS Density

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Alewife (All data)	LR	S = 0	44	Yes	2
Alewife (1 outlier removed)	SR	S1 = 0 S2 = 0	44	Yes	2
American Shad (All data)	LR	S < 0	41	Yes	4
American Shad (1 value removed)	LR	S < 0	41	Yes	4
Blueback Herring	SR	S1 < 0 S2 = 0	85	Yes	4
Spottail Shiner (All data)	LR	S = 0	7	No	1
Spottail Shiner (1 outlier removed)	LR	S = 0	7	No	1
Striped Bass (All data)	LR	S = 0	15	No	1
Striped Bass (2 outliers removed)	SR	S1 = 0 S2 = 0	15	No	1
White Perch	SR	S1 < 0 S2 = 0	63	Yes	4

LR = Linear Regression; SR = Segmented Regression

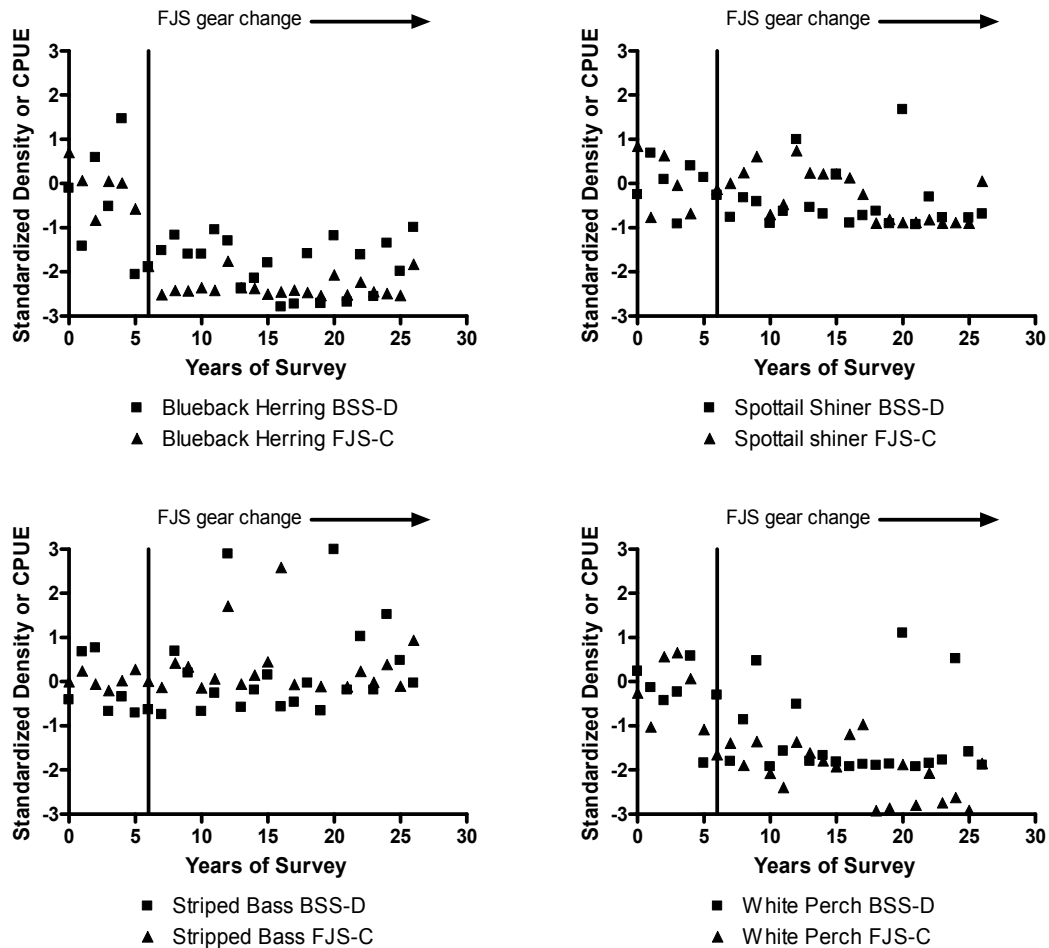


Note: Design Restricted

Figure I-21 River Segment 12 (Albany) population trends based on the BSS standardized density assigned a large level of potential negative impact

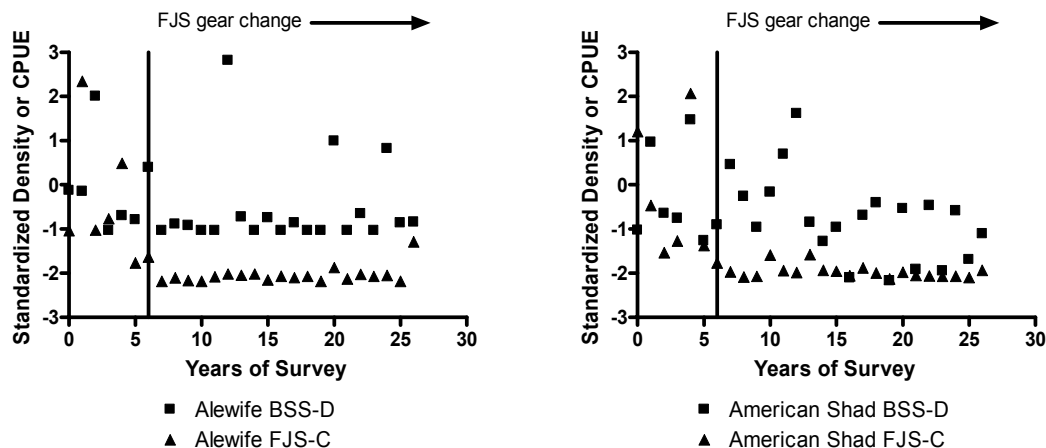
A visual comparison of the river-segment FSS standardized CPUE with the BSS standardized density suggested that the trends were not biologically different for blueback herring, spottail shiner, striped bass, and white perch (Figure I-22). Observations from both surveys overlap and cross over each other. Thus, for these RIS, all of the FSS data (1979–2005) were used in the regression analysis. The FSS density data for alewife and American shad, however, did show a potential gear effect (Figure I-23), and a post-1985 analysis was conducted.

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Note: All data were used in WOE analysis.

Figure I-22 River Segment 12 population trends based on the FSS standardized CPUE (C) and BSS density (D) not considered biologically different



Note: Post-1985 data were analyzed for WOE analysis.

Figure I-23 River Segment 12 population trends based on the FSS standardized CPUE (C) and BSS density (D) for which the FSS may indicate a gear difference

The following tables are the intermediate analyses for the assessment of population trends associated with fish CPUE sampled from River Segment 12 (Albany). Results of these river-segment trend analyses are compiled in Table H-18 in Section H.4 of the draft SEIS. The data used in this analysis were the standardized 75th percentile of the weekly fish CPUE for a given year collected from the FSS (Table I-37, Table I-38, and Figure I-23).

One extreme outlier (value greater than 3 standard deviations away from the mean) was removed from the FSS spottail shiner CPUE regression analysis (Tables I-37 and I-38), and one extreme outlier was removed from the FSS white catfish CPUE (value greater than 2 standard deviations away from the mean) regression analysis because of the influence these data had on the regression results. The results of the regression models with the observations removed were more conservative and were used for the trend analysis.

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1 **Table I-37 Competing Models Used To Characterize the Standardized River Segment 12**
 2 **(Albany) Fall Juvenile Survey Population Trends of YOY Fish CPUE**

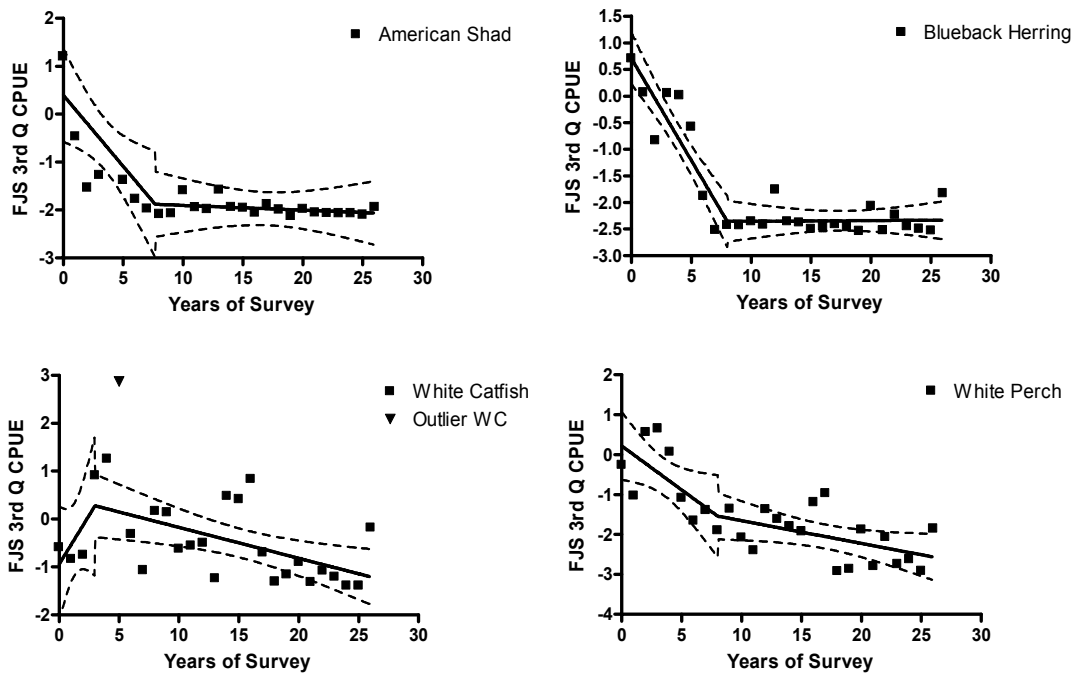
Species	Linear Regression			Segmented Regression			
	MSE	Slope	p-value	MSE	95 percent CI Slope 1	Join Point	95 percent CI Slope 2
Alewife (1985–2005)	1.00	0.033 ± 0.036	0.371	0.96	-0.185 to 0.083	1999	-0.108 to 0.656
American Shad (1985–2005)	0.94	-0.066 ± 0.034	0.064	0.96	-0.342 to 0.385	1992	-0.247 to 0.046
Blueback Herring	0.72	-0.089 ± 0.018	< 0.001	0.38	-0.484 to -0.282	1987	-0.035 to 0.037
Spottail Shiner (All data)	0.91	-0.057 ± 0.023	0.018	Did Not Converge			
Spottail Shiner (1 outlier removed)	0.52	-0.038 ± 0.013	0.008	0.53	-2.89 to 2.14	1980	-0.066 to -0.002
Striped Bass	0.98	0.034 ± 0.024	0.168	0.95	-0.010 to 0.162	1997	-0.415 to 0.180
White Catfish (All data)	0.91	-0.056 ± 0.023	0.020	Did Not Converge			
White Catfish (1 outlier removed)	0.72	-0.042 ± 0.018	0.031	0.68	-0.325 to 1.14	1982	-0.111 to -0.018
White Perch	0.67	-0.095 ± 0.017	< 0.001	0.64	-0.391 to -0.052	1987	-0.116 to 0.003

Table I-38 River Segment 12 (Albany) Assessment of the Level of Potential Negative Impact Based on the Standardized FSS CPUE

Species	Best Fit	General Trend	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact
Alewife	SR	S1 = 0 S2 = 0	10	No	1
American Shad	LR	S = 0	52	Yes	2
Blueback Herring	SR	S1 < 0 S2 = 0	78	Yes	4
Spottail Shiner (All data)	LR	S < 0	4	No	2
Spottail Shiner (1 outlier removed)	LR	S < 0	4	No	2
Striped Bass	SR	S1 = 0 S2 = 0	15	No	1
White Catfish (All data)	LR	S < 0	41	Yes	4
White Catfish (1 outlier removed)	SR	S1 = 0 S2 < 0	41	Yes	4
White Perch	SR	S1 < 0 S2 = 0	81	Yes	4

LR = Linear Regression; SR = Segmented Regression

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1
2 Note: Design Restricted
3 **Figure I-24 River Segment 12 (Albany) population trends based on the FSS standardized**
4 **CPUE assigned a large level of potential negative impact**

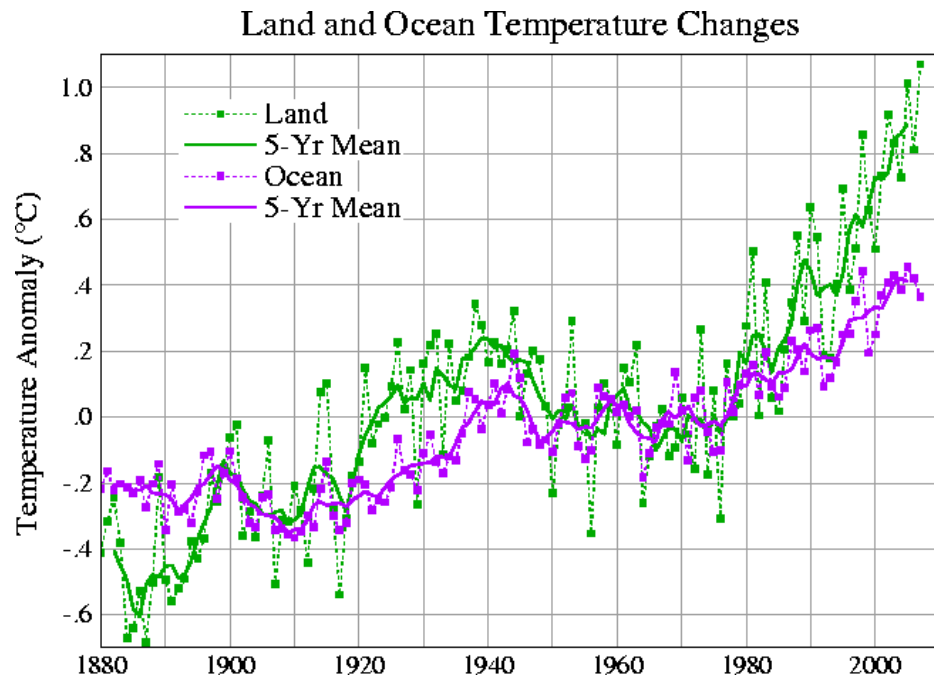
5 The WOE analysis for River Segment 12, Albany, for all population trend data post-1991 is
6 presented in Table I-39. This table is a compilation of Tables I-34, I-36, and I-38 and was used
7 to derive Table H-18 in Section H.3 in the draft SEIS.

Table I-39 River Segment 12 (Albany) Assessment of the Level of Potential Negative Impact Following Zebra Mussel Invasion in 1991 Based on the Standardized FSS and BSS Density and FSS CPUE

Species	Trend Post-1991	Percent Outside Defined Level of Noise (percent)	Support for Possible Negative Impact	Level of Potential Negative Impact Post- 1991
FSS Density				
Alewife	S2 = 0	20	No	1
American Shad	S2 < 0	13	No	2
Blueback Herring	S2 = 0	100	Yes	2
Spottail Shiner	S2 < 0	20	No	2
Stripped Bass	S = 0	33	No	1
White Catfish	S = 0	40 p	No	1
White Perch	S2 = 0	87	Yes	2
BSS Density				
Alewife	S2 = 0	47	Yes	2
American Shad	S < 0	53	Yes	4
Blueback Herring	S2 = 0	93	Yes	2
Spottail Shiner	S = 0	13	No	1
Stripped Bass	S2 = 0	27	No	1
White Perch	S2 = 0	87	Yes	2
FSS CPUE				
Alewife	S2 = 0	7	No	1
American Shad	S = 0	53	Yes	2
Blueback Herring	S2 = 0	100	Yes	2
Spottail Shiner	S < 0	0	No	2
Stripped Bass	S2 = 0	27	No	1
White Catfish	S2 < 0	53	Yes	4
White Perch	S2 = 0	93	Yes	2

Water Quality and Temperature

Both water quality and water temperature can act to shift RIS densities into adjacent river segments based on specific life stage needs. Water quality changes have been occurring over the past decade (Section 2.2.5 of the draft SEIS), and water temperatures have been increasing over the last 100 years (Figure I-36). An analysis of RIS distributional change within the Hudson River was conducted by comparing the first and last 5-year mean densities from the survey that was most efficient at catching a given RIS. Striped bass (Figure I-37), alewife (Figure I-38), spottail shiner (Figure I-39), hogchoker (Figure I-40), and white perch (Figure I-41) all appear to have shifted slightly upriver, while the bay anchovy has shifted slightly downriver (Figure I-42). All other RIS that could be evaluated (American shad, Atlantic tomcod, blueback herring, bluefish, and weakfish) did not show a change in their distributions. It is not possible from these data to determine what might have influenced these shifts.



Source: Hansen et al. 2006

Figure I-36 Historical trend in global land and ocean temperature

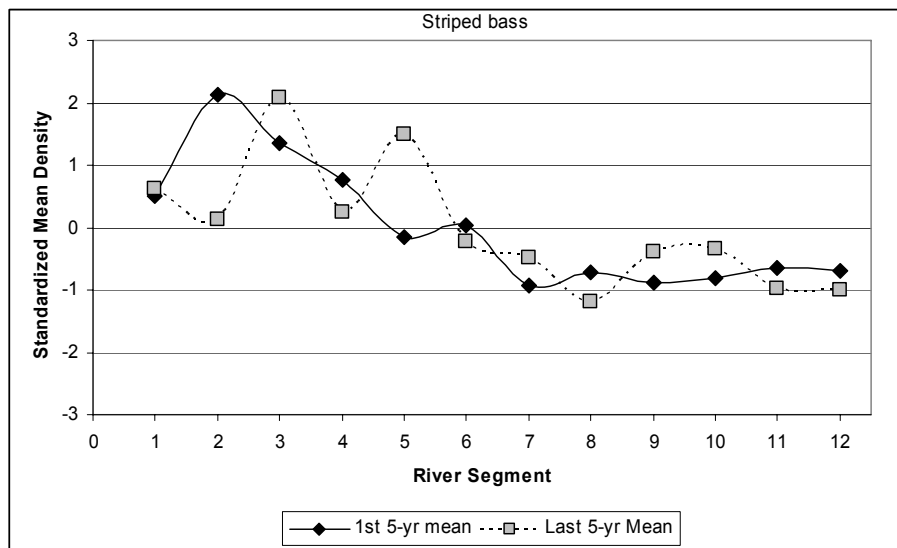


Figure I-37 Relative density of YOY striped bass from the BSS 1979–1983 and 2001–2005. data within each river segment of the Hudson River

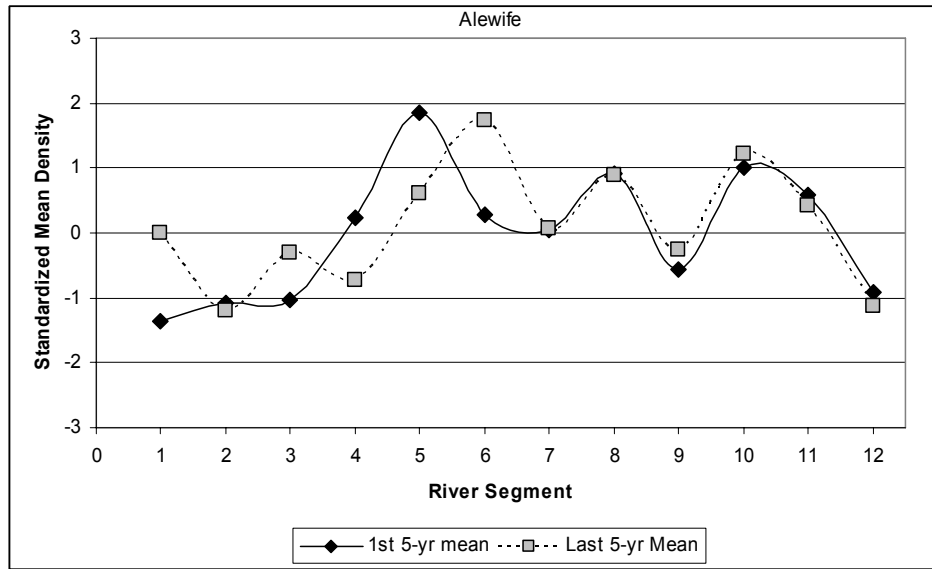


Figure I-38 Relative density of YOY alewife from the BSS 1979–1983 and 2001–2005; data within each river segment of the Hudson River

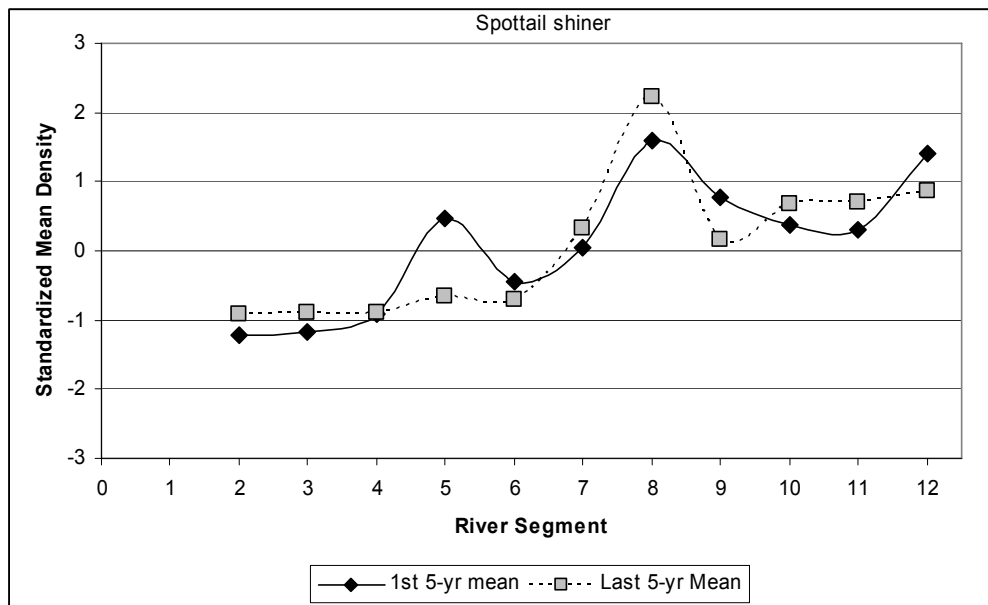


Figure I-39 Relative density of YOY spottail shiner from the BSS 1979–1983 and 2001–2005; data within each river segment of the Hudson River

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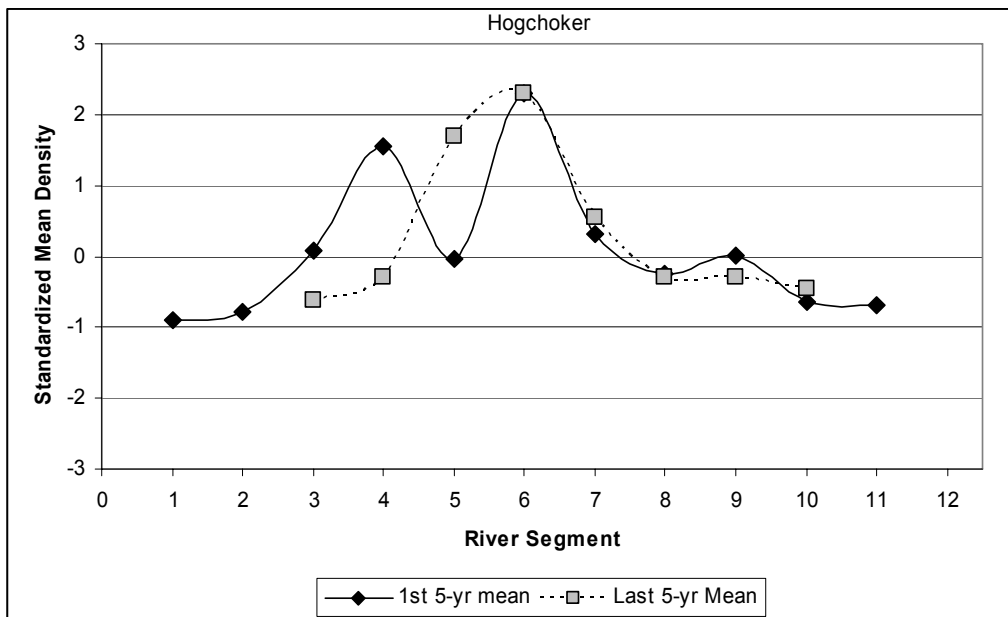


Figure I-40 Relative density of YOY hogchoker from the FSS 1979–1983 and 2001–2005; data within each river segment of the Hudson River

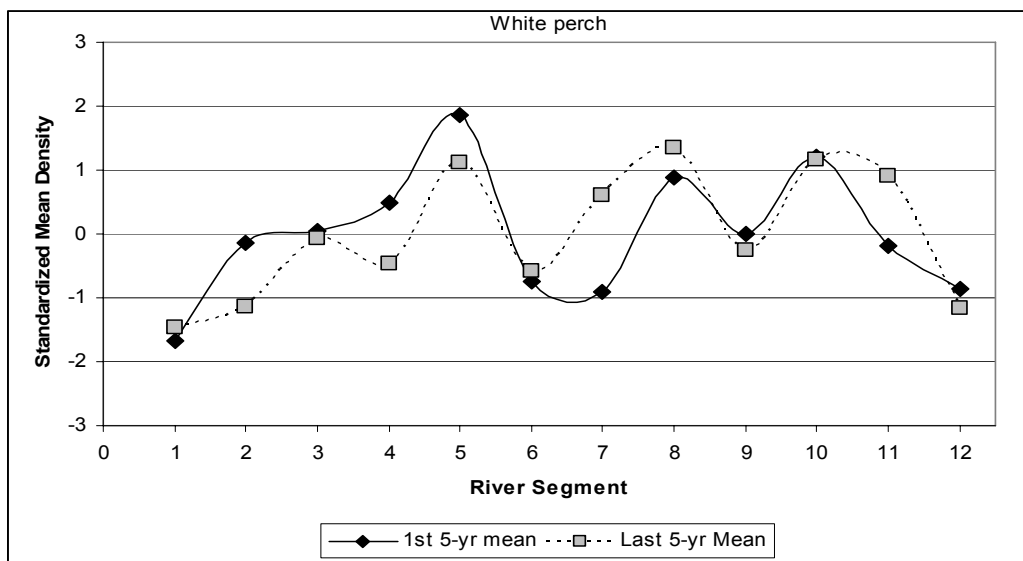


Figure I-41 Relative density of YOY white perch from the BSS 1979–1983 and 2001–2005; data within each river segment of the Hudson River

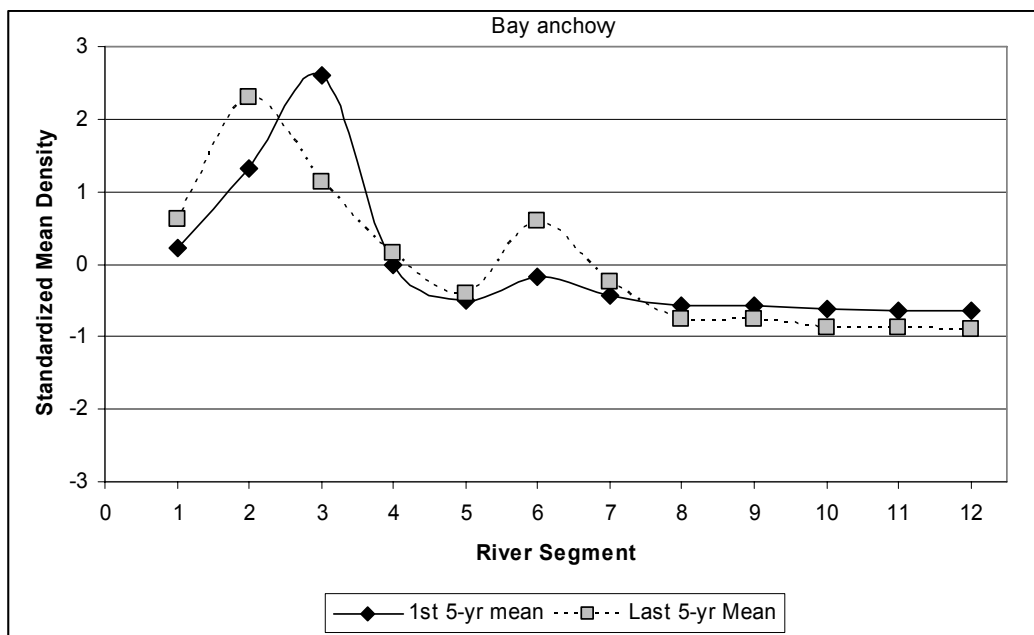


Figure I-42 Relative density of YOY bay anchovy from the FSS 1979–1983 and 2001–2005; data within each river segment of the Hudson River

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11. ABSTRACT (200 words or less) This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (all applicants will be jointly referred to as Entergy) to the NRC to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) for an additional 20 years under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This draft SEIS contains the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action. The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for IP2 and IP3 are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS, (2) the environmental report submitted by Entergy, (3) consultation with other Federal, State, and Local agencies; (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received during the scoping process.					
12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.) Indian Point Nuclear Generating Unit Numbers 2 and 3 IP2 IP3 IPEC Supplement to the Generic Environmental Impact Statement DSEIS National Environmental Policy Act NEPA License Renewal GEIS NUREG-1437, Supplement 38				13. AVAILABILITY STATEMENT unlimited	
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