7.0 Cooling Water Intake Requirements - CWA § 316(b)

7.1 Introduction

This section presents EPA's determination with respect to the application of CWA § 316(b), 33 U.S.C. § 1326(b), to the new NPDES permit for Brayton Point Station (BPS). CWA § 316(b) governs requirements related to cooling water intake structures (CWISs) and requires "that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." The operation of CWISs can cause or contribute to a variety of adverse environmental effects, such as killing or injuring fish larvae and eggs by entraining them in the water withdrawn from a water body and sent through the facility's cooling system, or by killing or injuring fish and other organisms by impinging them against the intake structure's screens.

In the absence of detailed regulations, EPA has for many years made CWA § 316(b) determinations on a case-by-case basis, both for new and for existing facilities with regulated CWISs. EPA recently promulgated new, final § 316(b) regulations providing specific technology standard requirements for *new* power plants and other types of *new* facilities with CWISs. 66 Fed. Reg. 65255 (Dec. 18, 2001) (effective date of the regulations is January 17, 2002). These regulations do not, however, apply to *existing* facilities such as BPS. EPA is currently in the process of developing regulations to apply CWA § 316(b) to existing facilities, but such regulations have yet to be finalized. As a result, EPA continues to apply § 316(b) on a case-by-case basis to existing facilities. In making determinations under CWA § 316(b), EPA must consider engineering issues, environmental/ecological issues, economic issues related to the costs of implementing CWIS technology options, legal issues, and, ultimately, policy issues regarding the final choice of what level of expenditure is appropriate in seeking to minimize adverse environmental effects. All of these issues are addressed below. In addition, the permit conditions that arise out of our CWA § 316(b) determinations are set forth below.

7.2 Legal Requirements and Context

7.2.1 Statutory Provisions

CWA § 316(b) is the statute's only provision that directly requires regulation of the withdrawal of water from a water body, as opposed to regulating the discharge of pollutants into water bodies. Rather than addressing all types of water withdrawal, however, this provision addresses only cooling water intake structures and provides that:

> [a]ny standard established pursuant to section 301or section 306 of this Act and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

33 U.S.C. § 1326(b). The plain meaning of this language is that Congress wanted EPA to ensure that the best technology available for minimizing adverse environmental impacts from CWISs would be utilized by plants withdrawing cooling water from the Nation's water bodies. The legislative history related to CWA § 316(b) is relatively sparse, but what there is tends to reinforce the plain meaning of the language used in the statute. In the House Consideration of the Report of the Conference Committee (October 4, 1972) on the final version of the 1972 CWA Amendments, Representative Clausen stated that "Section 316(b) requires the location, design, construction and capacity of cooling water intake structures of steam-electric generating plants to reflect the best technology available for minimizing any adverse environmental impact." Congressional Research Service, "*A Legislative History of the Water Pollution Control Act Amendments of 1972, Vol. 1,*" 93d Cong., 1st Session, p. 264 (cited hereafter as the "1972 Legislative History"). In addition, the Senate Consideration of the Report of the Conference Committee (October 4, 1972) for the final 1972 CWA amendments evidences Congressional awareness of the problem of fish being harmed by power plant CWISs. Id. at pp. 196-99, 202.[1]

It should also be remembered that CWA § 316(b), like other provisions of the statute, should be construed with Congress' ambitious overarching statutory purposes in mind. As the Supreme Court has explained:

> [t]he Federal Water Pollution Control Act, commonly known as the Clean Water Act, 86 Stat. 816, as amended, 33 U.S.C. § 1251 et seq., is a comprehensive water quality statute designed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." § 1251(a). The Act also seeks to attain "water quality which provides for the protection and propagation of fish, shellfish, and wildlife." § 1251(a)(2).

PUD No. 1 of Jefferson County v. Washington Department of Ecology, 511 U.S. 700, 704 (1994).

7.2.2 General Aspects of the Application of CWA § 316(b)

The statute neither dictates particular technologies to be used for CWISs nor specifies a particular method by which EPA is to make determinations under § 316(b). Case law and EPA guidance directs that the CWIS requirements of § 316(b) are ultimately to be imposed as part of NPDES permit

[1] Accord *In the Matter of Public Service Company of New Hampshire (Seabrook Station, Units 1 & 2)*, 10 ERC 1257, 1262 (U.S. EPA, NPDES Permit Application No. NH 0020338, Case No. 76-7, June 17, 1977); *Decision of the General Counsel No. 41 (In Re Brunswick Steam Electric Plant)* (June 1, 1976), pp. 200-01.

discharge limitations, which are developed under CWA §§ 301 or 306.[2] The requirements of CWA § 316(b) apply both to existing and new facilities,[3] and § 316(b) determinations must be revisited with each permit reissuance. Permit conditions imposed under § 316(b) must satisfy the statute and may be based either on applicable regulatory guidelines or, in their absence, on case-by-case Best Professional Judgment (BPJ) determinations.

7.2.3 Status of EPA CWA § 316(b) Regulations

Just as the statute does not specify required CWIS technologies or the methods by which EPA must make its determinations under § 316(b), there are also no Federal regulations presently in effect that specify such requirements for *existing* facilities. As mentioned above, EPA recently promulgated new regulations applicable to *new* facilities. 66 Fed. Reg. 65255 (Dec. 18, 2001) (effective date of the regulations is January 17, 2002).[4]

As also mentioned above, EPA is in the process of developing regulations to apply CWA §316(b)

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[2] See Virginia Electric & Power Corp. v. Costle, 566 F.2d 446, 448-51 (4th Cir. 1977); United States Steel Corp. v. Train, 556 F.2d 822, 850 (7th Cir. 1977); Hudson Riverkeeper Fund, Inc. v. Orange and Rockland Utilities, Inc., 835 F. Supp. 160, 165 (S.D.N.Y. 1993).

[3] See *Decision of the General Counsel No. 63 (In re Central Hudson Gas and Electric Corporation, et al.)*, pp. 379-80 (July 29, 1977); "Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact" (EPA 440/1-76/015-a) (April 1976) (hereinafter, the "EPA 1976 Development Document), p. 193; 41 Fed. Reg. 17388 (April 26, 1976) (Proposed Final CWA § 316(b) Regulations later remanded by federal court and then withdrawn by EPA) (discussing application of § 316(b) requirements to existing facilities).

[4] EPA has been very clear in the preamble to the new regulations that the requirements developed for *new facilities* do not apply to *existing facilities,* and that the new facility requirements should not be used as guidance for developing requirements for existing facilities. 66 Fed. Reg. 65256 (December 18, 2001). EPA stated that "[p]ermit writers should continue to apply best professional judgment in making case-by-case section 316(b) determinations for existing facilities, based on existing guidance and other legal authorities." Id. EPA explained that because the technology requirements for *new* facilities are based in part on economic analyses that might turn out differently for *existing* facilities, the requirements developed for new facilities should not be applied to existing facilities. 66 Fed. Reg. 65256 (December 18, 2001). Nevertheless, however, it is perfectly appropriate to look to the preambles of the new facility regulation for EPA's description of the history of the development of § 316(b) regulations and a description of EPA's method of applying the statute in the absence of regulations. This clearly does not involve application of the new facility requirements to existing facilities.

requirements to existing facilities. As part of that effort, EPA recently published for public review and comment proposed §316(b) regulations for application to existing power plants with flows of 50 million gallons per day or more (so-called "Phase II" facilities). 67 Fed. Reg. 17122 (April 9, 2002). Final Phase II regulations are not slated to be issued until August 2003. In the meantime, EPA has again clearly directed that the proposed regulations undergoing public review are not to be used as guidance in current permit development actions. The preamble to the proposed regulations states that "[b]ecause the Agency is inviting comment on a broad range of alternatives for potential promulgation, today's proposal is not intended as guidance for determining the best technology available to minimize the adverse environmental impact of cooling water intake structures at potentially regulated Phase II existing facilities." 67 Fed. Reg. at 17124. Until EPA promulgates final regulations, section 316(b) determinations for existing facilities are to continue being made "on a case-by-case basis applying best professional judgment," which may be more or less stringent than the requirements of the proposed regulations. Id. EPA and state permitting authorities are directed to use existing guidance and information to form their best professional judgment in issuing permits to existing facilities. 67 Fed. Reg. at 17125.

EPA first issued what were intended to be final regulations to provide national technology standards for cooling water intake structures under CWA § 316(b) in April 1976. See 41 Fed. Reg. 17387 (April 26, 1976). After litigation, however, those regulations were remanded to the Agency in 1977. See Appalachian Power Co. v. Train, 566 F. 2d 451 (4th Cir. 1977) (decision remanding regulations on procedural grounds without reaching the merits of their substantive provisions). EPA later withdrew the regulations.[5, 6] 44 Fed. Reg. 32956 (June 7, 1979); see also 66 Fed. Reg. 65261 (Dec. 18, 2001)

[5] The 1976 CWA § 316(b) regulations were remanded by the court and subsequently withdrawn by EPA, with the exception that 40 C.F.R. § 401.14 has remained in effect. This provision, however, does little more than repeat the language of CWA § 316(b). It also cross-references to "the provisions of part 402 of this chapter," but these are the very provisions that were remanded by the court and subsequently withdrawn by EPA. Forty C.F.R. Part 402 is currently "reserved."

[6] The permittee urges that EPA's 1976 Proposed Final Regulations and their preamble can still be looked to for discerning EPA interpretations of CWA § 316(b) because the court in Appalachian Power did not strike down the substantive aspects of the regulations. USGenNE, "Variance Request Application and Partial Demonstration Under the Clean Water Act, Section 316(a) and (b)" (May 24, 2001), pp. 42-43 (hereinafter, the "May 24 2001, USGenNE Partial 316(a) and (b) Demonstration"); USGenNE, "Clean Water Act Section 316(a) and (b) Demonstration, Brayton Point Station Permit Renewal Application" (November 2001) (submitted to EPA on December 7, 2001), Vol. I, Executive Summary, pp. 63, n. 93 (hereinafter, the "December 2001 USGenNE 316(a) and (b) Demonstration"). We agree, but add the caution that because these regulations did not go into effect and were later withdrawn, the interpretations they represent do not carry the legal force of fully effective regulations and they must be considered along with various other sources of EPA interpretations, such as pertinent guidance documents and permit decisions.

(Final § 316(b) Regulations for New Facilities; discussion of regulatory history).

7.2.4 CWA § 316(b) Determinations on a Case-by-Case, BPJ Basis

In the absence of regulations specifying national technology guidelines for CWISs, EPA has been applying, and continues to, apply CWA § 316(b) on a case-by-case, Best Professional Judgment (BPJ) basis. This is explained in EPA's recent final rulemaking for new facilities, see 66 Fed. Reg. 65256, 65262 (Dec. 18, 2001) (discussion of past and current approach to applying § 316(b)), and is also indicated in a memorandum from EPA Headquarters directing the EPA Regional offices to continue the case-by-case, BPJ application of § 316(b) in the interim before applicable regulations are completed. See EPA Memorandum from Michael B. Cook, "Implementation of Section 316(b) in National Pollutant Discharge Elimination System Permits," December 28, 2000. EPA is authorized to develop permit conditions on a case-by-case, BPJ basis by CWA §§ 402(a)(1)(B) and 402(a)(2).[7]

The December 28, 2000, EPA Headquarters memorandum cited above also instructed EPA Regional offices to continue using certain specific existing guidance documents in developing their case-by-case, BPJ § 316(b) decisions. Specifically, EPA stated that the May 1, 1977, "Draft: Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b)" (the "May 1977 Draft § 316(b) Guidance"), "continues to be applicable pending EPA's issuance of final regulations under section 316(b)." Id. p. 1. See also 66 Fed. Reg. 65262 (Dec. 18, 2001). The May 1977 Draft § 316(b) Guidance (at p. 5), in turn, cross-references to the EPA's "Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact," (EPA 440/1-76/015-a) (April 1976) (the "EPA 1976 Development Document"), for guidance regarding technological issues and additional information regarding intake impacts. See also 66 Fed. Reg. 65261-62 (Dec. 18, 2001). The December 28, 2000, EPA Memorandum also pointed to the following two "background papers" as providing potentially useful information for permit writers: (1) "Preliminary Regulatory Development, Section 316(b) of the Clean Water Act, Background Paper No. 3: Cooling Water Intake Technologies" (1994) (the "1994 EPA Background Paper No. 3"); and (2) "Draft Supplement to Background Paper No. 3: Cooling Water Intake Technologies" (1996) (the "1996 EPA Supplement to Background Paper No. 3"). Finally, the December 28, 2000, EPA Memorandum also instructed that past permit determinations could also be a useful source of

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[7] United States Steel Corp. v. Train, 556 F.2d 822, 850 (7th Cir. 1977); Hudson Riverkeeper Fund, Inc. v. Orange and Rockland Utilities, Inc., 835 F. Supp. 160, 165 (S.D.N.Y. 1993); EPA Office of General Counsel "Information Memorandum - Judicial Review of Section 316(b) Regulations– Appalachian Power Co. v. Train and Virginia Electric and Power Co. v. Costle (4th Circuit)," p. 3. See also 40 C.F.R. § 125.3 (relating to development of effluent discharge standards); Texas Oil & Gas Ass'n v. United States EPA, 161 F.3d 923, 928-29 (5th Cir. 1998) (BPJ effluent discharge standards); Natural Resources Defense Council v. U.S. E.P.A., 859 F.2d 156, 195 (D.C. Cir. 1988) (BPJ effluent discharge standards).

information for current permit writers.

While directing permit writers to certain potentially helpful information, EPA Headquarters also cautioned in the December 28, 2000, Memorandum against over-reliance on the past documents. Thus, EPA stated the following (at p. 2) (emphasis added):

> [p]lease note that the draft 1977 guidance and the two background papers do not impose legally binding requirements on EPA, the State, or the regulated community, and may not apply in a particular situation based on the circumstances. EPA and State decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from applicable guidance where appropriate. Any decisions on a particular facility should be based on the requirements of section 316(b).

7.2.5 Factors to Consider in Making CWA § 316(b) Determinations

CWA § 316(b) mandates that the design, location, construction and capacity of a CWIS reflect the Best Technology Available (BTA) for minimizing adverse environmental impact. However, there are no applicable statutory or regulatory definitions of the terms "available," "Best Technology Available," "adverse environmental impact," or "minimize," as they are used in § 316(b).

7.2.5a "Available" Technologies

In applying the BTA standard under CWA § 316(b), EPA obviously must decide what technologies are "available." Neither the Act nor current regulations expressly define this term. In addition, EPA guidance under CWA § 316(b) has not identified exactly how to determine when a technology should be considered to be "available."

Looking to the dictionary definition, "available" is defined in the American Heritage Dictionary (2nd Ed. 1982) as, "accessible for use; at hand." This suggests that, at a minimum, under CWA § 316(b) any technology that might be either directly required or indirectly required as the result of a flow limitation must be technologically feasible. A particular technology's feasibility could be demonstrated by an example of its use at another facility. Feasibility also might be established through other means such as, for example, appropriate pilot or bench-scale testing. Thus, in past investigations of potential CWIS-related technologies for minimizing adverse environmental impacts, EPA has evaluated technologies in use or under research for CWISs and technologies being used for other purposes that could be adapted for CWISs. See 1994 EPA Background Paper No. 3, pp. 1-1, 2-1, 2-5, 3-1; 1996 EPA Supplement to Background Paper No. 3, pp. 1-2.[8]
EPA has also in the past interpreted CWA § 316(b) to intend an economic "practicability" test for BTA

[8] See also "EPA 1976 Development Document, pp. 175-77, 193.

options. ” Although the CWA § 316(b) makes no mention of considering costs, economic practicability can be understood to be implicit within the meaning of the term “available.” EPA also found support for the conclusion that Congress intended a limited consideration of cost in a single passage from the sparse legislative history of § 316(b). Specifically, in the House Consideration of the Report of the Conference Committee, Representative Clausen stated that:

> [t]he reference here [in § 316(b)] to “best technology available” is intended to be interpreted to mean the best technology available commercially at an *economically practicable cost*.

1972 Legislative History, p. 264 (emphasis added). Citing to Representative Clausen’s remarks, EPA stated the following in the preamble to the Final CWA § 316(b) regulations issued in 1976:

> The brief legislative history of section 316(b) states that the term “best technology available” contemplates the best technology available commercially at an economically practicable cost. As with the statute, this language does not require a formal or informal “cost/benefit” assessment. Rather, the term “available commercially at an economically practicable cost” reflects a Congressional concern that the application of “best technology available” should not impose an impracticable and unbearable economic burden on the operation of any plant subject to section 316(b). Since the regulations require a case-by-case determination of the best available technology, consideration of the economic practicability of installing that technology must necessarily be conducted on a similarly individualized basis.

41 Fed. Reg. 17388 (April 26, 1976) (Final CWA § 316(b) regulations withdrawn by EPA after remand by federal court). Thus, EPA believed that Congress had intended an economic practicability test to be applied to BTA determinations under § 316(b). Applying such a test to a facility-specific case-by-case determination, as opposed to a national guidelines determination, would mean that the cost of proposed BTA actions should not be financially impossible for a plant to implement and remain in business (i.e., “should not impose an impracticable and unbearable economic burden” on plant operations).[9]

7.2.5b “Best” Technology Available

CWA § 316(b) requires that the design, construction, location and capacity of CWISs reflect the “best technology available for minimizing adverse environmental impact.” In the 1976 preamble to the

[9] Consistent with this understanding, the American Heritage Dictionary (2nd Ed.) (1982), defines “practicable” as, “capable of being effected, done or executed; feasible.”

Proposed Final CWA § 316(b) regulations, EPA explained that this meant that EPA's "effort must be to select *the most effective means* of minimizing . . . adverse effects." 41 Fed. Reg. 17388 (Final CWA § 316(b) regulations later withdrawn by EPA after remand by federal court) (emphasis added). This is consistent with the common meaning of the term "best," which is defined by the *American Heritage Dictionary (2nd Ed.)* (1982), as "surpassing all others in excellence, achievement, or quality . . .."

The above-described interpretations of the terms "available" and "best" in CWA § 316(b) are consistent with and supported by analogy to EPA's application of the "Best Available Technology economically achievable" (BAT) technology standard for the development of effluent guidelines under CWA §§ 301(b)(2)(A) and 304(b)(2)(B). To be sure, the *BAT* effluent discharge standard is not identical to the *BTA* standard for cooling water intake structures.[10] Nevertheless, Congress used the same words for both standards, albeit combined in different ways, and it is fair to analogize to the BAT standard in seeking guidance for how to apply the terms "best" and "available" in the BTA standard.

In applying BAT, EPA has determined that it should look to the single "best" performing plant in the industry –in terms of effluent reductions– to determine the "best available" technology.[11] In addition, however, EPA has also determined that it may look to any viable "transfer technologies" (that is, technology from another industry that could be transferred to the industry in question), as well as technologies that have been shown to be viable in research even if not yet implemented at a full-scale facility.[12] This is consistent with EPA's past work under § 316(b) as described above.

Therefore, to determine whether the location, design, construction, and capacity of a particular CWIS reflects the "Best Technology Available" for minimizing adverse environmental impacts, EPA will look to the best-performing CWIS to see what it achieves. Given that BPS is an existing fossil fuel-burning

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[10] See, e.g., *In the Matter of Public Service Company of New Hampshire (Seabrook Station, Units 1 & 2)*, 10 ERC 1257, 1261 (Permit Appeal Decision by Administrator of EPA) (June 17, 1977). See also 65 Fed. Reg. 49065 (August 10, 2000) ("EPA notes that 'Best Technology Available' (BTA) is a distinct standard under the CWA.").

[11] E.g., Texas Oil & Gas Ass'n v. United States E.P.A., 161 F.3d 923, 928 (5th Cir. 1998); Association of Pacific Fisheries v. Environmental Protection Agency, 615 F.2d 794, 816-17 (9th Cir. 1980); American Meat Institute v. E.P.A., 526 F.2d 442, 462-63 (7th Cir. 1975).

[12] These determinations, arising out of CWA legislative history, have been upheld by the courts. E.g., American Petroleum Institute v. E.P.A., 858 F.2d 261, 264-65 (5th Cir. 1988); Pacific Fisheries, 615 F.2d at 816-17; BASF Wyandotte Corp. v. Costle, 614 F.2d 21, 22 (1st Cir. 1980); American Iron and Steel Institute v. E.P.A., 526 F.2d 1027, 1061 (3d Cir. 1975); American Meat Institute, 526 F.2d at 462-63.

plant that would require retrofitting to achieve any *technologically -driven* improvements,[13] EPA will look in this regard to whether any existing fossil fuel-burning plants have undergone technological retrofits to better minimize adverse environmental impacts from their CWISs. In addition, EPA could look to any technologies that can be shown to be feasible for use at BPS, even if they have not previously been used to retrofit an existing facility. For example, in this regard, EPA could look to technologies being used at new power plants to determine if they would be feasible for retrofit at BPS. Indeed, use of a relevant technology at a new plant could well provide as stronger evidence of the feasibility of a technology than technologies "transferred" from another industry or established only at the research or pilot-testing level.[14]

Of course, because each CWA § 316(b) decision is made on a case–by-case basis, EPA must also consider whether any particular technology is truly feasible for use *at BPS* given the particular facts of the BPS situation. For example, while the fact that a technology works at a particular power plant might suggest that it could work at BPS, it still might not *actually* be feasible due to site-specific issues such as, for example, space limitations. If it is not actually feasible at BPS, it would not be the "best technology available" for BPS.

7.2.5c "Adverse Environmental Impact"

The term "adverse environmental impact" (AEI) as used in CWA § 316(b) is not defined in either the statute or existing regulations. As such, neither the statute nor the regulations expressly limit the extent of adverse environmental impacts that may be considered. As mentioned above, the legislative history behind CWA § 316(b) is sparse, but in the House Consideration of the Report of the Conference Committee for the final 1972 CWA Amendments, Representative Clausen stated that "Section 316(b) requires the location, design, construction and capacity of cooling water intake structures of steam-

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[13] Although EPA refers to "flow reduction" as a "technology" in the EPA Supplement to Background Paper No. 3, EPA understands that improvements could be made without actually changing technology by simply reducing the amount of cooling water used by BPS. Such reductions without technology changes would, however, require cutbacks in the generation of electricity. Requiring such cutbacks, sometimes on a seasonal basis, has been required in some permits. <u>See, e.g.</u>, Bulletin, Marine Resources Advisory Council, Vol. IX, No. 4, "Effects of Power Plants on Hudson River Fish," (requirements for plant included scheduled plant outages); *In the Matter of Florida Power Corporation, Crystal River Power Plant, Units 1, 2 and 3, Citrus County, Florida* (Findings and Determinations Pursuant to 33 U.S.C. § 1326; NPDES Permit No. FL 0000159), p. 8. Accordingly, the permittee in this case has evaluated flow reductions as a result of various measures including planned outages as a potential alternative means of satisfying CWA § 316(b). <u>See</u> December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.5.

[14] In one sense, one can think of a technology used at a *new* power plant as a potential "transfer technology" for use at *existing* plants.

electric generating plants to reflect the best technology available for minimizing *any* adverse environmental impact" (emphasis added). 1972 Legislative History, p. 264. This language suggests that all adverse environmental impacts should be considered and minimized.

Consistent with Representative Clausen's remarks, EPA's May 1977 Draft § 316(b) Guidance states as follows (at p. 15):

> [a]dverse aquatic environmental impacts occur whenever there would be entrainment or impingement damage as a result of the operation of a specific cooling water intake structure.

The May 1977 Draft § 316(b) Guidance (at p. 15) goes on, however, to state that, "[t]he critical question is the magnitude of any adverse impact." The guidance document then explains that "[t]he magnitude of an adverse impact should be estimated both in terms of short term and long term impact" with reference to the following factors: (1) "absolute damage;" (2) "percentage damage;" (3) absolute and percentage damage to any endangered species; (4) absolute and percentage damage to any "critical aquatic organism;" (5) absolute and percentage damage to commercially valuable and/or sport fisheries yield; and (6) "whether the impact would endanger (jeopardize) the protection and propagation of a balanced population of shellfish and fish in and on the body of water from which the cooling water is withdrawn (long-term impact)." Thus, the May 1977 Draft § 316(b) Guidance indicates that in assessing the magnitude of the adverse effect, EPA is to consider both the number of individual organisms killed or injured (i.e., "absolute damage"), as well as the percentage of the overall population of species that are damaged (i.e., "percentage damage"). It is also clear that "percentage damage" should be considered at levels below that which would cause the complete collapse of the population. In other words, consideration of "percentage damage" is not limited to cases of 100% damage.[15]

The May 1977 Draft § 316(b) Guidance also indicates that in trying to assess adverse impact, permitting agencies should also consider the overall sensitivity of the source water to adverse biological impacts from cooling water intake structures. The Draft Guidance explains (at pp. 11-12) that:

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[15] See also In the Matter of Public Service Company of New Hampshire, et al. (Seabrook Station, Units 1 and 2), 10 Env't Rep. Cas. (BNA) 1257, 1262 (EPA June 17, 1977);(CWA § 316(b) standard requiring that CWISs reflect BTA for minimizing adverse environmental impact differs from § 316(a) standard requiring that thermal discharge limitations protect balanced indigenous populations of fish, shellfish and wildlife, and § 316(b) may require further minimization of adverse impacts even if balanced indigenous populations would not be undermined). Accord *Decision of the General Counsel No. 63*, p. 371, 382 (July 29, 1977) (In re Central Hudson Gas and Electric Corporation, et al.); *Decision of the General Counsel No. 41*, 197, 201-02 (June 1, 1976) (In re Brunswick Steam Electric Plant).

> Some general guidance concerning the extent of adverse impacts can be obtained by assessing the relative biological value of the source water body zone of influence for selected species and determining the potential for damage by the intake structure. For a given species, the value of an area is based on the following considerations: 1. principal spawning (breeding) ground; 2. migratory pathways; 3. nursery or feeding areas; 4. numbers of individuals present; and 5. other functions critical during the life history. A once-through system for a power plant utilizes substantially more water from the source water body than a closed recirculation system for a similar plant and thus would tend to have a higher potential impact. A biological value/potential impact decision matrix for best intake technology available could be:
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> * * *
>
> An open system large volume intake in an area of high biological value does not represent best technology available to minimize adverse environmental impact and will generally result in disapproval.
>
> Exceptions to this may be demonstrated on a case by case basis where, despite high biological value and high cooling water flow, involvement of the biota is low or survival of those involved is high, and subsequent reductions of populations is minimal.

In a similar vein, the preamble to the 1976 proposed Final CWA § 316(b) regulations, which were later remanded to EPA by Fourth Circuit Court of Appeals, explained that, "[t]he potential for adverse environmental effects associated with cooling water systems may depend upon such factors as size and type of water body and relative magnitude of flow withdrawn for cooling." 41 Fed. Reg. 17388 (April 26, 1976). Of course, the general type of water body is only one factor to consider and case-specific analyses of the environmental effects of each particular plant are still required for permit development as explained above. See also 41 Fed. Reg. 17388-89 (Final CWA § 316(b) Regulations later withdrawn by EPA after remand by federal court) (assessing adverse effects depends on consideration of multiple factors, including type of water body, number of organisms killed or damaged, and overall damage to the ecosystem).

The permittee argues that no adverse environmental impact should be regarded to have occurred unless the effect is shown to "result in actual substantial harm to populations or communities of biota."[16] See

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[16] The permittee also argues that "[m]ere hypothetical or potential impact is not sufficient" to constitute AEI. May 24, 2001 Partial 316(a) and (b) Demonstration, p. 33. It is not entirely clear what is meant by this statement but it seems to be without support in the law or any EPA guidance. The permittee's citation to *In re Public Service Company of New Hampshire* does not support its argument. Since CWA § 316(b) applies to new CWISs as well as to existing ones, EPA is often

December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, pp. 47-48. See also May 24, 2001 USGenNE Partial 316(a) and (b) Demonstration, p. 33. Setting such a high threshold for the existence of AEI, however, is not supported by the statutory language, the legislative history, or the other materials discussed above. While there may be some *de minimis* threshold level of impacts below which EPA will not consider AEI to have occurred, EPA has not set any such threshold at the level of "substantial harm to populations of biota." Indeed, as discussed below in the section on "minimization" of adverse impacts, EPA has interpreted the § 316(b) technology standard to require minimization of adverse environmental impacts whether or not they are "significant," as long as the applicable economic tests are satisfied (the "wholly disproportionate cost" test is discussed further below).

Moreover, the permittee's assertion that its "substantial population effect" threshold has been adopted by EPA in guidance as well as in the Seabrook nuclear power plant permit decision by EPA that was upheld by the First Circuit Court of Appeals is simply unfounded. For example, in the preamble to the 1976 Proposed Final CWA § 316(b) Regulations, EPA stated the following:

> [s]ome commenters recommended that the Development Document should provide that the proper test for minimizing adverse environmental impact is related to damage to the aquatic ecosystem and not to the number of fish and other aquatic organisms killed or damaged.
>
> Section 316(b) requires that the best technology available be used to minimize adverse environmental impacts. As noted in the Development Document, there are many factors that should be considered when determining whether an adverse environmental impact exists or is likely to exist. The factors noted by the commenters are among those to be considered. All pertinent factors, rather than reliance on a single factor, should receive adequate consideration.

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necessarily in the position of assessing "potential" or "hypothetical" impacts in making BTA determinations. It is obviously impossible to assess either existing or future population-level effects of CWIS entrainment and impingement with certainty. Therefore, the permittee appears to attempt to foreclose virtually any requirements under CWA § 316(b) by arguing that AEI only exists where there are substantial population-level effects that are absolutely definite (i.e., are not "potential" or "hypothetical"). This is clearly incorrect in light of the EPA guidance documents discussing the need to assess potential future entrainment and impingement effects, both for new and existing facilities. Moreover, the permittee's position would clearly undermine the CWA § 316(b)'s goal of ensuring the use of the best technology available for minimizing adverse environmental impacts. A permittee or other interested party is, of course, entitled to question whether EPA's assessment of the "potential" effects in a particular case is reasonable in light of the available information and whether or not EPA has required appropriate steps to minimize any such potential adverse effects.

41 Fed. Reg. 17389 (April 26, 1976) (emphasis added). Furthermore, as discussed above, the May 1977 Draft § 316(b) Guidance (at p. 15) clearly indicates that adverse environmental impacts include more than just "substantial population effects." Thus, EPA has not stated that losses of individuals need not be addressed or that population reductions need not be addressed unless they are "substantial."

The Draft Guidance does make clear, however, that EPA must assess the *magnitude* of the adverse impact. See also EPA 1976 Development Document, pp. 13, 175. Moreover, EPA has been clear that the magnitude or seriousness of the adverse impacts should be assessed on a case-by-case basis taking into account the facts related to ecosystem and natural resources in question. See 41 Fed. Reg. 17388 (April 26, 1976); May 1977 Draft § 316(b) Guidance, p. 11-15. Thus, a given level of losses from an otherwise healthy ecosystem or fish population might be less environmentally significant than similar or even smaller losses from a stressed ecosystem or fish population. Having decided that the magnitude of the adverse effects should be assessed, EPA has then taken the approach that more serious adverse impacts warrant more serious expenditures for reductions based on a "wholly disproportionate" cost test, which is discussed below.[17]

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[17] The permittee also points to EPA Region I's October 26, 1999, Draft Information Document to support its argument that only "actual, substantial population-level effects" constitute AEI. This attempt also fails. First, the document cited to is only a Draft regional memorandum and, consistent with the disclaimer at the end of the document, it cannot displace the language of the statute, much less interpretations adopted by EPA in the preambles to regulations, formal permit appeal determination, or national guidance. Second, the Draft Regional memorandum does not support the company's argument. The Draft Regional memorandum (at p. 19) states that "a 316(b) Demonstration . . . can be successful if it provides convincing evidence that populations of CAO [, critical aquatic organisms,] will not decline in abundance as a result of the losses of all life stages attributable to entrainment, impingement, or other intake-related effects." Stating that a § 316(b) determination *could* be based on a finding that losses would cause no decline in abundance falls far short of a determination that only "actual, substantial population-level" impacts constitute AEI. While the Draft Regional document (at p. 19) does note that "316(b) demonstrations have traditionally focused on population-level effects on the principal species (CAO)," it does not endorse the permittee's test for AEI. Furthermore, the Draft Regional document (at p. 18) states that impact determinations should evaluate "the nature and intensity of impacts; the spatial and temporal scale of effects; and the potential for recovery from effects." It also states (at p. 18) that "logically" a § 316(b) determination should consider factors such as a "substantial decrease of formerly indigenous species," a "reduction of the successful completion of life cycles of indigenous species, including those of migratory species," and a "detrimental interaction with other pollutants, discharges or water-use activities." Finally, the Draft Regional document (see pp. 4, 19) notes that EPA also applies an economic test in making § 316(b) determinations (i.e., the wholly disproportionate cost test).

This approach is well illustrated in the Seabrook permit appeal decision, in which the EPA Administrator explained:

> . . . the RA [i.e., EPA Regional Administrator] may have meant only that some consideration ought to be given to costs in determining the degree of minimization to be required. I agree that this is so – otherwise the effect would be to require cooling towers at every plant that could afford to install them, regardless of whether or not any significant degree of entrainment or entrapment was anticipated. I do not believe that it is reasonable to interpret Section 316(b) as requiring use of technology whose cost is wholly disproportionate to the environmental benefit to be gained.

In re Public Service Company of New Hampshire, 10 ERC at 1261. Thus, it was the "wholly disproportionate cost" test that prevented an across-the-board cooling tower (or closed-cycle cooling) requirement, and *not* the argument advocated by the permittee (namely, that no adverse environmental impacts exist and require minimization until substantial harm to entire populations of fish have occurred). The First Circuit subsequently upheld EPA's application of the wholly disproportionate cost test. Seacoast Anti-Pollution League v. Costle, 597 F.2d 306, 311 (1st Cir. 1979).[18]

7.2.5d "Minimizing" Adverse Environmental Impacts

In past decisions, EPA has determined that the term "minimize" should be understood to have its common meaning, which is, "reduce to the smallest possible amount, extent, size, or degree." *American Heritage Dictionary (2nd Ed.)* (1982). See also 41 Fed. Reg. 17387-88 (Proposed Final CWA § 316(b) regulations later remanded to EPA by federal court and withdrawn by EPA); *Decision of the General Counsel No. 63 (In re Central Hudson Gas and Electric Corporation, et al.)*, p. 371, 381 (July 29, 1977); In the Matter of Public Service Company of New Hampshire, et al. (Seabrook

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[18] In support of its proposed "substantial population effects" threshold for discerning AEI, the permittee points to the First Circuit's affirmation of EPA's findings in the Seabrook case that entrainment losses would not threaten the viability of various species populations. May 24, 2001 Partial 316(a) and (b) Demonstration, p. 34 (citing Seacoast Anti-Pollution League, 597 F.2d at 309). Yet, EPA was only considering whether the intake would threaten the viability of the populations as *one* of the factors to consider in assessing the significance of the AEI. This was consistent with the various factors identified in the May 1977 Draft § 316(b) Guidance (at p. 15). The First Circuit merely affirmed EPA's fact findings in this regard. Seacoast Anti-Pollution League, 597 F.2d at 309-11. The ultimate decision in the Seabrook case, as discussed above, was *not* that there was no adverse environmental impact unless populations would be rendered non-viable or suffer substantial harm, and that therefore nothing needed to be done; rather, it was that in light of the magnitude of the adverse environmental impact, the large cost of moving the intake even further offshore would be wholly disproportionate to the benefits that would have been gained (note: the company had already agreed to move the intake out of the estuary at substantial expense). Id. at 311.

Station, Units 1 and 2), 10 Env't Rep. Cas. (BNA) 1257, 1260 (EPA June 17, 1977);*Decision of the General Counsel No. 41 (In re Brunswick Steam Electric Plant)*, 197, 203 (June 1, 1976). Based on the language and structure of CWA § 316(b), EPA has also determined that CWISs must reflect the BTA for minimizing adverse environmental impacts, whether or not those adverse impacts are considered to be significant. *Decision of the General Counsel No. 41*, at 203 ("The [cooling water intake] structures must reflect the best technology available for *minimizing* . . . adverse environmental impact – significant or otherwise.")(emphasis in original); *Decision of the General Counsel No. 63*, at 381-82 ("Under Section 316(b), EPA may impose the best technology available . . . in order to minimize . . . adverse environmental impacts – significant or otherwise."). In other words, once adverse impacts are beyond some *de minimis* level, there is no particular threshold of significance which must be crossed before the adverse impacts must be minimized by the application of BTA.[19]

Still, the May 1977 Draft § 316(b) Guidance is clear that EPA does not regard CWA § 316(b) to require the complete elimination of all entrainment or impingement in all cases. The Guidance states (at p. 3):

> The extent of fish losses of any given quantity needs to be considered on a plant-by-plant basis, in that the language of section 316(b) of P.L. 92-500 requires cooling water intakes to "minimize adverse environmental impact." Regulatory agencies should clearly recognize that some level of intake damage can be acceptable if that damage represents a minimization of environmental impact.

Thus, although EPA has read CWA § 316(b) to intend that greater than *de minimis* levels of entrainment or impingement may be considered an "adverse impact," and that such impacts must be reduced to the smallest amount possible (i.e., be "minimized") through the application of BTA, this may or may not require the elimination of all impacts in any given case. Less than complete elimination of all adverse effects could be appropriate if the effects are considered *de minimis*, if further reductions are not feasible with available technology, or if the cost of attaining these additional reductions would be wholly disproportionate to the benefits. The role of cost considerations in CWA § 316(b) determinations is discussed below.

7.2.5e Economic Considerations in CWA § 316(b) Determinations

EPA has interpreted CWA § 316(b) to authorize it to consider, to a limited extent, the cost of the options when making determinations of what constitutes BTA for minimizing adverse environmental impacts. First, as discussed in detail above, cost is considered in terms of "practicability." This can be understood as part of meeting the "availability" component of BTA. Second, as briefly mentioned

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[19] The significance or magnitude of the impacts comes into play, however, when considering whether the cost of undertaking actions to further minimize impacts is justifiable.

above, an option's costs are also to be considered under the wholly disproportionate cost test. This is discussed further below.

The text of CWA § 316(b) makes no express mention of considering costs in any way in determining BTA requirements. Nevertheless, EPA found support for the conclusion that Congress intended a limited consideration of cost in a single passage from the sparse legislative history of § 316(b). Specifically, in the House Consideration of the Report of the Conference Committee on the 1972 CWA Amendments (Oct. 4, 1972), Representative Clausen stated that:

> [t]he reference here [in § 316(b)] to "best technology available" is intended to be interpreted to mean the best technology available commercially at an economically practicable cost.

1972 Legislative History, p. 264. This statement reflects Representative Clausen's belief that economic practicability should be considered but does not, on its face, indicate that a comparison of costs and benefits should determine the result of a § 316(b) determination.

Recognizing the focus of Representative Clausen's remarks, EPA cited in support of the following conclusions in the preamble to the 1976 proposed Final CWA § 316(b) regulations:

> No comparison of monetary costs with the social benefits of minimizing adverse environmental impacts, much less a formal, quantified "cost/benefit" assessment, is required by the terms of Act. The statute directs the Agency to insure that enumerated aspects of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. Once such adverse effects have been identified (or, in the case of new structures, predicted) then the effort must be to select the most effective means of minimizing (i.e., "reducing to the smallest possible amount or degree") those adverse effects. The brief legislative history of section 316(b) states that the term "best technology available" contemplates the best technology available commercially at an economically practicable cost. As with the statute, this language does not require a formal or informal "cost/benefit" assessment. Rather, the term "available commercially at an economically practicable cost" reflects a Congressional concern that the application of "best technology available" should not impose an impracticable and unbearable economic burden on the operation of any plant subject to section 316(b). Since the regulations require a case-by-case determination of the best available technology, consideration of the economic practicability of installing that technology must necessarily be conducted on a similarly individualized basis.

41 Fed. Reg. 17388 (Final CWA § 316(b) regulations later withdrawn by EPA after remand by federal court). Thus, EPA made clear that it believed that Congress intended an economic practicability test to be applied to BTA determinations under § 316(b), but made equally clear that a cost/benefit analysis was not required.

EPA later adopted a new test involving a limited consideration of costs and benefits. In a permit appeal decision involving the Seabrook, New Hampshire, nuclear power plant, the Administrator of EPA reiterated much of what EPA had stated in the preamble to the regulations regarding both the absence of any cost/benefit analysis requirement and the need for costs to be economically practicable. Significantly, however, the Administrator also affirmed that no measures should be required as BTA "whose cost is wholly disproportionate to the environmental benefit to be gained." Specifically, the Administrator of EPA stated the following:

> . . . the Agency's position, that cost benefit analysis is not required under Section 316(b), is correct. Section 316(b) provides flatly that cooling water intakes shall "reflect the best technology available for minimizing adverse environmental impact." Unlike Sections 301 and 304, Section 316(b) determines what the benefits to be achieved are and directs the Agency to require use of "best technology available" to achieve them. There is nothing in Section 316(b) indicating that a cost benefit analysis should be done, whereas with regard to "best practicable control technology currently available" . . . Congress added express qualifiers to the law indicating a requirement for cost/benefit analysis. Indeed, but for one bit of legislative history [citation to Representative Clausen's remarks omitted], there would be no indication that Congress intended costs to be considered under Section 316(b) at all. I find, therefore, that insofar as the RA's decision may have implied the requirement of a cost/benefit analysis under Section 316(b), it was incorrect.
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> However, the RA may have meant only that some consideration ought to be given to costs in determining the degree of minimization to be required. I agree that this is so – otherwise the effect would be to require cooling towers at every plant that could afford to install them, regardless of whether any significant degree or entrainment or entrapment was anticipated. I do not believe that it is reasonable to interpret Section 316(b) as requiring the use of technology whose cost is wholly disproportionate to the environmental benefit to be gained.

In re Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), 10 ERC 1257, 1261 (NPDES Permit Application No. NH 0020338, Case No. 76-7; June 17, 1977) (Decision of the Administrator). In Seacoast Anti-Pollution League v. Costle, 597 F.2d 306, 311 (1st

Cir. 1979), the First Circuit Court of Appeals noted EPA's application of the "wholly disproportionate cost" test with approval and cited to Congressman Clausen's remarks to support the proposition that, "[t]he legislative history clearly makes cost an acceptable consideration in determining whether the intake design reflect[s] the best technology available." [20, 21]

EPA has not, however, specified any particular method for determining whether an option's costs are "wholly disproportionate" to its benefits under CWA § 316(b). Whether assessed qualitatively or quantitatively, an option's costs would have to be substantially greater than its benefits before those costs would be deemed "wholly disproportionate" to the benefits. Where to "draw the line" is a policy judgment left to the sound discretion of EPA in making its case-by-case § 316(b) decisions. The appropriate judgment regarding the point at which the costs of a technology become wholly disproportionate to its benefits might vary from case to case based on the type and extent of the adverse impacts to be addressed and the degree of certainty or uncertainty regarding the costs and benefits.

While there is no exact prescription for how to determine whether an option's costs are wholly disproportionate to its benefits under § 316(b), some guidance may be found in the EPA's application

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[20] Again, Congressman Clausen did not actually say anything about applying a "wholly disproportionate cost test;" he only stated that "best technology available" was intended to mean "the best technology available commercially at an economically practicable cost." 1972 Legislative History, p. 264. In *Decision of the General Counsel No. 63 (In re Central Hudson Gas and Electric Corp.)*, (July 29, 1977), p. 382, EPA's General Counsel cited to the Seabrook decision and reiterated EPA's "wholly disproportionate cost" test. The General Counsel further reiterated that the "this test is a limited one, for the Administrator . . . rejected the notion that a full cost/benefit analysis is required under Section 316(b)."

[21] In a July 2001 meeting, EPA noted to the permittee that the Agency would need to consider whether the recent Supreme Court case of Whitman v. American Trucking Association, Inc., 121 S. Ct. 903 (2001), had any bearing on our interpretation of the proper application of cost considerations under CWA § 316(b). This case addressed the question of whether or not certain language in the Clean Air Act authorized costs to be considered in the development of certain air emissions standards. The Supreme Court held that the Clean Air Act prohibited EPA from considering compliance costs in setting the standards in question because the statute did not grant authority to consider costs and such authority would not be inferred. Given the absence of language regarding cost considerations in CWA § 316(b), it seemed to EPA that the import of this case ought to be considered. The permittee has offered its opinion that for several reasons the case has no bearing on the interpretation of CWA § 316(b). See May 24, 2001 Partial 316(a) and (b) Demonstration, p. 40, n. 24. Although we disagree with certain aspects of the permittee's analysis, the bottom line is that we are adhering to EPA's "wholly disproportionate cost" test under CWA § 316(b) because the Agency has not withdrawn this longstanding interpretation in response to American Trucking.

of different "wholly disproportionate cost" test in setting Best Practicable Treatment (BPT) effluent discharge limitations. CWA § 304(b)(1)(B) expressly requires some balancing of costs against benefits in setting BPT standards.[22] Nevertheless, legislative history and case law both make clear that under the BPT "wholly disproportionate cost" test, the cost/benefit balancing is to be of a "limited" nature[23] and cost is not to be considered a factor of "primary" or "paramount" importance.[24] Presumably, therefore, in applying the "wholly disproportionate cost" test under § 316(b), which does not even mention the consideration of cost, costs should also not be a primary or paramount factor. Moreover, the courts have been clear that in developing national standards under the BPT "wholly disproportionate cost" test, environmental controls might be required that would cause some "economic dislocation," and even plant closures, to achieve the stated environmental objective.[25] Thus, application of the "wholly disproportionate cost" test under the BPT standards confirms that application of the similar test under § 316(b) could countenance significant economic impacts to a facility if the costs would not be wholly disproportionate to the benefits.

In applying the BPT "wholly disproportionate cost" test, the courts have also stated that EPA's balancing of costs and benefits "is a relatively subsidiary task and need not be precise." Eli Lilly, 598 F.2d at 656. A reasonable estimate of costs and benefits is sufficient. See, e.g., Eli Lilly, 598 F.2d at 656-57; Weyerhaeuser, 590 F.2d at 1049. The courts have also upheld an "overall" cost/benefit comparison and rejected arguments that EPA must do an "incremental" cost/benefit analysis, Weyerhaeuser, 590 F.2d at 1047-48, n. 55, or a "knee of the curve" analysis. Chemical Manufacturers, 870 F.2d at 203-07. In the context of the BPT standard, the courts have also been clear that EPA has broad discretion in determining how to consider costs and benefits and in deciding the point at which costs become "wholly disproportionate" to benefits. E.g., Chemical Manufacturers, 870 F.2d at 207 ("'The selection of the point of diminishing returns is a matter for agency determination.'" [citation omitted]); Eli Lilly, 598 F.2d at 656-57; American Iron & Steel Institute v. E.P.A., 568 F.2d 284, 297 (3d Cir. 1977). The courts have also ruled that they should defer to EPA's decisions applying the wholly disproportionate test unless they are "not reasonable" or are "arbitrary and capricious." Chemical Manufacturers, 870 F.2d at 206, 207. See also Association of Pacific Fisheries v. E.P.A., 615 F.2d 794, 809 (9th Cir. 1980) (court review should ensure that decision is the "product of reasoned decision-making, adequately supported by information available to the Agency").

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22 See, e.g., Chemical Manufacturers Association v. U.S. E.P.A., 870 F.2d 177, 203-04 (5th Cir. 1989); Eli Lilly and Company v. Costle, 598 F.2d 638, 656 (1st Cir. 1979).

23 See, e.g., Chemical Manufacturers, 870 F.2d at 204-05; Eli Lilly, 598 F.2d at 656.

24 E.g., Eli Lilly, 598 F.2d at 656; Weyerhaeuser Company v. Costle, 590 F.2d 1011, 1048 (D.C. Cir. 1978).

25 See, e.g., Environmental Protection Agency v. National Crushed Stone Association, 449 U.S. 64, 71 n. 10, 80, 83 (1980); Eli Lilly, 598 F.2d at 656.

These principles should also apply to the application and review of application of the wholly disproportionate cost test under CWA § 316(b).

Finally, the courts have noted that one of the reasons that Congress did not require a more precise form of economic analysis in setting effluent discharge standards under the CWA is the impossibility of fully quantifying all the environmental benefits to be obtained from making technological improvements to reduce pollutant discharges.[26] This rationale applies equally to the difficulty of quantifying all the benefits of minimizing the adverse impacts of cooling water intake structures.

7.2.6 Interaction of CWA §§ 316(b) and 316(a) Analyses

CWA §§ 316(a) and (b) impose different standards and address different, though related, concerns. While § 316(a) addresses thermal discharges, § 316(b) addresses the adverse environmental impacts of the operation of CWISs. Section 316(a) authorizes EPA (or the State) to issue a permit with thermal discharge effluent limitations less stringent than otherwise required under §§ 301 and 306, as long as the alternative limits would be sufficient to ensure the protection and propagation of a balanced indigenous population of fish, shellfish and wildlife in and on the receiving water. Section 316(b), on the other hand, requires that the design, location, construction and capacity of CWISs reflect the best technology available for minimizing adverse environmental impacts, subject to the economic tests discussed above. CWA § 316(b) BTA requirements are not excused even if the adverse environmental impacts from the CWIS would not preclude the protection and propagation of the source water body's balanced indigenous population of fish, shellfish and wildlife. Of course, under the wholly disproportionate cost test, the more serious the adverse impacts, the more significant the costs that would be justified to reduce those impacts. Moreover, in assessing the impact from the CWIS, EPA must consider the impacts from the operation of the CWIS alone as well as its impacts considered *in conjunction with* other environmental stressors.

EPA has long held the above-stated views on the interaction of CWA §§ 316(a) and (b). For example, in the preamble to the 1976 Proposed Final CWA § 316(b) Regulations, EPA stated:

> . . . the conclusion in a 316(a) hearing should not necessarily govern the outcome of 316(b). Certainly, the Agency would not deny a request for less stringent thermal effluent limitations under 316(a) where the necessary statutory showing had been made because of entrainment effects of the plant's intake structure. Similarly, the Agency should not be precluded from addressing evident entrainment problems simply because the plant's thermal effluent is not itself environmentally unacceptable. The concerns of the two

[26] See, e.g., Pacific Fisheries, 615 F.2d at 809; Appalachian Power Company v. Train, 545 F.2d 1351, 1361 (4th Cir. 1977); American Iron and Steel Institute v. E.P.A., 526 F.2d 1027, 1075 (3d Cir. 1975).

> sections are different and the legal standards by which compliance with their requirements is to be judged are similarly distinct.

41 Fed. Reg. 17389 (April 26, 1976) (Final CWA § 316(b) Regulations later withdrawn by EPA after remand by federal court). The Administrator of EPA reached a similar conclusion in deciding a permit appeal related to the Seabrook nuclear power plant, but also provided the following more detailed explanation of how §§ 316(a) and (b) interact:

> **Interdependence of Sections 316(a) and (b).** The RA ruled that a determination of the effect of the thermal discharge cannot be made without considering all other effects on the environment, including the effects of the intake (i.e., entrainment and entrapment); the applicant must persuade the RA that the incremental effects of the thermal discharge will not cause the aggregate of all relevant stresses (including entrainment and entrapment by the intake structure) to exceed the 316(a) threshold. I believe this is the correct interpretation of Section 316(a). The effect of the discharge must be determined not by considering its impact on some hypothetical unstressed environment, but by considering its impact on the environment into which the discharge will be made; this environment will necessarily by impacted by the intake. When Congress has so clearly set the requirement that the discharge not interfere with a balanced indigenous population, it would be wrong for the Agency to put blinders on and ignore the effect of the intake in determining whether the discharge would comply with that requirement.
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> The Utilities argue that the Agency recognized the independence of the 316(a) and (b) in the preamble to the regulations, which states that the "concerns of the two sections are different and the legal standards by which compliance with their requirements is to be judged are similarly distinct" (41 F.R. 17389). As SAPL points out, the fact that the legal standards of the two sections are different does not mean that factual aspects of the intake may not be considered in making a legal conclusion about the discharge.
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> Finally, the RA ruled that even if entrainment and entrapment effects would not cause an "imbalance" [in the indigenous population of organisms in the water body,] they must be "minimized." This is in accord with Agency policy that "the conclusion in a 316(a) hearing should not necessarily govern the outcome of 316(b)" (41 F.R. 17389). Thus, the RA concluded, even if the 316(a) burden were met, an applicant could face

> restrictions on intake capacity which could only be met by use of closed cycle cooling. I believe this conclusion is also correct. As mentioned above, some considerations of cost relative to the environmental benefits to be obtained through further minimization would be appropriate.

Public Service Company of New Hampshire, 10 ERC at 1261-62. Accord *Decision of the General Counsel No. 63*, pp. 381-83 ("Simply because cooling water could be discharged at a temperature which does not unduly disrupt the aquatic ecosystem does not mean that the withdrawal of the cooling water therefore will not also have an adverse environmental impact.").

7.2.7 Cumulative Impacts

Consistent with the above discussion regarding the interaction of CWA §§ 316(a) and (b), BTA determinations under § 316(b) must consider any adverse cumulative effects of the operation of the CWIS. EPA cannot determine the adverse effects of the CWIS in insolation from other stresses on the same environment. For example, the loss to a CWIS of a certain number of organisms, or a certain percentage of a population organisms, might be a more serious adverse impact in an environment already suffering from other adverse impacts than it would be in an otherwise healthy ecosystem. As quoted above, "it would be wrong for the Agency to put blinders on." *Public Service Company of New Hampshire*, 10 ERC at 1262. In the end, any such cumulative effects must be considered on a case-by-case basis to assess the magnitude of the adverse effects of CWIS operation and the appropriateness of requiring certain expenditures to minimize those impacts.

7.2.8 Aspects of BTA for CWISs

CWA § 316(b) spells out four aspects of a CWIS that must reflect the BTA for minimizing adverse environmental impacts. These are the CWIS's design, location, construction and capacity. Each of these factors is discussed below.

7.2.8a Location

The term "location" has been interpreted by EPA to refer to the water body or the segment of the water body in which the CWIS is located.[27] The EPA 1976 Development Document (at p. 15) states that, "[t]he most important locational factor influencing the intake design is the nature of the water source from which the supply is taken." In addition, "location" has been interpreted also to

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[27] The term "location" is not defined in either the CWA or current EPA regulations. In the 1976 Proposed Final CWA § 316(b) regulations, EPA proposed defining "location" as the "position or site occupied by the cooling water intake structure." 41 Fed. Reg. 17390 (April 26, 1976) (proposed 40 C.F.R. § 402.11(b)). As discussed above, however, these regulations were later withdrawn after remand to EPA by a federal court.

refer to where the intake is located *within a particular water body*, such as its location within the water column, its location relative to the shore line, its location relative to the point of the thermal discharge, or its location relative to any particularly sensitive areas in the water (e.g., migration routes, spawning areas, etc.). Id. at Section II, pp. 15 - 26, 178-79. See also EPA Background Paper No. 3, p. 2–3; 1977 Draft CWA § 316(b) Guidance, p. 6; Public Service Company of New Hampshire, 10 ERC at 1263-64, 1270-72.

"Location" has sometimes been referred to as the most important factor in minimizing adverse impacts from a CWIS, because many adverse impacts can be avoided simply by not siting the intake in areas of sensitive or important natural resources.[28] However, adjustment of the "location" of a CWIS to minimize adverse environmental impacts is likely to be easier for a new facility than an existing facility. Nevertheless, "location" must be considered for existing facilities because it may be possible in some cases to reduce impacts by replacing an existing CWIS with a new one at a new location. Of course, the cost of such a "retrofit" would need to be considered, as well as any additional adverse environmental impacts that might result from "construction" of the new CWIS. See EPA 1976 Development Document, p. 169.

7.2.8b Design

EPA has interpreted the "design" component of BTA for CWISs to refer to various elements that make up the CWIS itself.[29] These elements include various screening systems ranging from "trash racks" to other screening technologies intended to try to keep fish or even larvae or eggs from being drawn into the plant. Systems to be considered could include physical screening systems as well as "behavioral" screening systems. In addition, various fish bypass and return systems intended to minimize the adverse impacts of impingement could be considered under the design element. Finally, consideration may also be given to various types of pumps and intake technologies, such as velocity caps, that influence the volume and velocity of water drawn into the plant. See EPA 1976 Development Document, pp. 27 - 143. See also EPA 1996 Supplement to Background Paper No. 3. Design elements should be considered for both new and existing facilities, though the technical feasibility and economic considerations may differ for each, especially given that new equipment for an existing facility will require retrofitting. EPA 1976

[28] "Plant siting and the location of the intake structure with respect to the environment can be the most important consideration relevant to applying the best technology available for cooling water intake structures. Care in the location of the intake can significantly minimize adverse environmental impacts." EPA 1976 Development Document, p. 178.

[29] The term "design" is defined in neither the CWA nor current EPA regulations. In the 1976 Proposed Final CWA § 316(b) regulations, EPA proposed defining "design" as "the arrangement of elements that make up the cooling water intake structure." 41 Fed. Reg. 17390 (April 26, 1976) (proposed 40 C.F.R. § 402.11(c)). However, these regulations were later remanded to EPA by a federal court and the Agency then withdrew the regulations.

Development Document, pp. 142-43.

7.2.8c Construction

The term "construction" has been interpreted by EPA to apply to the physical aspects of installing the CWIS.[30] EPA review of construction-related CWIS impacts has considered damage to the area of the ecosystem impacted by the process of installing the CWIS and its long-term placement in the ecosystem.[31] EPA has also considered the effects of turbidity generated by construction activities and erosion around the area of the CWIS, as well as any adverse effects from the disposal of material dredged or excavated from the area in which the CWIS will be placed. See EPA 1976 Development Document, pp. 145 - 47. If considering potential retrofits to a CWIS, consideration must also be given to whether construction of the retrofitted equipment will reflect the BTA for minimizing adverse environmental effects.

7.2.8d Capacity

The term "capacity" as used in CWA § 316(b) has been defined to refer to the volume of cooling water drawn through the intake.[32] The velocity of the water drawn into the plant may also be considered under this factor (as well as under the design factor). In *Decision of the General Counsel No. 41*, at 200 - 01, EPA's General Counsel stated the following:

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[30] The term "construction" is not defined in either the CWA or current EPA regulations. In the 1976 Proposed Final CWA § 316(b) regulations, EPA proposed defining "construction" as the "process of physically constructing the cooling water intake structure, including site preparation." 41 Fed. Reg. 17390 (April 26, 1976) (proposed 40 C.F.R. § 402.11(d)). However, these regulations were later withdrawn by EPA after they were remanded by a federal court.

[31] The latter consideration obviously overlaps with the consideration of location. EPA has noted that the various aspects of BTA for CWISs listed in CWA § 316(b) can overlap considerably. See EPA 1976 Development Document, p. 15.

[32] The term "capacity" is defined in neither the CWA nor current EPA regulations. In the 1976 Final CWA § 316(b) regulations, EPA proposed defining "capacity" as the "maximum withdrawal rate of water through the cooling water intake structure." 41 Fed. Reg. 17390 (April 26, 1976) (proposed 40 C.F.R. § 402.11(e)). The preamble to the regulations explained that "[the] relative magnitude of flow withdrawn for cooling" was one of the key factors to consider in evaluating the adverse impact from a CWIS. It further stated that "entrainment . . . realistically cannot be separated from intake structure capacity and location," and that "the extent of entrainment and impingement damage is in many cases correlated with the amount of water withdrawn . . .." Id. at 17388, 17389. Further, in discussing compliance dates, EPA stated that "the available technologies of cooling water intake structures for minimizing adverse environmental impacts . . . are closely related to capacity (volume of flow) . . .." Id.

> . . . it seems clear to me that the term "capacity" in § 316(b) means the volume of water withdrawn through a cooling water intake structure. This conclusion is supported by the commonly understood meaning of the term "capacity" [footnote to dictionary definition of "capacity" referring to "cubic contents; volume" omitted], the definition of the term in the regulations [footnote omitted], and the legislative history of the Federal Water Pollution Control Act Amendments of 1972.
>
> In the course of debating the conference report of the Act on October 4, 1972, the Senate was well aware of the dangers posed to aquatic life by the withdrawal of large volumes of water through cooling water intake structures [footnote omitted].

Accord *Decision of the General Counsel No. 63*, at p. 381, n. 10; *In re Public Service Company of New Hampshire*, 10 ERC at 1262 (Decision of Administrator of EPA). See also *Supplement to Background Paper No. 3* (September 3, 1996), p. A-3; *Background Paper No. 3* (April 4, 1994), p. 2-3; EPA 1976 Development Document, p. 153.

As with the other factors, "capacity" must be considered in making CWA § 316(b) determinations for both new and existing facilities. As EPA stated in *Decision of the General Counsel No. 63*, at p. 381, n. 10:

> Since the magnitude of entrainment damage is frequently a function of the amount of water withdrawn, the only way that massive entrainment damage can be minimized in many circumstances is by restricting the volume of water withdrawn or by relocating the intake structure away from the endangered larvae. The latter approach is often not feasible. Thus, in certain cases, the only means of minimizing serious entrainment damage is to restrict the volume of water withdrawn.

See also *In re Public Service Company of New Hampshire*, 10 ERC at 1264 (Decision of Administrator of EPA); EPA 1976 Development Document, p. 178; EPA Draft CWA § 316(b) Guidance (May 1, 1977), p. 13 ("Reducing cooling water flow is generally an effective means for minimizing potential entrainment impact . . . [and i]n fact, . . . may be the only feasible means . . . where potentially involved organisms are in relatively large concentration and uniformly distributed in the water column").

i. Miscellaneous Issues Related to Capacity

(A) Cooling Towers

The question has periodically arisen as to whether EPA has authority under CWA § 316(b) to mandate the installation of cooling towers as BTA to achieve flow (or "capacity") reductions to minimize adverse environmental impacts. The answer that EPA has consistently given is that the Agency is *not* authorized to *directly* order the installation of cooling towers because, although closely related to the CWIS, cooling towers are not considered part of the CWIS itself. At the same time, however, EPA has also consistently concluded that CWA § 316(b) does authorize EPA to impose a capacity (or flow) limit based on the permittee's ability to meet that limit using technologies such as cooling towers that have been determined to be appropriate at the particular plant.[33] While some have characterized this as *indirectly* requiring cooling towers, this is not really the case. Rather, such a limit imposes a performance standard for CWIS flow (or "capacity") which the permittee may meet in any manner it chooses. This could involve installing cooling towers, but it also could involve the company cutting back operations to reduce its flow.[34] What EPA needs to determine is whether there is a practicable method of meeting the capacity limit which has costs that are not wholly disproportionate to its benefits.

(B) Plant Outages

Similar to the discussion above pertaining to cooling towers, EPA cannot mandate plant outages *per se* under CWA § 316(b).[35] Rather, EPA can require appropriate flow limits which in some cases might require major reductions only at certain times. It would be up to the company to decide whether to meet such limitations by installing closed-cycle cooling technologies or by having periodic plant outages. If EPA is relying on the use of periodic plant outages as a

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[33] See *Decision of the General Counsel No. 63* (July 29, 1977), pp. 377-78, 382; *In re Public Service Company of New Hampshire*, 10 ERC at 1262 (June 17, 1977); *Decision of the General Counsel No. 41* (June 1, 1976), pp. 199-203. See also *Supplement to Background Paper No. 3*, p. A-3; *Background Paper No. 3*, pp. 2-3 to 2-4; Draft EPA CWA § 316(b) Guidance, p. 13; EPA 1976 Development Document (April 1976), pp. 149-57, 191.

[34] Compare *Decision of the General Counsel No. 41* (June 1, 1976), pp. 203; EPA 1976 Development Document, p. 153, with *In re Public Service Company of New Hampshire*, 10 ERC at 1262 (June 17, 1977).

[35] In setting flow limits based on the feasibility of outages, EPA may consider the fact that a plant may already need to have regular maintenance outages. EPA would have to consider whether additional outages beyond the regular ones would be needed, as well as the feasibility, cost and other ramifications of scheduling those outages at times that would ensure the minimization of adverse environmental impacts from CWIS operation.

practicable method of achieving the capacity limit, EPA would need to determine that such outages would be practicable and that their cost would not be wholly disproportionate to their benefits. See *Supplement to Background Paper No. 3*, p. A-3 (discussion of scheduling outages during months of maximum impingement); Bulletin, Marine Resources Advisory Council, Vol. IX, No. 4, "Effects of Power Plants on Hudson River Fish," (requirements for plant included scheduled plant outages); *In the Matter of Florida Power Corporation, Crystal River Power Plant, Units 1, 2 and 3, Citrus County, Florida* (Findings and Determinations Pursuant to 33 U.S.C. § 1326; NPDES Permit No. FL 0000159), p. 8.

(C) Seasonal or Otherwise Variable CWIS Restrictions

As with effluent discharge limitations, EPA can impose seasonal or otherwise varying requirements under CWA § 316(b). For example, flow limits could be tighter during spawning seasons and less restrictive at other times of the year. See *Supplement to Background Paper No. 3*, p. A-3; EPA 1976 Development Document, pp. 2, 153.[36] As always, the practicability of methods for meeting such limits must be determined and the cost of doing so must be found not to be wholly disproportionate to the benefits.

7.2.9 Water Quality Standards

The NPDES permit's requirements pertaining to CWISs under CWA § 316(b) must also be consistent with applicable State legal requirements, including water quality standards. Determining exactly how to apply water quality standards to CWIS requirements in any given case will depend on the exact nature of the water quality standards and the particular circumstances of the case at hand. The most obvious consideration, however, is whether the CWIS requirements will provide for the protection of the designated uses of the water bodies of concern. For example, the Class SA portion of the Massachusetts section of Mount Hope Bay is designated to be "excellent habitat for fish." The CWIS-related requirements should not interfere with attaining that use designation.

In PUD No. 1 of Jefferson County v. Washington Department of Ecology, 511 U.S. 700, 711-12 (1994), the Supreme Court explained that while a discharge must exist to trigger the application of the water quality standards certification provisions of CWA § 401(a)(1), CWA § 401(d) and EPA regulations at 40 C.F.R. § 121.2(a)(3) authorize conditions to be placed on the permit applicant's *activity as a whole* so as to ensure compliance with any applicable effluent limitations under §§ 301, 302, 306 or 307, and any applicable water quality standard or other requirement of State law. The Court stated:

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[36] See also *In the Matter of Florida Power Corporation, Crystal River Power Plant, Units 1, 2 and 3, Citrus County, Florida* (Findings and Determinations Pursuant to 33 U.S.C. § 1326; NPDES Permit No. FL 0000159), p. 8.

> Section 401(a)(1) identifies the category of activities subject to certification – namely those with discharges. And § 401(d) is most reasonably read as authorizing additional conditions and limitations on the activity as a whole once the threshold condition, the existence of a discharge, is satisfied.

Id. Furthermore, the Court made clear that narrative provisions related to designated uses included in water quality standards may be enforced through permit conditions. Id. at 713-19. The Court explained:

> Under the statute, a water quality standard must "consist of the designated uses of the navigable waters involved *and* the water quality criteria for such water based upon such uses." 33 U.S.C. § 1313(c)(2)(A) (emphasis added). The text makes it plain that water quality standards contain two components. We think the language of § 303 is most naturally read to require that a project be consistent with *both* components, namely, the designated use *and* the water quality criteria. Accordingly, under the literal terms of the statute, a project that does not comply with a designated use of the water does not comply with the applicable water quality standards.
>
> Consequently, pursuant to § 401(d) the State may require that a permit applicant comply with both the designated uses and the water quality criteria of the state standards. In granting certification pursuant to § 401(d), the State "shall set forth any ... limitations .... necessary to assure that [the applicant] will comply with any ... limitations under [§ 303] ... and with any other appropriate requirement of State law." A certification requirement that an applicant operate the project consistently with state water standards –i.e., consistently with the designated uses of the water body and the water quality criteria – is both a "limitation" to assure "compl[iance] with ... limitations" imposed under § 303, and an "appropriate" requirement of State law.

Id. at 714-15.

7.3 Technological Options

7.3.1 Introduction

This section discusses potentially available, practicable technological alternatives for ensuring that the design, construction, location and capacity of the CWISs at BPS reflect the BTA for minimizing adverse environmental impacts, as required by CWA § 316(b). This discussion considers engineering, environmental and, at a general level, economic issues related to these alternatives. In addition, this section presents some preliminary "screening" (i.e., winnowing) of alternatives based on factors that EPA believes establish that the rejected alternatives would not be preferred over the alternatives retained for more detailed analysis. A reasonable range of options is retained for more detailed comparison after this initial screening. Subsequent sections of this report provide a more detailed economic analysis of the remaining alternatives and present EPA's analysis of whether the cost of particular options would or would not be wholly disproportionate to the benefits they would provide.

As part of its permit application, and in response to EPA information requests, the permittee has submitted a significant amount of information related to potential CWIS-related technologies. In evaluating alternative technologies, EPA has considered both the material submitted by the permittee and other materials, such as EPA's own (and contractor) expert engineering analysis, relevant guidance documents, information regarding experience at other power plants, and information from equipment manufacturers.

7.3.2 CWIS Technologies for Minimizing Adverse Environmental Impacts - General

The primary adverse environmental impacts of concern from the operation of CWISs at BPS are the entrainment of small marine organisms, such as fish eggs and larvae, and the impingement of larger marine organisms, such as fish.[37] Looked at broadly, and as dictated by CWA § 316(b), there are several major approaches to reducing these adverse impacts from CWISs that must be considered. They include the following: 1) "capacity" (or flow) reduction measures which are considered to yield corresponding reductions in the numbers of organisms entrained and impinged by the CWIS; 2) "design" and "capacity" options to lessen impingement by reducing the velocity of the water drawn into the CWIS so that fish are more likely to be able to swim away from the intake; 3) "design" options for barriers and fish return systems to try to reduce the number of organisms drawn into the CWIS where they are impinged or entrained and to try to return any impinged organisms to the source water body unharmed; and 4) "location" options, which for an existing plant would involve *re*-locating the CWIS to a new, less biologically productive or sensitive site or part of the water column that would reduce entrainment and/or impingement effects. With any of these options, the adverse environmental impacts of "construction" of the technology must also be considered along with alternatives for minimizing those impacts. For example, moving a cooling water intake to a new location might offer potential reductions in entrainment and impingement, but construction activities could have adverse environmental effects that would also need to be considered in deciding whether to require such a re-location under CWA § 316(b).

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[37] In addition to fish impingement, problems have arisen at some facilities, but not BPS, with impingement of lobsters (Schiller Station, NH), seals and diving birds (e.g., Seabrook Station, NH), and reportedly sea turtles (plants in Florida).

Within the broad categories described above, there are numerous specific technological options to consider. Indeed, a variety of technologies exist for generating electricity with little or no withdrawal of water from natural water bodies for cooling (e.g., “dry” cooling towers; wet cooling towers; wet/dry cooling towers; or use of gray water for cooling). These technologies have been in use for many years, and they generally result in little or no adverse environmental impacts from CWISs. Many of these options are discussed in EPA’s May 1977 Draft § 316(b) Guidance, the EPA 1976 Development Document, the 1994 EPA Background Paper No. 3, the 1996 EPA Supplement to Background Paper No. 3, and the various past regulatory preambles issued by EPA, including the preambles to the recent proposed and final CWA § 316(b) regulations for new facilities. See, e.g., 41 Fed. Reg. 17388 (April 26, 1976); 39 Fed. Reg. 36189 (Oct. 8, 1974).

Nevertheless, these technologies are not automatically considered BTA for existing facilities under the current case-by-case approach. For existing facilities, BTA determinations must be made on a site-specific basis taking into account the need to retrofit the technologies to the existing plant. Thus, since BPS is an existing power plant, EPA must evaluate what technologies would constitute BTA under CWA § 316(b) for a *retrofit at BPS*. This includes an evaluation of the practicability of a retrofit *at BPS*. See 41 Fed. Reg. 17388 (April 26, 1976). It also requires an assessment of the technology’s capacity to reduce adverse environmental impacts *at BPS*, an assessment of the cost of installing and operating the technology *at BPS*, and an evaluation of whether or not the cost of the technology would be wholly disproportionate to the benefits. See In re Public Service Company of New Hampshire, 10 ERC at 1261 (permit appeal decision by EPA Administrator) (“some consideration ought to be given to costs in determining the degree of minimization to be required . . . – otherwise the effect would be to require cooling towers at every plant that could afford to install them, regardless of whether or not any significant degree of entrainment or entrapment was anticipated”).

7.3.3 Major Submissions by the Permittee

Since issuance of the current NPDES permit in 1993, the permittee has submitted several major documents to the permitting agencies addressing CWIS technologies to support the next permit reissuance. The permittee has also made several smaller submissions and a number of presentations at meetings on this topic.

In late 1996, EPA sent the New England Power Company (NEPCO), then the permittee and owner and operator of BPS, an information request letter under CWA § 308. This request sought, among other things, information related to alternative technologies that might be used at BPS to reduce adverse environmental impacts from both the entrainment and impingement of marine life by the plant’s CWISs and the effects of its thermal discharge to Mount Hope Bay. NEPCO contracted Stone and Webster Engineering Company (Stone & Webster) to describe and compare alternatives. NEPCO then submitted to EPA a Stone & Webster report entitled "Feasibility Study of Cooling Water System Alternatives for Brayton Point Generating Station" (January, 1997) (the “January 1997 NEPCO Report”).

In September, 1998, NEPCO sold BPS to USGenNE, which continued the Section 316(b) alternative technology analyses. On February 22, 2001, USGenNE submitted a report entitled, "NPDES Renewal: USGen New England, Inc., Brayton Point Station, Somerset, Massachusetts" to the regulatory agencies (EPA-New England and MA DEP). This report stated that it summarized and condensed certain new information on "Cooling System Alternatives" provided by Stone & Webster, but also indicated that Stone & Webster was still doing additional work for USGenNE on CWIS options. Subsequently, USGenNE submitted the May 24, 2001 Partial 316(a) and (b) Demonstration, which includes additional material related to CWISs. On September 10, 2001, in response to another EPA information request letter, USGenNE submitted a document entitled, "A Response to Section 308 Information Request dated August 10, 2001." The latter document also evaluates certain technological alternatives for reducing BPS's thermal discharges and the volume of water withdrawn through its CWISs.

Then, on December 7, 2001, the permittee made a new submission to EPA and DEP entitled, "Clean Water Act Section 316(a) and (b) Demonstration, Brayton Point Station Permit Renewal Application" (November 2001) (hereinafter, the "December 2001 USGenNE 316(a) and (b) Demonstration"). This submission includes five large volumes with thousands of pages of material, including a 67-page "Executive Summary." Some of this material had been submitted previously by the permittee, while other portions had not. Such a late submission of this voluminous, complex package by the permittee – the permittee's application for permit renewal was due, and was originally filed by the permittee, in January 1998 – created a challenge for the regulatory agencies, but the agencies have endeavored to carefully review and consider the material in the December 2001 USGenNE 316(a) and (b) Demonstration.

A few points must be made regarding the above-mentioned submissions by the permittee. In the January 1997 NEPCO Report (p. 1-1), the permittee imposed the following constraints on its evaluation of alternatives:

- It would only consider thermal load-reduction alternatives that could reduce the average monthly thermal loading from BPS to Mount Hope Bay by approximately $2x10^{12}$ [trillion] BTUs. (Nb., The baseline heat load to Mount Hope Bay from BPS currently peaks around $4x10^{12}$ [trillion] BTUs per month. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, App. G, Tab: USGenNE § 308 Response of September 10, 2001, Table B-2.)

- It would only consider intake alternatives which at most would reduce station entrainment to levels consistent with the operation of Units 1[, 2] and 3 only, and which improve impingement survivorship to levels consistent with the angled-intake screens for Unit 4.

EPA was not made aware of these constraints in advance and neither approved them nor otherwise indicated that an evaluation based on such constraints would suffice under CWA § 316(b). Indeed, EPA believes that screening out options based on these constraints would not yield an adequate consideration of alternatives for BTA under CWA § 316(b).

A similar issue exists with the alternatives screening criteria used in the permittee's report of February 22, 2001. This report attached a February 2001 report entitled, "Summary of Cooling System Alternatives Analysis for Reducing Thermal Discharge and Entrainment and Impingement at Brayton Point Station." The latter report states (at p. 7) that, "[t]he focus of the ongoing cooling system alternatives analysis is to identify alternatives and combinations of alternatives that could (a) reduce the station's thermal discharge to levels that existed before Unit 4 started discharging heat into Mt. Hope Bay and (b) reduce circulation water flows to levels equivalent to Units 1, 2 and 3 only." Accordingly, the permittee then set plant performance criteria to meet these goals and used these criteria as a benchmark for evaluating alternatives. In a June 19, 2001, letter, EPA explained to the permittee that the government agencies had not embraced these criteria for their own evaluations of what constitutes adequate performance and that the agencies would instead look to the criteria stated in federal and state environmental laws, such as those found in CWA § 316(b). The letter also noted that EPA and the States had explained to the permittee at a number of meetings that the regulatory agencies had not determined whether or not rolling back the plant's thermal discharge and cooling water intake profile to the levels observed before Unit 4 was converted to once-through cooling would be sufficient to meet the environmental standards of applicable laws. <u>See</u> June 19, 2001, Letter from David Webster (EPA) to Meredith Simas (USGenNE). Nevertheless, the permittee continued to use this criterion for judging alternatives in the December 2001 USGenNE 316(a) and (b) Demonstration. <u>See</u> Vol. IV, § 4.4.

7.3.4 Options for Ensuring that the Design, Construction, Capacity and Location of the BPS CWIS's Reflect the BTA for Minimizing Adverse Environmental Impacts

7.3.4a Capacity Reduction Options

As discussed above, EPA has interpreted the term "capacity" in CWA § 316(b) to refer to the volume of flow through the CWIS. As is also discussed above, EPA has indicated in relevant guidance and past decisions that flow reduction measures are in many cases the most significant steps that can be taken to reduce adverse environmental impacts from entrainment and impingement, especially if it is not possible to re-locate the CWIS to an area that is not biologically sensitive or productive. There are numerous ways for power plants to generate electricity while reducing the capacity of (or volume of flow through) their CWISs. Methods considered by EPA for possible application at BPS are discussed below.

i. Closed-Cycle Cooling/Cooling Tower Options

Steam electric power plants can generate electricity while using substantially less water than is required for a once-through cooling system by instead using a "closed-cycle cooling" system. Generally, steam electric powerplants employ one of four basic types of circulating water systems to reject waste heat. These systems are (1) once-through cooling (presently used at BPS), (2) once-through cooling with supplemental cooling on the discharge, (3) entirely closed-cycle or recirculating cooling, and (4) combinations of these three systems. In a once-through (or non-recirculating) system, the entire amount of waste heat is discharged to the receiving water body. A once-through system with supplemental cooling (e.g., from "helper cooling towers") removes a portion of the plant's waste heat from the effluent before discharging it to the receiving water and transfers this energy to the atmosphere. This type of system does not, however, offer a reduction in the volume of water used.

Closed-cycle or recirculating cooling water systems employ a cooling device that withdraws the plant's waste energy from the cooling water and releases it directly to the atmosphere. The facility is then able to recirculate and reuse the previously heated water for additional cooling. There are two basic methods of heat rejection for closed-cycle systems. The first is wet (or evaporative) cooling using cooling towers. See, e.g., 1994 EPA Background Paper No. 3, pp. 2-3 to 2-5 (general discussion of cooling towers); 66 Fed. Reg. 65282 (Dec. 18, 2001). The second uses cooling ponds or lakes. These two methods dramatically reduce cooling water use, though they do require a much smaller amount of water as makeup.

A third type of cooling system does not use cooling water at all and, instead, employs "dry cooling towers" ("or air-cooled condensers"). This method eliminates the use of cooling water and rejects heat directly to the atmosphere from the surface of the condenser. No evaporation of water is involved. See, e.g., 66 Fed. Reg. 65282 (Dec. 18, 2001); EPA Office of Water, "Economic and Engineering Analysis of the Proposed § 316(b) New Facility Rule) (August 2000), Appendix A, p. 14 ("EPA Economic and Engineering Analysis"). Dry cooling systems are regarded to be substantially more expensive than wet cooling tower systems. See, e.g., 66 Fed. Reg. 65282-83 (Dec. 18, 2001).

Another type of closed system worthy of note is the "hybrid" (or "wet/dry") system which combines principles of both wet and dry tower operations. The advantage of this type of cooling system is that it can be used to reduce and /or eliminate any problematic water vapor plumes from mechanical draft cooling towers. See 65 Fed. Reg. 49081 (August 10, 2000) (discussion of wet/dry tower); December 10, 2001, Phone Memo from Sharon Zaya, EPA, Regarding Call with Gary Mirsky, P.E. Hamon Cooling Towers, N.J.; January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey; 39 Fed. Reg. 36192 (October 8, 1974); EPA Economic and Engineering Analysis, App. A, p. 14. This technology would be less expensive than dry cooling but more expensive than a wet cooling tower system. See 65 Fed. Reg. 49081 (August 10, 2000) (discussion of wet/dry tower); Science Applications International Corporation (SAIC) Report (March 15, 2002), Table 5.

As explained above, EPA has interpreted CWA § 316(b) not to allow it to directly mandate cooling towers because they are not actually part of a CWIS. However, EPA has also interpreted the law to allow it to impose a CWIS capacity (or flow) limit that is reflective of the performance capabilities of cooling tower technologies as BTA. This may indirectly help to push a plant to install cooling towers, but it is up to the plant to decide how to meet the permit's flow limit.

There is no question that *as a general matter* wet, dry and wet/dry cooling towers are all practicable, available technologies for power plants. Wet cooling towers have been widely used at power plants for many years. See, e.g., Id.; 65 Fed. Reg. 49080-81 (August 10, 2000); 1996 EPA Supplement to Background Paper No. 3, p. A-3; 41 Fed. Reg. 17388 (April 26, 1976); 1976 Draft EPA CWA § 316(b) Guidance, p. 13; EPA 1976 Development Document (April 1976), pp. 149-57, 191; 39 Fed. Reg. 36192 (October 8, 1974). Air cooling is also clearly a viable technology as air cooling systems have been installed or proposed for installation at a number of facilities in the United States, including new units at the Mystic Station and the Fore River Station in Massachusetts. See also 65 Fed. Reg. 49080-81 (August 10, 2000); November 6, 2000, Letter from Vern Lang (US F&WS) to EPA Proposed Rule Comment Clerk, p. 3 (comments on EPA's proposed regulations under CWA § 316(b) for new power plants listing a number of facilities currently operating, under construction, or recently approved for dry cooling); EPA Economic and Engineering Analysis, App. A, p. 14. In addition, wet/dry cooling towers are also a practicable technology used at a number of plants. See, e.g., 65 Fed. Reg. 49080-81 (August 10, 2000); EPA Economic and Engineering Analysis, App. A, p. 14-15; 39 Fed. Reg. 36192 (October 8, 1974); Literature from Marley Cooling Tower Company; Public Service Commission of Wisconsin/Wisconsin Department of Natural Resources, Final Environmental Impact Statement, Badger Generating Company, LLC, Electric Generation and Transmission Facilities (June 2000, 9340-CE-100), Executive Summary.

Finally, it is also important to recognize that a single power plant could combine the use of both open-cycle and closed-cycle cooling technologies in order to reduce overall plant flows to some predetermined level or to prevent going above some specified cost threshold. See 1994 EPA Background Paper No. 3, p. 2-3. Such "combination options" should especially be considered for existing plants being considered for possible retrofit technology changes, because it will be easier and less expensive for an existing plant to retrofit to partially closed-cycle cooling than to switch to a completely closed-cycle operation. Indeed, the permittee's "Enhanced Multi-Mode" proposal, which is discussed below, is a type of "combination option." Accordingly, a number of alternatives have been considered for BPS which involve partially shifting the facility to closed-cycle cooling while also allowing some open-cycle cooling to remain.

While it is clear that the above technologies are generally available and practicable, in making the case-by-case BPJ determinations for this permit, EPA must determine whether these technologies are available and practicable *specifically for retrofitting at BPS*. There could, for example, be practicability issues related to the adequacy of space to install cooling towers at a particular site. In addition to practicability, other issues must also be considered in determining whether the capacity reductions achievable from a particular closed-cycle cooling technology should be determined to be BTA at a specific plant. For example, cooling tower facilities could impose certain adverse environmental impacts on local residents and these must be considered. For mechanical draft cooling tower facilities (wet or dry), there are noise emissions that must be considered. For wet cooling tower systems, there may be concerns related to emission of plumes of mist or water vapor. Finally, use of any closed-cycle cooling technology will likely result in a marginal loss of electrical generation efficiency at the plant. This has an economic cost associated with it and could also potentially lead a plant to burn more fossil fuel and emit more air pollution in an effort to offset the efficiency losses. These kinds of issues are discussed below.

(A) "Air" or "Dry" Cooling Towers

As discussed above, using air (or dry) cooling towers would yield the maximum reduction in flow of any cooling technology by essentially eliminating the use of water for cooling. This option would, however, be substantially more expensive than using wet mechanical draft cooling towers. See EPA Economic and Engineering Analysis, App. A, p. 14; 66 Fed. Reg. 65282-84, 65304-06 (Dec. 18, 2001) (various estimates put the costs of dry cooling as from 1.75 to three times more than the cost of wet cooling); January 1997 NEPCO Report, Table 6-1 (preliminary capital cost estimate of $63.4 for dry cooling *for Unit 4* vs. $27.8 for mechanical draft wet cooling *for Unit 4*).[38] See also SAIC Report (March 15, 2002), Table 5 (costs for hybrid wet/dry cooling towers approximately 2.5 times that of conventional wet towers).

The permittee looked at a dry cooling alternative for Unit 4 only in the January 1997 NEPCO Report, see pp. 3-6 to 3-9, but did not carry it forward for further detailed analysis. See December 2001 USGenNE 316(a) and (b) Demonstration, p. 1-3. In the January 1997 NEPCO Report, at pp. 3-8 to 3-9, the permittee stated that the dry cooling alternative for Unit 4 would be "marginally feasible" but was considered a poor alternative due to its greater cost (more than twice as expensive), greater size (thus posing possible space constraints), greater noise, and greater diminishment of plant power generation capacity. The permittee also noted that since a retrofit from once-through to dry cooling had never been completed, to its knowledge, it would be inherently difficult and would require especially difficult and expensive engineering and design work. Id. at p. 3-8. In the December 2001 USGenNE 316(a) and (b) Demonstration, at p. 1-3, the permittee stated that dry cooling "was determined to be infeasible because this technology has never been retrofitted to an existing station and thus has significant risk of operating failure." This does not appear to be an entirely accurate representation of the conclusions from the 1997 NEPCO Report, and the December 2001 submission does not include any new analysis on the subject. Yet, while the permittee may have felt dry cooling was "marginally feasible" for Unit 4 alone, it does not mean that the permittee felt that dry cooling would be even marginally feasible for additional units.

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[38] The costs in the January 1997 NEPCO Report only address options that provide closed-cycle cooling only for Unit 4. It should also be noted that the more detailed cost analyses conducted by the permittee for the December 2001 USGenNE 316(a) and (b) Demonstration has resulted in substantially higher cost estimates. Compare January 1997 NEPCO Report, Table 6-1 (capital costs for mechanical draft cooling tower for Unit 4 estimated at $27.8 million), with December 2001 USGenNE 316(a) and (b) Demonstration, p. 3.3-18 (capital costs for mechanical draft cooling tower for Unit 4 estimated at $48 million). Thus, it is fair to assume the permittee's estimates for dry cooling would also increase substantially, though the permittee provided no cost estimate for converting any or all BPS units to dry cooling in its December 2001 USGenNE 316(a) and (b) Demonstration.

EPA does not agree that it has been demonstrated that retrofitting some or all the generating units at BPS with dry cooling has necessarily been demonstrated to be "infeasible" for one or more units at BPS. However, EPA Region I also is not aware of an example of a large, existing plant switching from once-through cooling to dry cooling. EPA does not believe that such a conversion is necessarily *infeasible* just because it may not have been done in the past – indeed, in the January 1997 NEPCO Report, the permittee stated that dry cooling for at least Unit 4 was "marginally feasible." However, EPA shares the view of the permittee that the absence of a track record of such conversions must be cause for serious caution and concern, and that this caution must grow as more units are considered for conversion.

As a result, like the permittee, EPA has also decided drop dry cooling towers from further consideration for retrofitting at BPS for a combination of reasons. Wet mechanical draft cooling towers, which *will* receive further detailed consideration, can achieve up to a 96% reduction in flow for each converted unit at much lower costs. Therefore, choosing air cooling would involve substantially greater expense for only an additional 4% reduction in flow for each unit that was converted. As mentioned above, costs for dry cooling could be as much as three times the cost of wet cooling towers, and this cost difference would be increased by the fact that dry cooling imposes a somewhat greater energy penalty. Moreover, there is substantially more uncertainty about the feasibility (or difficulty) of retrofitting open-cycle generating units to dry cooling than there is with respect to wet cooling, and this uncertainty grows as more units are considered for conversion. Thus, for the multiple unit options, which will achieve greater flow reductions than single unit options, the feasibility of converting to wet cooling towers is clear, whereas the feasibility of the dry cooling options is not.

Based on current information, EPA does not believe that in this case obtaining the small additional reduction in flow offered by dry cooling over wet cooling warrants the substantial additional cost (including energy penalties), especially in light of the substantial uncertainty regarding the technical feasibility retrofitting multiple units at BPS to dry cooling. Since EPA is evaluating wet mechanical draft cooling towers, including an option that would address all four generating units, EPA does not believe that further evaluation of air cooling at BPS is necessary.

(B) Wet Cooling Towers

Mechanical Draft versus Natural Draft Wet Cooling Towers. There are two principal types of wet cooling towers that are used in closed cycle systems: natural draft and mechanical draft towers. Natural draft towers "have no mechanical device to create air flow through the tower and are usually applied in very small or very large applications." See 1994 EPA Background Paper No. 3, p. 2-4. Mechanical draft towers use fans in the cooling process. See Id.; EPA Economic and Engineering Analysis, p. 11-2 to 11-3; App. A, p. 14.

The permittee evaluated both natural draft and mechanical draft cooling towers and concluded that natural draft towers should be dropped and further consideration should be given to mechanical draft applications. The reason offered for this decision was that the two technologies offer equivalent reductions in flow (and heat rejection), but natural draft towers are significantly more expensive to construct and pose more serious adverse visual impacts because they are much taller. February 22, 2001, Letter from Meredith M. Simas, USGenNE, to David Webster, EPA, and Edward P. Kunce, MA DEP, Attachment 1, p. 4. See also January 1997 NEPCO Report, Table 6-1.

EPA agrees with the permittee's decision to focus more detailed review on mechanical draft towers. Although EPA has not done a detailed check of the costs predicted by USGenNE for natural draft towers, the research we have done also indicates that natural draft towers would be more expensive to install than mechanical draft towers while achieving the same level of flow (and thermal discharge) reductions. See EPA Economic and Engineering Analysis, App. A, p. 14. In addition, the visual/aesthetic impacts are clearly far greater for natural draft towers because of their great height (approximately 6 times higher). See January 1997 NEPCO Report, pp. 3-13, 3-19. It should be noted that mechanical draft towers are likely to be somewhat noisier (due to the fans) and somewhat more costly to operate (due to the energy needed to run the fans). See January 1997 NEPCO Report, pp. 3-15, 3-21, 3-22; EPA Economic and Engineering Analysis, App. A, p. 14. EPA does not believe, however, that any of these issues are particularly significant. EPA believes it likely that any noise effects from mechanical draft towers can be sufficiently mitigated/controlled to meet applicable noise standards. Id. (Noise is discussed further below.) Further, EPA also believes that the difference in energy use between the two technologies is not large enough to be a significant issue and would be offset by the increased capital costs for the natural draft towers. (Energy and cost issues at BPS are discussed further below.) Mechanical draft cooling towers are a widely used technology at power plants in the United States and abroad, clearly indicating that their impacts or costs are not unacceptable as a general matter.

It should also be noted that although natural draft towers may emit less mist or water vapor than mechanical draft towers, see 39 Fed. Reg. 36189, 36192 (Oct. 8, 1974), this advantage is likely to be more than offset by the fact that any plumes will travel farther from the taller natural draft towers than they would from the shorter mechanical draft towers. See Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities (EPA-821-R-01-036) (November 2001), p. 3-33 (EPA TDD 2001- New Facilities); 1/8/02, Email from Timothy Connor, EPA Headquarters to Mark Stein, EPA Region 1; 12/12/01 Memorandum from Mark Stein to Brayton Point NPDES Permit File ("Brief Notes on an Issue Discussed During Conference Call with John Gulvas of Consumers Energy and the Palisades Nuclear power station in Covert, Michigan"); January 1997 NEPCO Report, p. 3-15. While it may not be entirely clear which technology would be preferable from this perspective, even if natural draft towers had a marginal advantage, EPA still agrees with the permittee's decision to focus on mechanical draft towers because we do not believe the plume problems are likely to be especially significant, there are means to address any such problems, and we believe that at this site the advantages of mechanical draft towers (i.e., less expensive, less visual/aesthetic impacts) outweigh any marginal advantage that natural draft towers might have in this regard.

General Applicability of Mechanical Draft Cooling Towers at BPS. Mechanical draft cooling towers appear to be practicable for use at BPS. Such cooling towers have been designed and installed to work effectively in cooling systems using salt or brackish water. See, e.g., December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-2; Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule (EPA 821-R-02-003) (April 2002), p. 4-1 (EPA TDD 2002- Existing Facilities); 12/20/01 Email from Timothy Connor, EPA, to Mark Stein, EPA. Experience at other plants has also shown that closed-cycle mechanical draft wet cooling towers can be retrofitted to an existing once-through power plant. See SAIC Report (March 15, 2002), Attachment A (Case 4); EPA TDD 2002 - Existing Facilities, Chapter 4; Memorandum from Nick Prodany and Mark Stein to Brayton Point NPDES Permit File, "Notes on Telephone Call with Engineer at Canadys Station power plant in South Carolina;" 12/12/01 Memorandum from Mark Stein to Brayton Point NPDES Permit File ("Brief Notes on an Issue Discussed During Conference Call with John Gulvas of Consumers Energy and the Palisades Nuclear power station in Covert, Michigan"); January 1997 NEPCO Report, p. 3-6; 12/18/01 Email from Timothy Connor, EPA, to Mark Stein, EPA. Indeed, the permittee has not argued that such a retrofit would be impracticable.[39] Furthermore, EPA and the permittee agree that there is adequate space at BPS to install closed-cycle mechanical draft wet cooling towers, though space becomes increasingly tight as more cooling tower cells are added. See, e.g., December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Figures 3.3-1, Sections 3.3, 3.3.5, 3.3.6.

Shifting to closed-cycle cooling with mechanical draft cooling towers at BPS clearly could achieve major reductions in the adverse impacts of entrainment and impingement from the CWISs at the plant by enabling substantial reductions in flow through the plant. The extent of the flow reductions that mechanical draft cooling towers would achieve at BPS depends on whether they would be installed for all or only some of the generating units. For traditional steam electric facilities located on fresh water bodies, closed-cycle (recirculating) cooling water systems can, depending on the quality of the make-up water, reduce water use by 96 to 98 percent from the amount used by a once-through cooling water system. Steam electric generating facilities that have closed-cycle (recirculating) cooling water systems using salt water have been estimated to reduce water usage by from approximately 71 to 96 percent depending on drift, blowdown and evaporative losses. See Memorandum from CK Environmental to Martha Seagull, Tetra Tech, Inc. (June 26, 2000). Consistent with these figures, the permittee has estimated that the total water withdrawal rate at BPS could be reduced by approximately 96 percent – from 931,000 gallons per minute (gpm) to 39,000

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[39] EPA acknowledges that the permittee has pointed to a number of detriments for retrofitting closed-cycle mechanical draft cooling towers at BPS, and has reached the opinion that retrofitting *the entire facility* to closed-cycle cooling towers would be "unsuitable" for a variety of economic, engineering and environmental reasons. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, p. 8, n. 7. The company has, however, proposed the installation of its "Enhanced Multi-Mode" system which utilizes a 20-cell mechanical draft wet cooling tower.

gpm, or from the present permit limit of 1.4 billion gallons per day to 56 million gallons per day – if the entire plant were shifted to closed cycle cooling with wet mechanical draft towers, with correspondingly lesser reductions if only certain units are converted. USGenNE § 308 Response of September 10, 2001, pp. 3.3-2 to 3.3-3; December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.3-25.

The permittee also evaluated the option of using gray water (treated wastewater effluent) to provide "makeup" water for the closed-cycle cooling tower options. Id. §3.3.4. Specifically, the permittee investigated obtaining wastewater effluent from the Fall River Publicly Owned Treatment Works (POTW). The Fall River POTW discharges an average annual daily flow of approximately 20 MGD to Mount Hope Bay which could be used for cooling water purposes. However, the POTW is located across the bay and a pipeline would be required to be constructed to transport the gray water to the power plant. The permittee concludes that such a pipeline would be feasible, but EPA believes it could raise sensitive environmental issues and permitting uncertainties. Id. at p. 3.3-22. In addition, as the permittee notes, the use of treated sewage as cooling water that will be vaporized and emitted from a cooling tower may raise public health and environmental concerns, such as the spreading of viruses, bacteria or trace contaminants. Although the permittee indicates that there are no cases of health problems attributed to the use of gray water for cooling towers or even from the aerosols generated by wastewater treatment plants, EPA believes this issue would warrant additional analysis if this option is to be pursued.
Furthermore, the permittee estimates that this option would add an additional $29 million in capital costs. Apart from the above concerns, the permittee ultimately concludes that the gray water option is not feasible because the POTW cannot consistently provide enough water to meet the makeup needs of the power plant. Id. at p. 3.3-21. EPA believes that the gray water option could provide some potential benefits for reducing water withdrawals from Mount Hope Bay. Nevertheless, based on current information, we are not convinced that this option is feasible or advisable because of the limited and variable volume of gray water available from the POTW (especially during the summer), the permitting and environmental issues related to the construction of the pipeline crossing the bay, public health concerns involving air emissions, and other issues and uncertainties that would need to be further investigated and resolved. In addition, it is not clear that the small additional reduction in cooling water withdrawal is worth the added environmental impacts.

The permittee has also submitted substantial information concerning its views of the engineering requirements, capital and operating costs, and environmental implications of retrofitting closed-cycle cooling at BPS. EPA agrees with the permittee that retrofitting cooling towers for all or some of the generating units at BPS would involve a complicated construction project involving substantial cost. The complexity and cost would be greatest for retrofitting the entire facility and correspondingly less for the various partial retrofit options. However, none of these options are impracticable. The permittee has also indicated that retrofitting all or some of the units at BPS with closed-cycle mechanical draft wet cooling towers could cause adverse noise, visual/aesthetic, fogging and icing impacts. Furthermore, shifting to closed-cycle cooling will likely result in a marginal decrease in electricity generated for sale by the plant due to an "efficiency penalty" and an "auxiliary energy penalty." This represents a cost to the permittee. It also *potentially* could lead to marginal increases in air pollution if the facility were to burn more fuel in an effort to generate more electricity to offset the lost electrical generation.

Thus, there are several environmental issues to consider with respect to potential cooling tower retrofitting at BPS. However, EPA does not believe that any of these issues present a fatal flaw for a retrofit of mechanical draft wet cooling towers at BPS in order to comply with CWA § 316(b). Of course, all applicable Federal, State and local requirements (e.g., noise emissions, air emissions) will need to be complied with prior to installation and operation of any new facilities.

***"Unit-Specific"* and *"Multi-Mode"* Options.** The permittee and EPA have each evaluated a variety of both "unit-specific" and "multi-mode" mechanical draft wet cooling tower options. Despite our having considered numerous options, there could be additional variations that have not been evaluated either by the permittee or EPA.

Unit-Specific Options. Unit-specific options involve conventional cooling towers engineered to work only with particular generating units. The permittee indicates that if one of the unit-specific cooling towers needed to be shut down –for example, due to a safety hazard from a water vapor plume– then the associated generating unit must also be shut down. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-4. EPA has learned, however, that a number of power plants around the country have wet cooling towers that are only used some of the time –for example, to address seasonal environmental concerns– and at other times are "by-passed" allowing the facility to operate in a once-through mode. See February 8, 2002, "Phone Memo" by Sharon Zaya, EPA, "Phone Call to Drew Seidel, Plant Manager at Victoria Power Station, TX;" February 8, 2002, "Phone Memo" by Sharon Zaya, EPA, "Phone Call to Tom Shusko, Plant Manager at Albright Power Station, WV;" 1/23/02 Email from Timothy Connor, EPA, to Mark Stein, EPA; 1/11/02 Email from Michael Moe, SAIC, to Mark Stein, EPA; 1/24/02 Memorandum from Mark Stein, EPA, to Brayton Point NPDES Permit File, "Notes on Telephone Conversation with Gary Kolle of Prairie Island Nuclear Generating Station in Minnesota." In effect, the enhanced multi-mode system proposed by USGenNE is a form of cooling tower "by-pass." Therefore, EPA has also considered this possibility as a variation on the "unit-specific" options and is discussed under "Multi-Mode" options in this section.

For "unit-specific" options, EPA has considered the following:

– Closed-Cycle cooling with mechanical draft wet cooling towers for the entire facility (i.e., all units at the plant) (flow rate: 56 MGD).

– Closed-Cycle cooling with mechanical draft wet cooling towers for combinations of less than all four units (e.g., Units 1 & 2; Units 3 & 4; Units 1 or 2 & 3) (minimum flow rate: 350 MGD).

– Closed-Cycle cooling with mechanical draft wet cooling towers for Unit 3 alone (flow rate: 654 MGD).

EPA believes this is a reasonable and appropriate range of options to consider for unit-specific wet mechanical draft cooling towers. These options include both single-unit and multiple-unit alternatives. Converting the entire facility would achieve the maximum reduction in flow and associated adverse environmental impacts that is available with this technology (also gaining the greatest reduction in thermal discharges). This option, however, would also be most expensive. The Unit 3 alone option would provide the greatest flow (and thermal discharge) reduction of the single-unit options since Unit 3 has the highest design flow and temperature rise of the four units at BPS. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 2-2. Although Unit 4's flow and temperature rise are close to Unit 3's, Unit 3 operates far more often than Unit 4. Id. at pp. 2-2, 3.3-28. Options involving the conversion of less than all four units, but more than a single unit, provide intermediate levels of flow reduction, cost and thermal discharge reduction. As discussed in more detail below, fitting any of these options with the capacity to bypass the cooling towers and run in a once-through cooling mode would likely add some cost in terms of “piping” and pumping, see SAIC Report (March 15, 2002), Table 5, but would enable the permittee to avoid the generating unit outages due to vapor plume-related hazards that it believes may be necessary.

Multi-Mode Options. Multi-mode options involve an arrangement of cooling towers that can operate in either closed-cycle, “helper” or “piggyback” modes to enhance flow and thermal reductions while giving the power plant greater operational flexibility and minimizing costs. The multi-mode cooling towers are not associated only with specific generating units, but, rather, draw heated effluent from the discharge canal, cool it, and recycle the cooled water back to an individual unit. As a result, they may be able to provide flow and thermal discharge reductions even if particular generating units are not in operation by cooling the hot water from other units that are in operation. The unit-specific cooling towers provide no such benefit when the associated generating unit is not operating. In other words, beyond the thermal discharge and cooling water flow reductions that occur when a particular generating unit is off-line, a multi-mode cooling system provides an additional benefit because it can be used to address the heat from other units that *are* operating. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.1-1, Tables 3.1-1 and 3.1-2. Another key aspect of the multi-mode options is that they enable the cooling towers to be “bypassed,” and generating units to remain in production, if necessary to abate water vapor plumes (as discussed in detail below). See Id. at p. 3.1-10. EPA commends the permittee for developing the multi-mode options as a operationally flexible approach to potentially retrofitting cooling towers at BPS.

The multi-mode options that EPA has considered include the following:

– The permittee’s “Basic Multi-Mode Option,” utilizing a 20-cell cooling tower;

– The permittee’s “Enhanced Multi-Mode Option,” utilizing a 20-cell cooling tower (flow rate: annual - 650 MGD (summer: 750 MGD & winter: 600 MGD); and

– All of the above unit-specific Closed-Cycle cooling water options using mechanical draft wet cooling towers but designed to have the ability to operate with multi-mode capability (including bypass capability).

EPA believes the above options provide a reasonable and appropriate range of multi-mode options for consideration. The Enhanced Multi-Mode system is the permittee's preferred option. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, p. 1. This option provides an additional point on the continuum of flow reductions and costs for the mechanical draft wet cooling tower options. It also offers significant operational flexibility at the plant. For these reasons, EPA believes this option warrants detailed consideration and analysis. Similarly, the Basic Multi-Mode should be evaluated because it provides another point on the flow reduction and cost continuum for which the permittee developed a significant amount of data. Id., Vol. IV, Section 3.1.2. The Basic option, however, achieves less flow reduction and less flexibility, albeit at lower cost. Id. at Table 4-1. The Enhanced Multi-Mode option "achieve[s] further flow and heat reduction compared to the basic multi-mode system by utilizing additional piping . . . at a cost of approximately $9 million[, which] allows either Units 3 or 4 to operate in a closed-cycle mode . . . [or] would also be capable of cooling the discharge of Units 1 and 2 in a helper tower mode." Id. at p. 3.1-15. With the Basic Multi-Mode option, only Unit 4 would be capable of operating in a closed-cycle mode. Compare Id. at Table 3.1-1, with Table 3.1-2.

The permittee focused only on the Basic and Enhanced Multi-Mode options using a 20-cell cooling tower that could handle a flow of 260,000 gpm in order to meet its stated goal of eliminating a volume of flow equal to that represented by Unit 4. EPA has also considered multi-mode options with cooling towers to handle more than 260,000 gpm in order to achieve greater flow (and thermal discharge) reductions. It is clear that this is a practicable alternative both as a matter of common sense and because the permittee actually evaluated a "larger" multi-mode option at an earlier stage of its evaluation. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. V, Appendix C, p. C-16. Specifically, the permittee evaluated a 38-cell multi-mode cooling tower that would handle a flow of 330,000 gpm.[40] Of course, additional cooling tower cells, and additional piping and pumping capacity, would result in additional expense.

[40] For the Basic and Enhanced Multi-Mode options, the permittee evaluated a 20-cell cooling tower with "a water flow rate through the cooling tower cell of approximately 13,000 gpm." However, for the 24-, 30-, and 38-cell multi-mode cooling tower options earlier evaluated by the permittee, and described in Appendix C to Volume V of the December 2001 USGenNE 316(a) and (b) Demonstration, the permittee considered flow rates through the cooling tower cells of only between 8,000 and 9,000 gpm. Id. at pp. C-1, C-9, C-12, C-16. As the permittee states, conditions were "optimized" only for the Basic and Enhanced Multi-Mode options, so that these 20-cell options are actually equivalent to the 30-cell option evaluated earlier by the permittee as described in Appendix C to Volume V. Id. at p. C-1.

(C) Options Evaluation

For the most part, all the wet mechanical draft cooling tower options raise the same issues concerning potential impacts from the facilities. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 4-4. Therefore, the issues for these options are discussed together. Where important distinctions can be drawn between the options, these distinctions are identified. Of course, as a general matter, the more cooling tower cells an option involves, the greater the magnitude of the potential impacts. This does not, however, necessarily mean that any such impacts are either significant or unacceptable.

Noise. Noise can be a concern with respect to mechanical draft cooling towers if the towers are located very near to sensitive receptors (e.g., residences). Noise comes principally from the fans and possibly from water falling within the towers. See EPA TDD 2001- New Facilities, p. 3-35.

BPS is essentially surrounded on three sides by water and on one side by part of the Town of Somerset. The permittee indicates it would locate any cooling towers in a north-central area of the site. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Figures 3.3-1, 2.2-1; NEPCO January 15, 1998, NPDES Permit Application, Figure 1. The nearest residences to this area are approximately 1900 feet to the east in Somerset and approximately 1900 feet to the west across the Lee River in Gardners Neck in Swansea. See Figure 7.3-1, "Brayton Point, Somerset, MA, Distances from Proposed Cooling Towers to Sensitive Receptors (EPA, Jan. 24, 2002).

Before installing and operating any cooling towers an appropriate noise analysis will need to be done by the permittee to ensure compliance with applicable State and/or local noise standards. (There are no applicable Federal noise requirements.) That being said, EPA believes based on current information that the site configuration and the availability of various types of noise mitigation (e.g., low noise fans), if any is needed, should enable retrofitting of mechanical draft cooling towers at BPS while achieving compliance with applicable regulatory standards to prevent unacceptable impacts to the nearest receptors. See, e.g, December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3; Executive Summary, p. 8, n. 7; EPA Economic and Engineering Analysis, App. A, p. 14; Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1), Section 4.3.7 (Dec.14, 2001); EPA TDD 2001- New Facilities, p. 3-35. If any special noise mitigation measures were required, it could increase the cost of cooling towers but not likely by a particularly significant degree.

Undoubtedly, noise would be greatest from a conversion of all 4 units to closed-cycle cooling (which the permittee indicates would involve 72 cooling tower cells), followed by the other multi-unit options (i.e., the Units 1 & 2 (30 cells), Units 3 & 4 (42 cells), and Units 1 or 2 and 3 (37 cells) options), followed by the conversion of Unit 3 (22 cells) and the Basic and Enhanced Multi-Mode options (20 cells). December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.3-27. The amount of noise generated is essentially proportional to the number of cooling cells and fans required for the options. The Unit 3 and Basic and Enhanced Multi-Mode options would yield similar noise based on the similar number of cooling tower cells and fans required.[41] Id. at pp. 3.3-27, 4-2, 4-5, 3.3-3. If a Multi-Mode option involving more cells were utilized, the extent to which it might produce more noise would depend on the number of additional cells and fans that are involved. None of this is to say that any noise issues cannot be controlled, and the permittee does not argue that noise presents a "fatal flaw" for the cooling tower options. Id.

Visual/Aesthetic Impacts. With respect to visual impacts, it cannot be denied that adding mechanical draft wet cooling towers will add additional visible industrial facilities to BPS. However, EPA does not ultimately believe that this should be regarded to be an unacceptable impact when the environmental benefits of cooling towers are considered. The permittee also has not argued that such impacts should be viewed as unacceptable.

BPS is already a huge industrial facility with large buildings, tall smoke stacks and electrical transmission lines on the site. Thus, the mechanical draft cooling towers would not be out of character with the surroundings at the plant. See Public Service Commission of Wisconsin/Wisconsin Department of Natural Resources, Final Environmental Impact Statement, Badger Generating Company, LLC, Electric Generation and Transmission Facilities (June 2000, 9340-CE-100), Executive Summary, p. 6 (of 7). The unit-specific mechanical draft wet cooling towers would be built on fill at "grade elevation +30 feet (msl)" and are expected to be 65 feet "above grade" high, with the top of the tower at around +95 feet (msl), which is shorter than the existing smoke stacks (three 350-foot stacks and one 500-foot stack) and the largest building on site. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.3-4, 3.3-10. The cooling towers included as part of the permittee's "enhanced multi-mode" cooling system proposal are slightly taller, at 67 feet tall, with the top of the tower at +97 (msl).

The permittee has not concluded that any of these options would present an unacceptable visual impact. We agree with the permittee on this point. The mechanical draft cooling towers should not have the sort of dramatic adverse visual impact that might be regarded to be associated with conventional natural draft cooling towers, which are much taller. That being said, we also agree with the permittee that somewhat greater visual impacts might be imposed by the use of multiple, unit-specific options because more cooling tower cells mean additional visible facilities. Id. at pp. 3.3-3, 4-5.

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[41] Moreover, the permittee did not explain why some or all of the cooling towers could not be built on the southwest portion of the site near the discharge canal, and further from the nearest residences, that the permittee has identified would be used for the helper cooling tower option if it were selected. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Figure 3.2-23. This question was asked of the permittee at the January 29, 2002 meeting and the permittee indicated that it would be significantly more expensive due to the need for lengthier "piping runs." See 1/30/02 Email from Mark Stein, EPA, to David Webster, EPA, et al. ("Subject: Brayton - FYI). In any event, if noise were a problem, locating the towers further south might be another way to mitigate those impacts, though apparently at some cost.

It is also possible that under certain meteorological conditions mechanical draft cooling towers may emit a visible plume into the air or create fog that could constitute an adverse visual impact. (See discussion of possible plume effects on traffic safety below.) This may occur when ambient air temperatures are low, as compared to plume temperatures, and ambient humidity levels are high. The former condition promotes plume cooling and condensation, whereas the latter condition inhibits evaporation of the water in the plume. The direction and persistence of the plume would be determined by a number of factors including wind speed and direction, relative temperatures and humidity, the time needed for evaporation and dispersion, and the design of the cooling towers in question. Typically, however, a vapor plume will not be visible to off-site observers and/or will dissipate after traveling only a short distance due to dispersion and evaporation. See EPA TDD 2001- New Facilities, p. 3-33; Badger Power EIS, p. 54; Public Service Commission of Wisconsin/Wisconsin Department of Natural Resources, Final Environmental Impact Statement, Badger Generating Company, LLC, Electric Generation and Transmission Facilities (June 2000, 9340-CE-100), Executive Summary, p. 6 (of 7); "AES Londonderry Highlights" (p. 6 of 7) (AES, Inc., 1/18/02), p. 6 (of 7).

With respect to potential visual impacts from a visible plume from mechanical draft wet cooling towers at BPS, EPA notes that while our October 1982 Permit Modification Determination, at pp. 19-20, indicated that salt drift was the primary problem with the former Unit 4 spray pod cooling system, which sprayed warm water directly into the air for cooling, EPA stated that the system also created fog that was an undesirable impact for the local community. EPA believes that any fogging from new mechanical draft cooling towers would be either nonexistent or much less than was experienced with the old spray pod system. Mechanical draft towers do not throw the water directly into the air like the spray pod system. In addition, the towers would be equipped with drift eliminators that would remove water droplets and reduce drift to a rate of 0.0005%. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3, 3.3-3. See also 39 Fed. Reg. 36189 (October 8, 1974). This should mean a vastly reduced tendency to create visible fog as compared to the spray pod system and should reduce the density of any visible plume. Moreover, any fogging that does occur would typically be most severe on the plant site close to the towers. Finally, during at least some of the conditions when cooling tower fog might occur, naturally occurring fog is also likely to occur in the coastal environment of BPS. See 3/4/02 Memorandum from Mark Stein, EPA, to Brayton Point NPDES Permit File, "Memorandum to File re 2/21/02 Visit to Brayton Point Station for Meeting." Under such conditions, fogging from the cooling towers would present only a small marginal increase over background conditions.[42]

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[42] USGenNE's plume modeling analysis predicts that, on average, over the course of a year, a 20-cell cooling tower would yield 6 hours of "plume-induced" fog at nearby receptors as compared to 336 hours of natural "background fog" (i.e., a less than 2 % increase). December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: Section 308 Information Request Submittal - 9/10/01, Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station (September 2001), Appendix B, p. 1 (Table: Hours of Plume Induced Fogging and Icing Summary). While this analysis was performed for a different purpose, it gives an idea of the relatively

In sum, EPA does not believe that the visible plume or any fogging from the cooling towers should be regarded as imposing an unacceptable adverse visual/aesthetic impact. Any adverse visual impact from cooling towers is relatively insignificant when compared to the major environmental benefit they could provide to the Mount Hope Bay ecosystem and fishery. See also EPA TDD 2001- New Facilities, p. 3-34. Potential local concerns about possible visible plumes or fog might also diminish when people learn that any such visible plume is merely water vapor –rather than any smog precursors or toxic air pollutants, for example– from cooling towers which have been installed to protect the fishery of the Mount Hope Bay estuary. In any event, while EPA does not believe this problem should be significant, it is clear that visible plume and fogging issues, if any, would be progressively worse for the alternatives involving more cooling tower cells. In addition, before installation of cooling towers, all applicable air emission standards will need to be satisfied.

Traffic Safety (Fogging, Icing). Another issue to be considered for a wet cooling tower such as would be used at BPS is whether there will be emissions of mist (i.e., water droplets) or water vapor that could cause a traffic hazard on nearby roadways due to fogging or icing. Protecting public health and safety is at the top of the priority list for EPA and the other involved state and federal agencies. Therefore, we take this issue seriously and have evaluated it from several perspectives.

The permittee has indicated that it believes that cooling towers at BPS would emit a vapor plume that could cause a fogging/icing traffic safety concern on nearby portions of Route 195 and the Braga Bridge. See, e.g., December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3. The permittee also indicates that it would have to shut down *the cooling tower* during these periods to eliminate this potential hazard. Id. The permittee states that this would substantially increase the cost of the unit-specific options because shutting down the cooling towers also requires shutting down the associated generating units. The permittee states that these increased costs can be avoided for the multi-mode options, however, because the cooling towers can be shutdown if necessary to prevent fog or ice and the generating units can continue to operate in the once-through mode. This contributes to the permittee's preference for the Enhanced Multi-Mode option from the perspective of cost and operational flexibility.

Based on current information, EPA's assessment of the fogging/icing traffic safety issue is that it is uncertain whether this problem would occur to a significant degree if cooling towers are installed at BPS, but that there are several ways to eliminate the problem if it does occur. Methods for managing this potential problem are discussed below, along with the uncertainties surrounding the magnitude of the problem. Following that discussion, reasons for uncertainty regarding the likely extent of any problem are presented.

Cooling towers can be equipped with highly efficient mist (or "drift") eliminators that can nearly eliminate the emission of water droplets (and salt) from a wet mechanical draft tower. As the permittee

small marginal effect of the cooling towers on fog.

explains, such drift eliminators can achieve a drift rate of 0.0005%, which would represent only a very small marginal increase over the moisture naturally in the air in a coastal environment such as that around BPS. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3, 3.3-3. See also 39 Fed. Reg. 36189 (October 8, 1974). As a result, mist emissions should not significantly contribute to fogging or icing.

However, as the permittee indicates, mechanical draft wet cooling towers also emit water *vapor* (as opposed to *mist*). See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3, n. 7. Under certain meteorological conditions, this water vapor could condense and cause ice on road surfaces and/or fog. The permittee has conducted a site-specific modeling analysis based on a 20-cell cooling tower that predicts that such a cooling tower at BPS would emit a plume of water vapor that under certain meteorological conditions could cause fogging or icing on certain nearby "receptors." See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: Section 308 Information Request Submittal - 9/10/01, Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station (September 2001). The permittee has also concluded that this fogging or icing could cause a traffic safety problem on Route 195 and the Braga Bridge. Id. at p. 3-3.

The company's fogging and icing analysis is based on a CalPuff modeling analysis using, among other things, meteorological data from T.F. Green Airport in Providence, RI, from 1989 to 1993. This analysis estimates that in an average year there are 343 hours of "background fog and ice" (fog: 336 hours/ice: 7 hours) near the plant and the cooling tower would add 7 hours of "plume-induced fog and ice" (fog: 6 hours/ice: 1 hour). This represents only a two percent (2%) increase over background conditions. In addition, the analysis predicts that 4 of these hours of fog or ice would "impact the highway and bridge." December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: Section 308 Information Request Submittal - 9/10/01, Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station (September 2001), p. 9 (of 13) and Appendix B, p. 1 (Table entitled, "Hours of Plume Induced Fogging and Icing Summary").

Nevertheless, the permittee's modeling analysis also concludes that this fogging or icing threat to the highway or bridge would require cooling tower "plume outages" an average of 54 times a year for an average total duration during the year of 166 hours. Id. This is more than 41 times the number of predicted hours of plume-induced fog or ice at the highway and bridge (4 x 41.5 = 166). The permittee explains that this is because in order to *prevent* fog or ice *before* it occurs, the permittee would have to shut down the tower and generating unit whenever certain meteorological conditions occur that *might* lead to fog and ice, and that such conditions occur more frequently than actual fog or ice and may persist for several hours at a time. Id. at p. 8 (of 13). The permittee also states that the problem would be more severe if more than 20 cooling tower cells were utilized at the power plant. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3, 3-4, 4-6; Vol. III, App. G (Dynamic Cost Analysis, p. 7). In addition, the permittee states that generating unit outages are made even longer due to the 5 to 12 hours necessary to get a generating unit back on-line after it has been taken off-line. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab:

Section 308 Information Request Submittal - 9/10/01), Attachment A, p. 10 of 13. Indeed, in the permittee's Dynamic Cost Analysis, the permittee assumes that *648* hours of generating unit outages per year would occur for the Unit 3 Closed-Cycle option, based on 54 outages and 12 hours of unit restart time, and that *486* hours per year of outage for units 1, 2 and 3 would occur for the Entire Station Closed-Cycle option based on 54 outages with 9 hours of restart time per unit. Id. Vol. III (Tab: Dynamic Cost Analysis), Unit 3 Conventional Closed Cycle Spread Sheet, p. 3 of 8. The 648 and 486 hours of predicted outage are *162* and *121* times more than the 4 hours of additional fog or ice actually predicted by the permittee's model to affect the highway and bridge in the average year.

As mentioned above, because the permittee concludes that water vapor plumes will lead to required cooling tower shutdowns and associated generating unit shutdowns for the unit-specific cooling tower options, the permittee has included a substantial cost for hundreds of hours of "plume outages" for the unit-specific options. The permittee has not included such costs for the multi-mode options because the cooling towers can be bypassed, assuming such a bypass will still enable the permittee to meet its permitted heat and flow limits. The cost of the outages reflects lost profits due to the outages. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-4, Section 4-6, Table 4-1; Vol. III, App. G (Tab: Dynamic Cost Analysis, pp. 7-8; Tab: Section 308 Information Request Submittal - 9/10/01, p. 4).

EPA has looked at the plume/safety issue from a number of perspectives. Most importantly, EPA has concluded that to the extent a traffic safety issue may exist, there are several ways to adequately control it. First, as the permittee has indicated, if necessary, a cooling tower and associated generating unit could be shut down for a short period to avoid a safety issue. The permittee has indicated that it would expect to undertake such shutdowns if necessary. With the multi-mode options, of course, the permittee could shut down the cooling towers but continue to operate the generating units. Likewise, EPA believes that the unit-specific options could be engineered to allow the cooling towers to be bypassed so that the generating units could be operated in once-through mode during the period of any plume-related safety hazard. As discussed above, EPA has learned that a number of power plants around the country have cooling towers that are only used some of the time, so this is clearly a practicable approach. This approach may add some cost, due to piping or pumping needs, but any such costs would most likely be less expensive than the permittee's predicted generating unit outages. Indeed, the ability to bypass the cooling towers is one key aspect of the multi-mode cooling tower operations. EPA's evaluation estimated what the costs to operate in various multi-mode fashions might be and found them to be less than the cost of the outages. See SAIC Report (March 15, 2002), p. 15, Table 5; Abt Report (April 5, 2002), p. 8. (Costs are discussed more fully below.) Of course, the plant would still need to operate within its overall permit limits for flow, maximum-temperature, Δ-T, and Btu loadings, but this is also true for the multi-mode options.

Second, when it is predicted that potentially hazardous fog or ice conditions might occur as a result of the cooling towers, instead of shutting the towers down, it might be feasible to develop an early warning system according to which the permittee would notify the Massachusetts Highway Department in order to initiate icing controls (e.g., salting of roads) or activate lighted cautionary signs warning of potential fog conditions. 4/9/02 Memorandum by Damien Houlihan (EPA), "Re: Record of 4/9/04 Conference Call with MA DEP and Massachusetts Highway Department." As discussed above, the permittee's analysis predicts only a small marginal increase in fog and ice conditions from background, and the Massachusetts Highway Department already has programs in place for dealing with these background conditions.

Third, there are also plume abatement technologies that can be utilized with mechanical draft cooling towers to substantially reduce or eliminate vapor plume effects. These technologies are generally referred to as "wet/dry" or "hybrid" cooling towers. See EPA TDD 2001- New Facilities, p. 3-33; January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey; Materials obtained from Marley Cooling Technologies, Inc.; Public Service Commission of Wisconsin/Wisconsin Department of Natural Resources, Final Environmental Impact Statement, Badger Generating Company, LLC, Electric Generation and Transmission Facilities (June 2000, 9340-CE-100), Executive Summary, p. xii; "AES Londonderry Highlights" (p. 6 of 7) (AES, Inc., 1/18/02). Switching to hybrid cooling towers would, however, significantly increase the capital cost of the equipment and reduce electrical generation efficiency somewhat more than wet cooling towers. EPA's consultants have estimated that adding plume abatement could more than double the *capital cost* of the cooling towers without plume abatement. See SAIC Report (March 15, 2002), p. 15, Table 5. See also 66 Fed. Reg. 65283 (Dec. 18, 2001) (costs of dry cooling compared to costs of hybrid cooling and wet cooling); 1/31/02 Email from Richard Scogland, Marley Cooling Technologies, to Sharon Zaya, EPA, "Subject: Cost Estimate for Marley's Clearflow;" 2/1/02 Email from Kenneth Detmer, Wisconsin Public Service Commission, to Mark Stein, EPA, "Subject: Cooling Towers;" January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey. However, despite these capital costs, EPA "... estimates the increase in overall project costs for a [retrofitted] hybrid wet/dry cooling tower unit over a wet (only) unit would range between 20 and 65 percent." EPA TDD 2002- Existing Facilities, p.6-6. EPA further notes that Power Tech Associates, a consultant who estimated the costs of cooling system conversion for Hudson River power plants, states that "the effect of using wet/dry towers is much less than a 25 percent increase in the overall conversion costs." Id. p. 6-6.

Another interesting alternative to abate plume effects would be to add more cells to the cooling towers. This would lessen any potential impacts because the factors determining cooling tower impact are the quantity of heat being disposed of and the air volume into which that waste heat is being rejected. A system with additional cooling tower cells, may have far less impact than the one with fewer cells, because more air flow is used. Neither EPA nor USGenNE has evaluated this option, but clearly an analysis of this option could be performed in order to determine its feasability and costs. See memo from Kirk Winges, Senior Atmospheric Scientists from MFG, Inc, entitled "Comments on "Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station," dated September 2001"

Ultimately, of course, the permittee may choose whichever method, or combination of methods, it wants from the several practicable approaches should the need for plume abatement arise. The choice of method would most likely be determined by the cost and the permittee's operational preferences. At present, the permittee indicates that it prefers the Enhanced Multi-Mode option because, among other things, the cooling towers could be shut down to avoid plume hazards without requiring generating unit outages. This option, however, achieves less flow and thermal discharge reductions than any of the unit-specific options. For the unit-specific options, the permittee indicates it would engage in generating unit shutdowns to prevent plume-related hazards, but that these outages result in substantial cost to the company. EPA has concluded, however, that engineering a "bypass" of the cooling towers would likely be a less expensive, practicable alternative in the long-run for the unit-specific options. Alternatively, an early warning system in conjunction with the Massachusetts Highway Department might be sufficient to avoid either outages or cooling tower bypass. This would require further consultation and coordination between the Department, the permittee, EPA and the MA DEP. A more expensive option, but one that would maximize operational flexibility and the flow and thermal discharge reductions achievable by the unit-specific options, would be to install hybrid cooling. (The company also might want to consider, at a minimum, installing cooling towers that are amenable to retrofitting with plume abatement technology at a later date.)

Having addressed the issue of how to abate any plume hazards, EPA must also state that, based on current information, we believe it is uncertain that cooling towers at BPS would emit a vapor plume that would become a traffic hazard on the highway or bridge. It is also uncertain whether the hours of potential hazard predicted by the permittee would actually require generating units using cooling towers to be shut down for hundreds of hours per year in order to achieve our clear priority of ensuring public safety.

There are several reasons why the EPA believes that there is substantial uncertainty over whether the plume problem will be as severe as the permittee asserts. First, EPA has reviewed the permittee's air modeling analysis and has a number of concerns and questions about it. While the "CALPUFF" model used by the permittee is certainly acceptable for certain air modeling purposes, the question is whether the model <u>and</u> the pre- and post-processors used with the model were appropriate for the purpose of assessing the plume issue in this case, especially when compared to other models that have been developed more specifically for modeling cooling tower plumes (such as the SACTI model developed by EPRI). <u>See</u> May 7, 2002 memorandum from Martha Seagall to Damien Houlihan containing MFG, Inc. Review of CALPUFF Model, January 3, 2002, Memorandum from Brian Hennessey, EPA, Through Steven Rapp, EPA, to Mark Stein, EPA ("Air Impact Analysis of Evaporative Cooling for Brayton Point Generating Station (Somerset, Massachusetts)); 12/11/01 Email from John Irwin, EPA, to Warren Peters, EPA, et al. (cc: Brian Hennessey, EPA, et al.); 12/05/01 Email from Warren Peters, EPA, to Brian Hennessey, EPA (cc: Joe Touma, EPA, John Irwin, EPA, et al.); December 10, 2001, Phone Memo from Sharon Zaya, EPA, Regarding Call with Gary Mirsky, P.E. Hamon Cooling Towers, N.J. January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey; 2/1/02 Email from Kenneth Detmer, Wisconsin Public Service

Commission, to Mark Stein, EPA, "Subject: Cooling Towers" (expressing opinion that CALPUFF model works for wet/dry cooling tower evaluations, but uncertain about using it for traditional wet towers). EPA does not presently believe that the permittee has established the reasonableness of its modeling analysis.

Second, experience at the other plants does not appear to corroborate the threat suggested by the permittee. EPA spoke with representatives of two power plants that use mechanical draft cooling towers and learned that any icing concerns at these facilities are limited to areas very close to the cooling towers themselves (within a few hundred feet) and had not effected roadways or bridges within relatively short distances from the cooling towers (in one case within approximately a half-mile, and in another case within around 700 feet). January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey; 12/12/01 Memorandum from Mark Stein to Brayton Point NPDES Permit File ("Brief Notes on an Issue Discussed During Conference Call with John Gulvas of Consumers Energy and the Palisades Nuclear power station in Covert, Michigan"); 39 Fed. Reg. 36192 (October 8, 1974). See also Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1), Sections 4.3.4.2, 4.3.5.1.1, 4.3.5.1.3 (Dec. 14, 2001). Neither icing nor fogging appeared to create a problem in any of the situations referenced above. One facility did install a wet/dry system to enable it to remove a visible plume due to initial concerns over potential highway icing or fogging, but this facility reported to EPA that it did not turn out to be a problem in practice. The facility only uses the "dry components" to mitigate an aesthetic issue related to a periodically visible plume of fog during humid conditions. January 4, 2002, Phone Memo from Sharon Zaya, EPA, Regarding Call with Ken Daledda, Bergen Station, New Jersey. Additionally, EPA identified 16 facilities with full-recirculating cooling systems and very large megawatt capacities that were within close proximity (that is, several yards to several hundred yards) to major highways, navigable rives and lakes, and railways. Only one of these facilities (Bergen Generating Station as discussed above) utilize a form of plume abatement. The other plants utilize either natural draft or mechanical draft wet towers. See EPA TDD 2002 - Existing Facilities, p. 6-7.

Third, EPA notes that in the January 1997 NEPCO Report, at p. 3-21, the permittee predicted that although "incidence of ground fog can occur during periods of high relative humidity, cool weather, moderate to low winds and inversions or some combination thereof . . . [, i]t is unlikely however that the fog would extend further than 500 to 1,000 feet downwind of the towers." No concern was expressed about off-site icing. Furthermore, in the December 2001 USGenNE 316(a) and (b) Demonstration, the permittee explained that the helper towers are identical to the mechanical draft cooling towers, see Vol. IV, pp. 3-1, 3.2-1, and that even for the 48-cell helper tower "[f]ogging during cool wet weather, and when temperatures are cold enough, icing are expected to rarely be an issue with the helper tower design since these are local effects and the helper towers are located near the discharge canal and further away from the highway and bridge than the multi-mode or closed-cycle alternatives." Id. Vol. IV, p. 3.2-19. The area near the discharge canal appears to be only around 500 feet or less further from the highway and bridge. See Figure 7.3-1, "Brayton Point, Somerset, MA, Distances from Proposed Cooling Towers to

Sensitive Receptors (EPA, Jan. 24, 2002). Although permittee expresses particular concern over fogging and icing impacts to Route 195 and the Braga Bridge, the bridge appears to be approximately 5000 feet (0.95 miles) from where the cooling towers would be located, while the nearest point on Route 195 is approximately 2164 feet away (0.41 miles), and the nearest residential streets are approximately 1900 feet away (0.36 miles). See Figure 7.3-1, "Brayton Point, Somerset, MA, Distances from Proposed Cooling Towers to Sensitive Receptors (EPA, Jan. 24, 2002). Moreover, moving the cooling towers further to the south on the site into the area that the permittee suggested the helper towers could be located would add even more distance and make any potential problems even less likely. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Figure 3.2-19, 3.2-23. See also n. 48, supra.

Fourth, as a matter of common sense, it does not seem that the problem should be severe enough to require hundreds of hours of generating unit outages. The permittee's own analysis confirms that in the coastal environment of Mount Hope Bay, the local roads and highways of this area periodically experience icing and fogging from natural conditions which is managed by local highway safety programs. The permittee's analysis predicts that a 20-cell cooling tower would add only a small marginal increase in fogging and icing (around 2%) over background conditions in an average year. This average increase is well within the range of natural fluctuation in background conditions. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: Section 308 Information Request Submittal - 9/10/01, Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station (September 2001), Appendix B, p. 1 (Table: Hours of Plume Induced Fogging and Icing Summary). Again, the permittee predicted that in an average year only 1 hour of "plume-induced ice"and only 6 hours of "plume-induced fog" would occur, as compared to 343 hours of "background fog and ice" (a 2 % increase). Only 4 of these hours of plume-induced fog or ice were predicted to "impact the highway and bridge." In response to this, the permittee predicts that literally hundreds of hours of unit outages per year would be needed to eliminate this potential plume effect. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: Section 308 Information Request Submittal - 9/10/01, Report on Fogging and Icing Effects Associated with Cooling Towers at Brayton Point Station (September 2001), p. 9 (of 13) and Appendix B, p. 1 (Table: Hours of Plume Induced Fogging and Icing Summary). As discussed above, this seems unrealistic based on common sense and experience at other plants, and we are not yet persuaded of the validity of the permittee's modeling analysis.[43]

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[43] It is also worth noting that Badger Generating Company, LLC, an affiliate of PG&E operating in Wisconsin, proposed a new combined-cycle natural gas electric generating plant in the village of Pleasant Prarie, WI, that would use hybrid wet/dry cooling towers to control any threat of fogging or icing on roadways surrounding the facility. With the hybrid cooling towers, the analysis concluded that only a few hours per year of fogging and/or icing would result on certain roads immediately surrounding the plant. There was no suggestion, however, that these few hours of predicted fog or ice required many times more hours of generating unit outages, or indeed any outages at all, to eliminate all possibility of any fog or ice. In addition, the company argued that "[o]n days of rain, fog, snowfall, or blowing snow . . . plant-induced fogging and icing would not be important, since

Nevertheless, as stated above, the permittee proposes to deal with possible plume hazards from the unit-specific options by shutting down generating units and their associated cooling towers during conditions when it believes the risk exists. As a result, the permittee has included the cost of such outages in the costs of the closed-cycle cooling tower options. Because of EPA's uncertainty about the likely need for these outages, EPA has evaluated the costs of these options under the following three scenarios: (a) accepting the permittee's estimate of plume outages, (b) assuming half the plume outages predicted by the permittee, and (c) assuming no plume outages (but adding capital costs to equip the unit-specific cooling tower options to operate in a multi-mode fashion). EPA's economic analysis is presented further below.

Salt Drift. With any salt water cooling tower, one must consider the issue of salt emissions from the towers. This should not be a significant problem at BPS, however, because the towers can be equipped with drift eliminators that reduce drift to 0.0005%. As the permittee has indicated, this would produce a rate of drift "several orders of magnitude lower than the total emissions from the past operation of the Unit 4 spray canal." See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3, 3.3-3. See also 39 Fed. Reg. 36189 (October 8, 1974). It would also produce "salt deposition and saline air concentrations that represent only a slight increase over ambient coastal conditions." December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3-3. See also EPA TDD 2001 - New Facilities, pp. 3-34 and 3-35; January 1997 NEPCO Report, at p. 3-21. However, to the extent that residential icing caused by salt drift is actually an issue, the concern would be greater from the options that involve more cooling towers and the placement of the cooling towers at the site. Any cooling towers that are installed and operated at BPS will, of course, have to comply with all applicable air emissions requirements (e.g., particulate emissions).

Energy Issues. One detriment of switching BPS from open-cycle cooling to closed-cycle cooling is that the change would marginally decrease the generating efficiency of each converted unit ("efficiency penalty"). See EPA TDD 2001 - New Facilities, p. 3-10, Table 3-2, pp. 3-9 to 3-21. In addition, the amount of electricity that a converted unit generates for sale is further reduced because a certain amount of energy must be used to run the fans and pumps utilized in a mechanical draft cooling tower ("auxiliary power penalty").

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there might already be fog and ice on Pleasant Prairie roads and drivers would already be more cautious." The Public Service Commission and the Department of Natural Resources of the State of Wisconsin considered the potential for additional fogging and icing to be a concern but were satisfied with the few hours that would be left after the installation of hybrid cooling. Thus, the State approved the facility recognizing the small number of hours of plant-induced fogging and/or icing that might occur. See Public Service Commission of Wisconsin/Wisconsin Department of Natural Resources, Final Environmental Impact Statement, Badger Generating Company, LLC, Electric Generation and Transmission Facilities (June 2000, 9340-CE-100), pp. xi, 73-74, 137-138; see also Executive Summary.

EPA estimates that for a conversion to wet mechanical draft cooling towers, assuming a 100% load factor, the annual efficiency losses would be approximately 0.29% for Units 1, 2 and 3, and 0.09% for Unit 4 (assuming current levels of "piggyback" operations). See SAIC Report (March 15, 2002), Table 9. See also EPA TDD 2001 - New Facilities, Table 3-14. The efficiency losses would increase to 0.75% for Units 1, 2 and 3, and 0.18% for Unit 4, assuming a load factor of 67%. See SAIC Report (March 15, 2002), Table 9. See also EPA TDD 2001 - New Facilities, Table 3-15. Since BPS Units 1, 2 and 3 are base-load units with a capacity factor of approximately 80%, the penalties are expected to be in between the two sets of figures. See EPA TDD 2001 - New Facilities, p. 3-10. Since Unit 4 has a much lower capacity factor of around 20%, its penalty figures would likely be somewhat higher than those for the 67% load factor. Because Unit 4 operates less, however, the efficiency penalty for that unit would have a relatively smaller effect on the overall efficiency of the plant. See SAIC Report (March 15, 2002), p. 21. It should be noted that EPA's estimated efficiency penalties for the Enhanced Multi-Mode, Closed-Cycle Units 1 & 2, Closed-Cycle Unit 3, and Closed-Cycle Entire Station Units options range from 58% to 77% lower than those predicted by the permittee. Id. at Table 10.

The company also predicts that the unit-specific options will result in greater lost generation than the multi-mode options, see December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Table 4-1, because the multi-mode systems have "more flexibility to operate at a higher performance relative to the structure's size under a greater variety of atmospheric conditions than any of the other cooling tower alternatives." Id. at Section 4.7. This relates, at least in part, to the permittee's predictions of plume outages for the unit-specific options but not for the multi-mode options. As discussed above, however, EPA has concluded that it is uncertain that the plume-related problems will be as significant as the permittee predicts and that there are potential methods for controlling any such problems other than resorting to unit outages.

In light of our consultant's analysis, EPA believes the permittee's estimates of auxiliary power penalties are reasonable. See SAIC Report (March 15, 2002), p. 30. For some alternatives, EPA's estimates are lower, whereas for other alternatives EPA's estimates are higher. See SAIC Report (March 15, 2002), Table 7. See also EPA TDD 2001 - New Facilities, pp. 3-22 to 3-30, Table 3-20.

On one level these various penalties represent an economic issue (i.e., lost revenues due to reduced sales of electricity). Therefore, the company considered these penalties in its economic evaluation of the alternatives, see December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, App. G (Tab: Dynamic Cost Analysis), and EPA has done the same. See Abt Report (April 5, 2002), pp. 21-22. EPA's economic analysis is presented further below.

On another level, these penalties raise energy supply issues that should be considered. Having done so, however, EPA does not believe that these penalties are significant from an energy perspective, especially when considered in light of the major reduction in adverse impacts from the CWIS (and from thermal discharges) that could be provided by a closed-cycle cooling system. EPA's research indicates that New England has an adequate power supply at present and is predicted to have an adequate supply moving into the future, thanks in part to the construction and proposal of new power plants that have added, and will continue to add, generating capacity to the supply inventory in the Region. See, e.g., EPA-New England, Energy Fact Sheet (Feb. 12, 2001); "NEPOOL Forecast Report of Capacity, Energy, Loads and Transmission, 2001 - 2010 (ISO-NE: April 1, 2001), pp. 1-2 (Section I Summaries, Summer and Winter System Capabilities and Peak Load Forecasts). Therefore, neither the small marginal loss in efficiency nor the small marginal increase in energy use that would result from converting to closed-cycle cooling at BPS presents a significant problem for the Region's energy supply. See SAIC Report (March 15, 2002), Tables 6, 7, 9, 10 and 11 (USGenNE and SAIC independent estimates of reduction in energy produced for sale by BPS due to the Closed-Cycle Entire Station units option are 3.3% and 2.6%, respectively); see also EPA TDD 2001 - New Facilities, Tables 3-1, 3-2, 3-14, 3-15, 3-20.[44] Moreover, as new, more efficient plants continue to come on line, the overall efficiency of the Region's energy supply will increase even if BPS has a marginal loss of efficiency due to shifting entirely or partially to closed-cycle cooling. For example, the proliferation of new, combined-cycle power plants will significantly increase the overall efficiency of the Region's power supply and more than offset any lost efficiency from closed-cycle cooling at BPS. See EPA TDD 2001 - New Facilities, p. 3-8.

In addition, there is at least one potentially significant energy *benefit* provided by shifting to closed-cycle cooling. The permittee has determined that improved cooling will enable it to operate more at peak demand times during the hottest days of the year – assuming compliance with applicable air pollution standards – because the plant will less frequently threaten to exceed the permit's current maximum temperature limit of 95° F. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, App. G, (Tab: Dynamic Cost Analysis, p. 4). This not only enables the plant to sell more electricity during the peak pricing period, which benefits the permittee economically, but it also may benefit the Region's overall power supply because that supply is most likely to be overstretched, if ever, during the hottest days of the year when peak demand occurs. See Abt Report (April 5, 2002), pp. 12, 23-24. With cooling towers, BPS will be able to generate more power to help meet this peak demand. (It should also be noted, however, that this benefit may be marginally offset by the fact that efficiency penalties are likely to be somewhat greater during the hot summer days.) See EPA TDD 2001 - New Facilities, p. 3-9.

Plant Reliability, Operational Flexibility, and Construction-Related Outages. The permittee argues that the unit-specific cooling tower alternatives, but not the multi-mode options, reduce plant reliability because of the potential for plume-related outages in the winter, attributed to fogging/icing problems. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 4.5. Any problem in this regard would be more severe for the options using more cooling towers. As explained

[44] Interestingly, according to a recent article in the Salem Evening News ("PG&E Drops All-Coal Plan," December 20, 2001), USGenNE recently decided to drop its plans to expand at its Salem, MA, power plant. A company official was quoted as explaining the decision by stating, "the supply (of power) [in New England] is far outstripping the demand."

above, however, EPA believes that plume-related hazards of the magnitude suggested by the permittee are uncertain and that there are potential methods of controlling any such hazards without generating unit outages.

Nevertheless, if such temporary outages were to occur, as predicted by the permittee, it would ultimately represent an economic issue to the permittee rather than an energy supply problem to the Region. It is unlikely that any such temporary, intermittent outages would jeopardize the adequacy of the Region's power supply because that supply is constituted and managed to respond to occasional scheduled and unscheduled outages while maintaining adequate power. Any plume-related outages would similarly be managed without supply shortfalls. In addition, as discussed above, adding cooling tower technology is expected to enable BPS to generate somewhat more electricity during peak summer demand periods. This may help the Region's power supply at the time it is most stressed.

For the installation of any of the closed-cycle cooling tower options at BPS, the permittee also predicts generating unit outages "for the tie into . . . the generating units . . . [to] complete the cooling system conversion." December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 4.9. Unlike plume outages, construction outages are one-time events. Although any such outages would be sequenced to coincide with regularly scheduled maintenance outages, the permittee predicts that the construction outages would exceed the duration of the regular maintenance outages and, therefore, represent additional downtime for the units involved. The permittee predicts that these outages will be somewhat greater for the site-specific options than the multi-mode options. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 4.8, Table 4-1 (e.g., 5.5 months for the Enhanced Multi-Mode option; 8 months for the Closed-Cycle Unit 3 option).

There is no reason to expect that these one-time outages should endanger the Region's power supply. The Regional power supply is already managed to accommodate periodic scheduled and unscheduled outages without a shortfall in capacity. There is nothing to suggest that the type of outages discussed here could not be handled in this manner. These outages could also, if necessary, be scheduled and sequenced to avoid peak demand periods. Ultimately, any such outages represent an economic issue for the permittee and both EPA and the permittee have evaluated such outages in our economic analyses, as discussed below. It should also be noted here that, as an engineering matter, EPA believes that the permittee has overestimated the necessary construction outages based on research concerning other plants that have converted their cooling systems from once-through to closed-cycle cooling towers. See SAIC Report (March 15, 2002), pp. 25 - 29 and Attachment A; Memorandum from Nick Prodany and Mark Stein to Brayton Point NPDES Permit File, "Notes on Telephone Call with Engineer at Canadys Station power plant in South Carolina."

Air Pollutant Emissions. Another issue that must be addressed is the possibility that due to lost efficiency as a result of installing cooling towers, a power plant would burn more fuel in an effort to make up for lost electricity generation and thus produce increased air emissions. This should not, however, be an issue at BPS because the permittee has indicated that due to the fixed steam capacity of the boilers at BPS, the plant *cannot* actually burn more fuel to make more steam and generate more electricity in response to efficiency losses due to cooling towers. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, App. G, (Tab: Dynamic Cost Analysis, p. 4). See also EPA TDD 2001 - New Facilities, p. 3-31 to 3-33. Instead, any needed lost megawatt-hours from BPS due to cooling tower-related penalties would be replaced by generation at other plants. It is more than likely that these other plants will be similar or cleaner burning facilities, given that BPS is an old coal burning plant. Therefore, the marginal penalties discussed above are likely, in turn, to lead to no changes in air pollutant emissions at BPS and only very marginal changes across the Region. Id. Moreover, it must be understood that any emission increases would be limited by applicable air pollution standards. Since the MA DEP has recently promulgated new air pollution standards that apply to BPS and will require significantly reduced air emissions from the plant (and several other major, older power plants), see 310 CMR 7.29, the overall air emissions from this plant will be substantially reduced compared to current levels regardless of whether the plant burned marginally more fuel to make up for efficiency losses due to cooling towers. In addition, these new regulations will also lead to substantial overall emission reductions in Massachusetts. EPA reiterates that any new cooling towers will be subject to air permitting requirements and will obviously need to satisfy all applicable air pollution standards (e.g., standards for particulate emissions).

Construction Effects. As the permittee states, all the cooling tower options raise the likelihood of some "moderate" noise and truck traffic effects from construction activities. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 4-4. It should also be noted that construction for new air pollution control equipment will be occurring during a similar time-frame. Ultimately, some construction effects cannot be avoided if improvements are to be made to reduce the plant's adverse water and air impacts on the environment. However, no filling of wetlands or tidelands should be needed for any of the construction. Moreover, the industrial nature of the site and existing facilities, as well as the large size and buffering capacity of the site, should moderate the impacts of construction. Any effects would be further reduced if the facilities were constructed in areas farther from local residences, and all local traffic and noise ordinances will obviously have to be complied with.[45] It should also be noted that, as proposed by the permittee, the multi-mode and single-unit options have roughly similar construction durations of 13 months for the Unit 3 option, and 16 months for the multi-mode options, whereas the multiple-unit options have longer construction periods of 21 months for the Unit 1 & 2 option and 32 months for the entire facility option. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Table 4-1, Vol. V - Appendix B (Tabs B6, B7, B13, B15, B16). Thus, construction effects would undoubtedly increase as more units are converted to new cooling systems.

[45] Given that fuel is currently barged to the plant, it *may* also be feasible to bring some materials to the site by water so as to minimize truck traffic on streets surrounding the plant.

(D) Conclusions as to Wet Cooling Towers and Options Carried for Detailed Review

In sum, EPA believes that several potential options for retrofitting BPS with closed-cycle cooling with mechanical draft wet cooling towers warrant further detailed consideration in light of biological, engineering and economic factors. Generally, this technology can achieve significant reductions in adverse environmental impacts by reducing flow through the CWIS, as well as reducing thermal discharge. Although retrofitting this technology to BPS presents a number of economic, engineering, and environmental issues, none of these issues appear to present a fatal flaw for these options at this stage of our analysis.

The various mechanical draft wet cooling tower options that EPA has decided to carry forward for further analysis provide different increments of flow (as well as thermal discharge) reduction, different degrees of potential environmental concern, and different costs. They also include both unit-specific and multi-mode options that address either all or a portion of the generating units at BPS. As a result, an appropriate range of viable options is retained for more detailed consideration. EPA's more detailed review includes a thorough, independent evaluation of the costs of these options, and a determination of whether or not these costs are wholly disproportionate to the environmental benefits they would provide. These detailed evaluations are presented further below.

EPA believes that the following options should receive further detailed consideration:

- (A) Closed-Cycle Cooling with "Unit-Specific" Mechanical Draft Wet Cooling Towers for Unit 3 alone (flow rate: 654 MGD);
- (B) Closed-Cycle Cooling with "Unit Specific" Mechanical Draft Wet Cooling Towers for Units 1 or 2 & 3 (flow rate: 350 MGD);
- (C) Any of the above options engineered to allow a multi-mode capabilities, without shutting down generating units;
- (D) Closed-Cycle Cooling with "Unit Specific" Mechanical Draft Wet Cooling Towers for the Entire Station (i.e., all four units) (with by-pass capability) (56 MGD); and
- (E) The permittee's Enhanced Multi-Mode system (with 20 cooling tower cells) (flow rate: annual - 650 MGD (summer - 750 MGD & winter 600 MGD).

This set of alternatives covers a reasonable range of options in terms of flow reduction, expense, and overall environmental impact. The option for unit-specific closed-cycle cooling of the entire facility offers the greatest environmental protection in terms of flow (and thermal discharge) reduction, but is also the most expensive option and poses the greatest potential non-water impacts. For options that involve converting more than one but less than all of the plant's generating units to closed-cycle cooling, EPA decided to eliminate the Units 1 and 2 option because it would reduce flow and thermal discharge less than the Units 1 or 2 & 3 option. EPA decided that conversion of Units 1 or 2 & 3 warranted further consideration. Although Units 1 and 2 have lower flow rates than Unit 4, Units 1 and 2 are base-load units and, therefore, operate more frequently than Unit 4. As a result, greater environmental improvement would be achieved at a similar cost by converting Units 1 or 2 & 3, than by converting Units 3 and 4. For a single unit conversion, EPA focused on the Unit 3 option because converting that unit would have the largest effect on flow and thermal discharge reductions of all the units.

EPA has also retained for further consideration the option of equipping the various unit-specific cooling tower options with bypass/multi-mode capabilities, so that generating units could continue to operate even if the cooling towers were offline. This approach warrants further consideration because it could provide a relatively easy and inexpensive means of avoiding the expensive, plume-related outages of the generating units that the permittee fears with respect to the unit-specific options. (Of course, overall permit conditions would still need to be met.)

EPA has also retained the permittee's Enhanced Multi-Mode proposal for further detailed consideration. As the permittee has explained, the multi-mode options involve an array of mechanical draft cooling towers and plumbing changes that result in a system that can operate in closed-cycle, "helper" or "piggyback" modes to enhance flow and thermal reductions while giving the power plant greater operational flexibility and reducing costs. EPA believes the company has shown ingenuity in developing the multi-mode options. EPA has decided to carry the Enhanced Multi-Mode system forward for further review and to drop the Basic Multi-Mode system because the former achieves greater flow and thermal discharge reductions at a similar cost. Although USGenNE has assessed the Enhanced Multi-Mode proposal to cost $9 Million more than the Basic Multi-Mode option, the former offers added flexibility by enabling the cooling towers to be used in closed-cycle fashion with either Unit 3 or 4 to achieve further flow (and heat) reductions. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Table 4-1 and p. 3.1-1, and Sections 3.1.3.1 and 3.1.2.1. Moreover, the permittee has indicated its support for the Enhanced Multi-Mode option.[46]

ii. Wet *"Helper"* Cooling Towers

The permittee also evaluated "helper" mechanical draft cooling towers as another potential option for satisfying CWA § 316(b). The permittee's most recent evaluation is presented in the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.2. This assessment looks at five (5) helper tower options involving the installation of 8, 18, 24, 30, and 48 cells. EPA has decided

[46] The permittee does not concede that this proposal is necessary to comply with CWA § 316(b), but indicates that it is willing to undertake this expense because this option will achieve significant reduction of the adverse impacts of CWIS operations at BPS by reducing cooling water flow through the plant, and in recognition of the importance of the natural resources of Mount Hope Bay, the fact that other parties may disagree with its views on the role of BPS in the decline of the bay's fishery, and the permittee's desire to help promote the recovery of these resources. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, pp. 3-6, 47.

that these options would not satisfy the requirements of CWA § 316(b) because they do not result in any significant flow reductions. (Only the 48-cell helper tower option achieves any flow reduction. It reduces summer flow from 1080 MGD to 925 MGD by recirculating cooling water to the Unit 4 condenser. Id. at 3.2-15, 3.2-17, 3.2-20.)

Except for the 48-cell option, helper cooling towers transfer a portion of the heat energy discharged in the facility's effluent directly to the atmosphere, but do not result in a recirculation of cooling water flow. Thus, helper tower systems are designed primarily to reduce thermal discharges rather than to reduce cooling water withdrawal rates. See EPA Economic and Engineering Analysis, App. A, p. 15. See also December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 4.4, Table 4-1. Therefore, EPA does not believe that these options could constitute BTA under CWA § 316(b) and concludes that they do not warrant further analysis in this determination document.

iii. Non-Closed Cycle Flow Reduction Options

There are also methods of reducing flow at BPS without utilizing closed-cycle cooling. These methods, however, are only likely to achieve limited improvements by themselves. As a result, EPA does not regard any of them alone to constitute BTA. EPA will consider these options, however, as possible components of a larger overall approach to ensuring that the capacity and design of the CWISs at BPS reflect the BTA for minimizing adverse environmental impact under CWA § 316(b).

(A) "Piggy-back" Cooling

In the January 1997 NEPCO Report, the permittee looked at two "piggyback" cooling options. These options were re-evaluated by the permittee in the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.4. Piggyback cooling essentially eliminates the need to withdraw water from the Lee River through the intake to Unit 4 by "routing a portion of the mixed, warm condenser discharge of Units 1, 2, and 3 into the pump bay of Unit 4" for cooling. Id. at p. 3.4-1. This is made possible by the layout of the piping network at BPS. By eliminating the Unit 4 CWIS flow, these options could yield a maximum estimated reduction in flow rate of 260,000 gpm (or 29%), and a corresponding reduction in entrainment and impingement, as compared to that which occurs when Unit 4 is in operation. Id. It should be noted that this is not a 29% reduction on an annual volume basis, because Unit 4 only operates around 20% of the time.

Moreover, the permittee indicates that piggyback cooling could only be used around 8 months of the year. Id. at pp. 3.4-1 to 3.4-2. The piggyback cooling process transfers the waste heat from Unit 4 to the already heated effluent from Units 1, 2 and 3, thereby making this water even hotter. Thus, the piggyback options reduce flow but do not reduce the total heat load discharged to the bay, and when intake water temperatures are relatively warm, the heated effluent from piggyback cooling would likely exceed the permit's current limitations for maximum temperature and Δ-T. The maximum temperature limit would especially be a problem during the summer. Due to this thermal discharge problem, implementation of year-round piggyback cooling would also require either installation of a thermal discharge reduction technology or substantial cutbacks in operations. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.4-1, 3.4-3.

The two piggyback cooling options evaluated by the permittee include the "simple" (or "conventional") piggyback operation described above and a variation which involves re-routing the existing Unit 4 intake flow directly to Unit 3. In the latter mode, the flow drawn from the Taunton River for Unit 3 would be replaced with flow from the Lee River withdrawn through the newer Unit 4 CWIS. This approach would take advantage of the impingement reduction capabilities of the newer Unit 4 intake screen technology (i.e., angled revolving screens). The permittee indicates that the Unit 4 angled screens divert some fish from the intake so as to reduce impingement from levels experienced by the flush-mounted screens used for the CWIS for Units 1, 2 and 3.

Thus, the two piggyback options offer the same reductions in flow and entrainment, but the modified piggyback option would achieve greater impingement reductions by substituting flow through the Unit 4 angled screens for flow through the Unit 3 screens. It is impossible to quantify the exact margin of additional impingement reduction, but the permittee has pointed to information suggesting a possible 50% reduction in impingement for angled screens as compared to the non-angled screens. See NEPCO 1997 Report; EPA October 1982 Modification Determination, p. 21-37.

Although the modified piggyback option provides a potential impingement reduction benefit, the permittee explains that it prefers the conventional piggyback option because it would have lower capital costs (i.e., zero), lower energy penalties, and could be implemented more quickly. See January 1997 NEPCO Report, Table 6-2; December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.4-9. Furthermore, the permittee also states that if obtaining the benefits of the Unit 4 intake screens was a goal, it would be more economical to simply retrofit the Unit 3 intake with angled screens than to implement the modified piggyback option. Id. The permittee does not, however, recommend implementation of either piggyback option because neither achieves the permittee's own flow reductions targets. Id.

EPA has concluded that neither piggyback option constitutes BTA by itself for a number of reasons. First, piggyback cooling only reduces flow levels at times that Unit 4 is in operation and flow for both units 3 and 4 would otherwise be used by the plant. Since Unit 4 has a relatively low capacity factor of around 20%, the Unit 4 intake is already not operating much of the time. Second, the permittee has already been utilizing conventional piggyback cooling on a seasonal basis for a number of years, under approval from the regulatory agencies, and under MOA II, conventional piggyback cooling is used 8 months of the year. Thus, while piggyback cooling reduces flow rates by 29% from levels that occur when both intakes are operating, piggyback options do not provide a full 29% reduction on an annual volume basis over existing circumstances. Id. at p. 3.4-7 (as compared to MOA II requirements, the permittee estimates annual flow reductions of 4% for the conventional piggyback option and 7% for the modified piggyback option). To provide a significant reduction in flow compared to existing conditions, the piggyback option would need to be used significantly more frequently that it is now (e.g., continuously). As discussed above, however, BPS could not do this and at the same time comply with the maximum temperature and Δ-T limits of its permit unless the plant significantly curtailed generation during the summer (or also installed a substantial thermal reduction technology of some kind). Such curtailment would be quite expensive and would reduce generation at times of peak demand. Third, as discussed below, EPA does not believe that even a 29% reduction in annual flow volume would be sufficient to satisfy CWA § 316(b). Fourth, unlike the closed-cycle cooling options discussed above, the piggyback cooling options can reduce flow but do not contribute to the additional goal of reducing the amount of heat discharged to the bay.

(B) Flow Reduction from Changes in Pumping Capacity or Practices

In a CWIS, pumps are used to draw water in through the intake and circulate it through the plant's cooling system. One-speed pumps take in the maximum flow that the pump can handle at all times the pump is operating. They are either on or off. See, e.g., December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.5-5. Pumps can, however, be designed to operate at variable speeds so that when set on a lower speed they withdraw less water from the source water body. Using some type of variable speed pump within a power plant cooling system would enable the facility to reduce flow whenever conditions such as low inlet temperatures and/or low demand dictate that less flow is needed to provide adequate cooling for the amount of electricity being generated. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.5-1. In other words, variable-speed pumps give a plant some ability to tailor its cooling water withdrawals to the minimum amount actually needed for cooling without reducing electricity generation.

As with the piggyback cooling options, however, flow reductions may be limited at certain times by the cooling needs of the generating unit and the maximum temperature and Δ-T limitations of the permit. Thus, the use of variable speed pumps could allow a reduction in flow for a once-through cooling system, but only at times when higher flows are not needed. These options also do not achieve any thermal discharge reductions. See Id. at Table 4-1.

At BPS, each generating unit's condenser cooling system is equipped with 2 circulating water pumps. These pumps are not redundant. Instead, they are "½-size"and both pumps must operate in order to meet a unit's maximum cooling water needs. Id. at p. 3.5-3. For Units 1, 2 and 3, the present pumps are one-speed, while the Unit 4 pumps already have variable-speed drives. Id. at p. 3.5-7.

The permittee has studied several options for reducing flow by altering pumping capacity or practices at BPS. January 1997 NEPCO Report, Section 4.5; December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.5. First, the permittee investigated the simple option of periodically using only 1 of the 2 pumps associated with each generating unit. This option was rejected as being unreliable because the current pumps are not designed to be turned on and off on a frequent basis. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, pp. 3.5-12, 3.5-14. Second, the permittee investigated installing two-speed motors on the pumps, thus giving them high and low settings. Id. at Section 3.5.2. Third, the permittee investigated installing variable speed drives (VSDs) in the pumps for Units 1 and 2, which would enable the permittee to run the pumps at varying speeds. Id. at Section 3.5.3. The permittee concluded that VSDs would not be appropriate for Unit 3 because that unit generally requires maximum flows. Id. at p. 3.5-7. As stated above, Unit 4 already has VSDs. Fourth, the permittee considered "throttle flow" operations under which flows would be reduced by throttling the condenser outlet valves during periods of reduced generation.

The permittee ultimately concluded that either the two-speed pump, VSD (for Units 1 and 2), or throttled flow options would all be suitable as flow reductions measures, but since they do not achieve thermal discharge reductions they would, at a minimum, need to be coupled with a thermal reduction option. Id. p. 3.5-14. The permittee also concluded that these options alone do not by themselves meet the permittee's own flow reduction goals. Id. at p. 3.5-12.

Obviously, unlike the other options discussed above, these options do not provide a constant entrainment and impingement reduction benefit. Instead, they provide a benefit only when the plant is actually able to reduce flows and still generate electricity, operate in a once-through cooling mode, and meet thermal discharge limitations. Because of the variability in inlet water temperatures and electricity demand, it is difficult to reliably project the effectiveness of this option for reducing flow (and entrainment and impingement) on an annualized basis. According to the permittee's projections, the two-speed pump, VSD and throttled flow options all achieve similar flow reductions in the winter months, but very little reduction in the summer months. See Id. at Table 4-1. The permittee points out, however, that since the winter flounder spawning season occurs in the winter, the winter reductions may be environmentally significant. At the same time, however, it must be noted that even in the winter months these pump-related options achieve far more modest flow reductions than the closed-cycle cooling options. Id.

Of course, the pump-related options are also much less expensive. Id. (capital costs range from only $0.6 million to $2.5 million). In addition, generation penalties from these options are substantially offset by costs savings from reduced energy needs for pumping. See Id. at pp. 3.5-6, 3.5-8, 3.5-10.

In light of the above considerations, EPA believes that flow limits reflecting one of the three pumping options deemed suitable by the permittee should be *a part of* any set of CWIS design or capacity requirements to reflect BTA. EPA has also concluded that the pumping options should not be regarded to constitute BTA *by themselves* because they do not achieve flow reductions year-round and they do not achieve sufficiently large flow reductions at any time of year. In addition, these options do not achieve any thermal reductions.

(C) Generation Curtailment & Timed Maintenance Outages

The permittee's January 1997 NEPCO Report, Section 4.4, also looked at a so-called "flow reduction" option. As conceived by the permittee, this option essentially involved curtailing the generation of electricity to a level that would enable it to reduce flow by 29% (i.e., equivalent to eliminating the flow for Unit 4). Not surprisingly, the permittee indicated that very high energy losses would occur with this option on an annual basis. For example, the report states that this option would reduce BPS generation capacity by 300 MW. Id. at p. 4-7. The overall effect on plant energy output would, of course, depend on the extent to which generation was curtailed. See Id. 4-7 to 4-8, Table 6-1. The permittee also states that such generation curtailment would diminish station reliability. These problems would be especially acute during the high demand summer period.

Given that there are available methods of reducing flow without making major reductions in electrical generation, EPA does not believe this method constitutes BTA for BPS. Generation curtailment (or flow reduction) could, however, be a suitable method of meeting some short-term or seasonal heat reduction target. While EPA is not setting BTA limits based on this "flow reduction" option, the permittee is of course free to meet the final permit requirements in any manner it chooses, including by using curtailing generation. As discussed elsewhere in this document, some facilities have chosen to achieve seasonal flow reduction targets by curtailing generation.

In the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.5.5, the permittee also investigated an option of "seasonally timed outages," which would involve scheduling regular maintenance outages during the Mount Hope Bay winter flounder spawning season (February through May) so as to maximize the environmental benefit gained from flow reductions associated with maintenance outages that must happen anyway. The permittee notes, however, that timing maintenance outages with the winter flounder spawning season "would be difficult due to ISO New England scheduling constraints and other competing environmental factors, such as air quality operating constraints during the ozone season."

Although it would be environmentally beneficial for the permittee to schedule regular maintenance outages to coincide with the winter flounder spawning season whenever possible, EPA believe's that flow limits based on this practice alone would not constitute BTA. First, this practice would only achieve periodic, short-term reductions in flow, rather than the major flow reductions that other options under consideration can achieve. Second, EPA understands that there may be competing concerns (such as air quality constraints or energy demand) that constrain the permittee from scheduling all maintenance outages in this manner. Therefore, flow reductions from this option could not always be counted on. In contrast, options such as closed-cycle cooling provide substantial, definite and year-round flow reductions.

7.3.4b Location Options

As a general matter, in the absence of closed-cycle cooling, one of the best ways to minimize the potential adverse impacts of a CWIS is to locate the intake in an area where impacts are more likely to be less severe, such as an off-shore, ocean location. It is always advisable in order to reduce adverse impacts from a CWIS to locate the intake in relatively less sensitive or biologically productive areas as well as areas where low approach velocities can be attained. Of course, other steps may also be needed to ensure that the capacity, design and construction of the CWIS reflect BTA.

Of course, for BPS, the CWISs are unfortunately already located in a sensitive estuarine environment. Therefore, the question here is whether re-locating the CWISs would constitute BTA in this case.

The permittee investigated relocating the intake to an off-shore location and concluded that, although technology existed to implement such an option, it was economically impracticable and raised a number of serious potential environmental issues that would have to be studied in depth before it would be approved. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.7. The permittee concluded that an off-shore intake re-location would require boring an 18-mile tunnel through bedrock to a location in Rhode Island Sound. As the permittee notes, the new, 9-mile Massachusetts Water Resources Authority sewage treatment plant outfall generally indicates that such a tunneling project could be done.

However, the permittee also indicates that the project would be a massive, complex construction project that would take approximately 5 years to complete and "is estimated to cost on the order of $600 million." Id. at p. 3.7-3. The permittee also predicts that project construction could cause a number of potential adverse environmental effects, including to groundwater resources along the tunnel route. Id. at p. 3.7-2. Significantly, the permittee also points out a serious, potentially unacceptable environmental concern raised by this option. The offshore water taken in through the new intake would be heated and discharged into Mount Hope Bay. This could have harmful environmental effects because the offshore water has a different temperature, salinity and nutrient content from the bay water. Id. EPA agrees that this issue would require careful study before approval, and while this issue could be avoided by also relocating the discharge point offshore, that would add additional expense to an already hugely expensive and difficult project.

Having considered the matter, EPA concludes that CWIS location changes do not constitute BTA in this case. First, we agree that while entrainment and impingement effects are likely to be reduced by moving the intake outside the Mount Hope Bay estuary, a major reduction in impacts would likely require moving the intake outside Narragansett Bay to the ocean. Even still, there would be adverse impacts to the assemblage of organisms residing at the new location. Second, even assuming permits could be obtained to allow such a project, the work would likely be hugely expensive and would undoubtedly entail significant potential adverse environmental impacts from construction. Third, the environmental issues related to potentially discharging off-shore water, after cooling, into Mount Hope Bay would need to be carefully evaluated before such a project could be approved. EPA believes that the closed-cycle cooling options for reducing capacity are likely to be capable of achieving significant and sufficient improvements more quickly and at far lower cost. Thus, EPA does not believe that re-locating the CWIS would reflect BTA in this case.

7.3.4c Design Options

In general, the major options for ensuring that the "design" of a CWIS reflects the BTA for minimizing adverse environmental impacts, involve technologies that attempt to reduce impingement and entrainment of marine life by reducing intake velocities or by imposing some type of barrier to prevent organisms from entering the CWIS. In addition, technologies can be installed, such as fish return systems, to try to increase the survival rate of marine life that is impinged by any barrier mechanism. (CWIS design options to reflect BTA also include pumping modifications, but pumping options are discussed elsewhere in this document.)

i. Velocity Reduction Measures

Design options for reducing the velocity of the water drawn into the CWIS help to reduce impingement by making it easier for fish to escape the influence of the CWIS. A commonly used standard for intake flow velocity is that the flow should not be greater than 0.5 feet per second (fps) *at the screens*. See 65 Fed. Reg. 49087 (August 10, 2000) (discussion of literature regarding intake flow velocity).[47] Other information points to similar velocity thresholds. See 1996 EPA Supplement to Background Paper No. 3, p. A-1 ("studies conducted with white perch and striped bass indicate a marked increase in impingement at approach velocities greater than 0.8 fps;" "Research indicates that approach velocities lower than 0.8 to 1.1 fps may be required to protect certain species against impingement" [references omitted]). Indeed, the CWIS angled traveling screen system installed at Unit 4 was apparently designed to try to produce an approach velocity of 0.5 fps based on certain research suggesting it would be beneficial. See EPA October 1982 Modification Determination, p. 37, 21-36. However, while the approach velocity at the Unit 4 CWIS is reported by the permittee to be 0.5 fps *at the bar racks*, it is around 1.0 fps *approaching the traveling screens*. 1997 NEPCO Report, p. 2-6; December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 2-5. Moreover, the approach velocity at the intake for Units 1, 2 and 3 is approximately 1.4 fps *at the trash racks*. See Brayton Point Station Monitoring Program, A Technical Review (September 30, 1992) (Metcalf & Eddy, under contract to EPA); December 2001 USGenNE

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[47] Please note that we are not citing the preamble to the Proposed CWA § 316(b) Rule for new power plants as if it imposes, or provides guidance suggesting, a velocity requirement of 0.5 fps for an existing plant such as BPS. We recognize that it does not. We only cite to the preamble here for the purpose of pointing to the technical references listed there that themselves independently suggest a velocity requirement of 0.5 fps. In other words, we are relying on the references and not on EPA's federal register notice to suggest that 0.5 fps has been pointed to as a possible standard.

316(a) and (b) Demonstration, Vol. IV, p. 2-2 ("theoretical" velocities calculated to be 1.35 fps at the trash racks for Units 1 and 2 and 1.56 fps at the trash racks for Unit 3). Approach velocities *at the screens* would be even higher. Therefore, it does not appear that approach velocities at the screens are optimal for minimizing impingement at either of the BPS CWIS's.

That being said, there are no obvious measures that appear to make sense for reducing velocity at the BPS CWISs. Velocity caps are technologies used for offshore ocean intakes to reduce approach velocity, but would not be appropriate at BPS. See EPA 1994 Background Paper No. 3, p. 3-9. It should be noted that in the January 1997 NEPCO Report, the permittee considered an option that involved installing angled, fine-mesh screens for the intake for Units 1, 2 and 3. This option also involved increasing the area of the intake bays to decrease the current screen approach velocity to 0.5 fps or less in order to prevent screen overloading during periods of heavy loadings from materials such as seagrass. January 1997 NEPCO Report, p. 4-34 to 4-35. However, the permittee indicated that this option had an associated capital cost of $30 million dollars. Id. p. 4-37, Table 6-2. More recently, the permittee has estimated the cost for a similar option to be $56.4 million. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.6-5. EPA does not believe that an expenditure at that level would make sense for a technology that only yields marginal potential reductions in impingement. There are other steps with a similar order of magnitude of capital expense that can reduce impingement while also achieving improvements with respect to the (relatively) more serious problems of entrainment and thermal discharge. EPA believes that major expenditures for minimizing adverse environmental impacts from the CWIS should be directed toward measures which simultaneously address all these problems.

ii. **Barrier Mechanisms**

Barrier mechanisms can be divided into the general categories of Behavioral Deterrent Technologies and Physical Barriers.

(A) Behavioral Deterrent Technologies

Behavioral barriers which could be considered as possible steps to reduce *impingement* at BPS include sound barriers, light barriers, electrical barriers, air bubble barriers, and chain or cable barriers. These technologies are not, however, effective for reducing *entrainment* of floating or drifting organisms. Moreover, whether these technologies are capable of reducing impingement by repelling fish is highly uncertain. To determine their potential efficacy at a particular plant, a site-specific analysis of conditions at the plant and the likely behavior of the relevant species of marine life would be necessary. Thus, extensive testing would be required to determine whether one of these technologies might be effective at BPS.

In the January 1997 NEPCO Report, the permittee discussed behavioral barrier alternatives but dismissed them without further development of cost estimates because, according to the permittee, no effective site-specific options were identified for potential use at BPS. For behavioral deterrent systems, the permittee concludes that the technology is not feasible because visual barriers such as light or bubble curtains would have no effect on entrainment of larvae and eggs, and because sound and light systems are still considered to be in an experimental stage of development and would not be suitable for full scale installation at BPS. The permittee reached the same conclusion in its February 22, 2001, report entitled, "NPDES Renewal: USGen New England, Inc., Brayton Point Station, Somerset, Massachusetts."

EPA agrees that at the present stage of development, behavioral deterrent systems do not constitute BTA for BPS. They are simply not clearly "available" or effective. In addition, even if effective at reducing impingement, they would not help with the problem of entrainment. EPA is aware that the Salem Nuclear Generating Station in New Jersey is actively investigating the feasibility of behavioral barriers as a technology to reduce impingement at the facility. Thus, it is possible that in the future such measures may be developed and require further consideration. At present, however, EPA believes it advisable to direct expenditures for reducing impingement at BPS to measures whose efficacy is more certain, and that any major expenditures should be directed to measures that will also reduce the (relatively) more significant problems of entrainment and thermal discharge impacts.

(B) Physical Barriers

There are many types of physical barrier technologies that can be considered for their potential to reduce entrainment and impingement impacts. These include screen systems (such as fine mesh screens), passive intake systems (such as perforated pipes, porous dikes, wedge-wire screens, and artificial filter beds), and diversion and/or avoidance systems. In addition, there are various fish return technologies that seek to maximize the survival of impinged organisms by returning them to the source water body with as little harm as possible. These include fish bypass systems, fish buckets and baskets, fish troughs, fish elevators, fish pumps, spray wash systems, and fish sills.

At present BPS has two different types of screening systems in operation. See Section 2.2.2. The CWIS for Units 1, 2 and 3 draws from the Taunton River and utilizes flush-mounted traveling screens. The screens are presently operated continuously as required by MOA II ¶ 8.e. Material is cleared from the screens with a high-pressure spray wash system. The material travels down a sluiceway and back to the water through a pipe to a point approximately 300 feet east of the intake. Impingement is monitored and reported by the permittee under requirements in the NPDES permit. In addition, fixed screens are installed upstream of the traveling screens from May to October to keep horseshoe crabs from being drawn into the traveling screens where the spray wash system is ineffective to remove them. Id. at p. 2-3. The CWIS for Unit 4 draws from the Lee River and utilizes angled traveling screens which are run continuously as per MOA II ¶ 8(e). This intake has a bypass system to remove fish that enter the CWIS but do not reach the traveling screens and return them to the Lee River downstream of the intake. Id. at p. 2-5. Fish that do reach the traveling screen are captured in fish buckets, washed into a trough by a low-pressure screen wash, and fed into a pipe which returns them to the Lee River downstream of the intake. Id. The screens for both CWISs are of a standard size (i.e., do not have fine-mesh) and do not prevent the entrainment of fish larvae, eggs, or plankton.

In considering possible retrofits to the existing screening systems, the permittee has considered and rejected a number of possible options. In its February 22, 2001, report, the permittee considered and rejected cylindrical wedge-wire screens; drum screens; infiltration intakes; porous dikes; barrier nets; and fine-mesh and dual-flow traveling water screens.

Cylindrical wedgewire screens are a type of physical barrier that could possibly reduce fish losses to some extent, but the physical size of the screening device restricts application of wedge-wire screens to use for closed-cycle make-up water or other small flows. The permittee has stated that cylindrical wedge-wire screens do not presently appear feasible and testing would be required to further evaluate the risks of severe clogging and bio-fouling. EPA-New England has determined that several full-scale CWIS applications of this technology have performed satisfactorily, but with course bar spacings of 10mm. The potential use of bar spacing as small as 0.5 to 2.0 mm in order to protect at least some early life stages of fish has not been evaluated at a CWIS. Therefore, large-scale pilot studies would be needed to determine the potential of this technology for reducing adverse environmental impacts at BPS. Accordingly, EPA does not presently consider this technology to represent BTA for minimizing adverse environmental impacts at BPS.

The permittee also rejected rotary drum screens because they do not offer performance or cost advantages over similarly functioning traveling screens or angled traveling screens. EPA found no evidence of a drum screen application at a CWIS. Drum screens have been used at irrigation and hydroelectric facilities, but even in these applications the screens are limited by the requirement for maintaining constant water elevations. EPA agrees that angled stationary diversion screens would be preferred over rotary drum screens.

Passive intake systems, such as porous dikes and infiltration intakes, are a subset of the physical barrier technologies. They screen out debris and biota with little or no mechanical activity. Most of these systems are based on achieving very low water withdrawal velocities at the screening media so that organisms can avoid the intake. The permittee determined these systems to be infeasible because of the high circulating water requirements of the facility and problems of biofouling. In the early 1980's, in anticipation of changing from closed-cycle cooling to once-through cooling at Unit 4, NEPCO did an extensive study on the possible suitability of using porous dike systems at the threshold of the intake structure. The results of the study indicated that this technology is effective at excluding juvenile and adult fish, but the permittee also predicted that use of this technology would result in major problems from porous dike clogging, ice build-up and frazil ice in the dike proper, as well as biofouling by colonization with fish and plant life. As a result, this option was rejected. EPA concurs with the permittee’s decision to drop these technologies.

The permittee also eliminated “barrier nets or curtains” from consideration on the basis of the high water velocities, variable tidal and storm induced currents, and large quantities of debris experienced at BPS. Barrier nets or curtains act on the same principle as other screening systems, but use different screening media. For example, the technology known as the “Gunderboom” is made with a geotextile fabric curtain. Most of the recent information on barrier net efficacy relates to their use at hydroelectric facilities.

It should be understood that if a net or curtain successfully blocks an organism from being drawn into the cooling system, then that organism is by definition impinged on the screening material. The question then becomes whether or not the organisms survive this impingement (or the measures used to wash them off of the screening material). This technology may be more likely to be successful in a river environment where organisms could be blocked from entering the CWIS and then washed downstream away from the intake, whereas they might be less successful in a ocean or estuarine situation where they would be washed back and forth against the barrier by the tide and be subjected to strong coastal storms, waves and tidal forces. It appears that acceptance of nets by resource agencies is growing for use at hydroelectric facilities. Ultimately, the ability of a net or curtain to protect early stages of fish from entrainment depends on the size of the mesh of the screening material. A Gunderboom has been used at a power plant on the Hudson River in New York (Lovett Station) and although there have been some problems anchoring the device, it has been reported to significantly reduce entrainment at that plant. (E.P. Taft, "Fish Protection Technologies: A Status Report," Environmental Science and Policy (2000)).

Serious questions remain, however, regarding the feasibility of net or boom anchoring systems for coastal plants subject to potentially severe storm conditions. This raises the potential for operational and even safety problems if the net or curtain came loose and blocked the CWIS or created a navigational hazard. This has been raised as a concern with respect to the Gunderboom technology both by the permittee and by another coastal power plant in New England that has evaluated the technology (Pilgrim Nuclear Power Station). Moreover, in rejecting the Gunderboom technology in its response to an EPA information request letter in September 2001, the permittee also provided a letter from the Gunderboom company in which the company agreed that safely anchoring the system at BPS was not presently feasible. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III (Tab: "Section 308 Information Request Submittal - 9/10/01, p. 16 and Attachment C.3). The permittee also pointed to potential interference with navigation from a Gunderboom installed seaward of the CWISs. Id.

EPA-New England does not presently consider barrier nets or booms as fully demonstrated at least for coastal plants. Moreover, since it is not clear that these technologies can significantly reduce CWIS mortality for the organisms of concern at BPS, EPA presently agrees with the permittee's conclusion that these technologies should not be deemed BTA for BPS.

Another option considered by the permittee is the so-called "fine-mesh" screen. Fine-mesh screens use much smaller mesh sizes than conventional traveling screens. Fine-mesh screens must also be coupled with some sort of fish return system. Fine-mesh screens may be capable of screening out most small fish and possibly some eggs and larvae. What they block from being entrained depends on the relative size of the mesh and the organisms in question. Of course, to the extent that fine-mesh screens successfully stop smaller organisms from being entrained, those organisms will necessarily be impinged. As a result, the question then becomes whether or not these tiny, delicate organisms can survive the impingement process.

Fine-mesh screens can also pose operational concerns, at least at certain sites, because they tend to capture more debris and, therefore, are more prone to clogging. As the permittee points out, they may also be prone to clogging by the growth of marine organisms, such as barnacles, on the screens. Although such "biofouling" can be combated by using biocides such as chlorine in the spray wash for the screens, such a practice would likely kill any surviving organisms impinged on the screens. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.6-3.

As the permittee also reports, a number of power plants around the country have installed fine-mesh screens for their CWISs, including retrofit installations,. See Id. at p. 3.6-2. These plants report success at reducing entrainment and impingement mortality. Nevertheless, the true benefit of these technologies must be assessed on a site-specific basis taking into account the size of the mesh, the approach velocity, the fish-return system, and the specific organisms and life stages in question. Again, to the extent fine-mesh screens reduce entrainment, they result in increased impingement of tiny organisms and the survival of these organisms must be evaluated.

The permittee evaluated two options involving replacing the traveling screens at BPS with fine-mesh screens –"angled fine-mesh" traveling screens and "modified dual-flow" traveling screens– but ultimately rejected both. These two approaches use similar technologies but configure them in different ways. Id. at pp. 3.6-3, 3.6-7, Figures 3.6-2, 3.6-9. For both options, the permittee expressed serious concern about potential clogging of fine-mesh screens at BPS due "a greater abundance of debris and trash" than experienced at other plants using fine-mesh screens. Id. at pp. 3.6-1, 3.6-10, 3.6-14. BPS actually tried a fine-mesh screen on Unit 4 in the past but replaced it with a larger mesh screen due to heavy loading with debris. The permittee also expressed concern about biofouling and clogging by frazil and floating ice. Id. at p. 3.6-3. The permittee explains that a mesh size of 1 to 2 mm might be too large to prevent entrainment of winter flounder larvae and eggs, id., but a smaller mesh size (such as 0.5 mm) would be more prone to clogging. The permittee also explains that approach velocities would need to be reduced to 0.5 feet per second in order to reduce the threat of overloading the screens with debris, but that to achieve this would require additional construction. Id. at p. 3.6-4. The permittee also indicates that modified dual flow traveling screens have the advantage of "eliminat[ing] debris carryover," id. at p. 3.6-7, but have lower impingement survival than the angled fine-mesh screens. See Id. at pp. 3.6-3, 3.6-7, 3.6-8.

With respect to biological performance, the permittee essentially seems to conclude that while there may be potential benefits to fine-mesh screens, such benefits are quite uncertain at BPS. The permittee makes the following statements:

– "A fine-mesh traveling water screen intake system minimizes entrainment, but increases potential for impingement of organisms . . .." Id. at p. 3.6-2.

– "This screening system offers some promise of reducing mortality of both impinged fish and entrainable organisms by including two fish return systems in its design." Id.

- "There is no data to quantify the expected improvement in impingement survival due to specific site and species survival factors. As always, some impinged species have higher survival than other species, and ambient water temperatures have some influence on the condition and survival of impinged fish" Id.

- "Because this intake design [i.e., the angled fine-mesh screen] incorporates both impingement return and angled bypass system, this alternative should provide some improvement in survival for at least some species of impinged fish." Id.

- "It is not known if the entrainable species at the Brayton Point Station would have higher survival on the screens or in passage through the cooling system." Id.

- "Disadvantages of the fine-mesh traveling water screen concept include: . . . increased impingement of organisms and debris; . . . [m]esh size of 1 to 2 mm may still be insufficient to prevent entrainment of early life stages of winter flounder larvae and eggs." Id. at p. 3.6-3.

- With the dual flow screen, "[m]ore water tends to enter the side of both the ascending and descending sides of the screen closest to the pumps. This unequal distribution leads to hot spots where impingement is more likely to occur than with a design that spreads the flow more uniformly. However, even with this limitation, the lower approach velocity, the modified lifting buckets, and spray wash system . . . should provide some potential for improvement in survival for at least some impinged fish." Id. at p. 3.6-8.

The permittee has made an "order of magnitude estimate" of approximately $50 million for the capital cost of each of the two fine-mesh screen alternatives. Id. at p. 3.6-15. See also January 1997 NEPCO Report, p. 4-37 (order of magnitude cost estimate of $30 million for fine-mesh screen option). Neither option requires any unit outages for construction and neither option results in any efficiency or auxiliary energy penalties, though their annual operations and maintenance expenses are $430,000 for the angled fine-mesh screens and $170,000 for the dual flow fine-mesh screens. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.6-15.

Based on present information, EPA concurs with the permittee's decision to reject the two fine-mesh screen alternatives from further consideration at this time. The biological benefits of using fine-mesh screens at BPS are simply unclear. Entrainment would be reduced, but by how much is uncertain. Moreover, while reducing entrainment, fine-mesh screens would increase impingement of tiny, fragile organisms and the extent to which such organisms would survive is unclear. Site-specific analysis would be required to try to characterize the overall effect of using fine-mesh screens at BPS. In addition, these options provide no thermal reduction benefit. Meanwhile, the company has estimated the capital cost of these options to be virtually the same as the costs for the Enhanced Multi-Mode and the Closed-Cycle Unit 3 options, see id. at Table 4-1, whereas the latter options provide clear benefits by cutting both entrainment and impingement as a result of flow reductions, and also by reducing thermal discharges. While EPA understands that these closed-cycle cooling options may also have additional costs due to construction outages and energy penalties, EPA concludes that it makes more sense to undertake any significant capital expenditures on closed-cycle options that will provide more certain benefits than to undertake similar expenditures for measures, like fine-mesh screens, whose benefits are uncertain. Finally, the permittee has concluded that fine-mesh screens would pose a serious reliability problem due to screen clogging that might even lead to unit outages. While EPA has not independently evaluated this claim in detail, it appears to represent an additional reason to reject the fine-mesh screen alternatives at the present time.

The permittee also evaluated an option referred to as "modified traveling water screens." This alternative essentially involves modifying the existing traveling screens for Units 1, 2 and 3, in order to improve the fish return system and reduce impingement mortality. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.6.3. The permittee explains that this option would include "new screen mesh baskets with lifting buckets to retain impinged fish, low pressure fish removal sprays, a fish return trough, and operating components capable of continuous rotation of the traveling water screen assembly." Id. at p. 3.6-10. The permittee estimates that the costs of these modifications will be relatively modest (around $1.3 million), with no energy penalties due to lost efficiency, auxiliary energy needs, or construction outages. Id. at p. 3.6-12. The permittee concludes that the improved fish return system and more reliable components of this option "offer[ ] some assurance for reducing mortality to impinged fish in comparison with the existing screening facilities at Units 1, 2 and 3." Id. at p. 3.6-11. While acknowledging that "[t]here is no data to quantify the exact improvement in impingement survival due to specific site and species survival factors . . .," the permittee nevertheless concludes that "the features of this intake alternative should provide some improvement in survival for at least some species of impinged fish." Id.

EPA concludes that the "modified traveling screen" option should be carried forward for further review as a potential component of any set of options that utilizes the existing CWISs. It is clear that this type of a screening system retrofit of the intake for Units 1, 2 and 3 is economically and technologically practicable. Id. at p. 3.6-10, 3.6-12. Further, although this option would not provide flow reductions, entrainment reductions, or thermal discharge reductions, it does seem that it will help to reduce impingement mortality at relatively small expense, thus optimizing the performance of the existing screening system. In addition, the improved reliability of the component parts of this option are highly desirable because any option that continues to use the existing CWISs will be required by the NPDES permit to include continuous operation of the traveling screens, as per MOA II ¶ 8.e, in order to obtain the maximum environmental benefit from the existing technology. Id. at p. 3.6-10. Of course, if the intake for Units 1, 2 and 3 was not used under a future cooling tower option, and only the Unit 4 intake continued to be used, then there would be no need for these screening system upgrades.

7.3.5 Summation - Comparison Chart

The chart below presents a comparison of the major options that EPA believes warrant further detailed consideration. It also covers the existing NPDES permit and MOA II for the sake of comparison. The chart looks only at the *annual* flow rate and *annual* thermal rejection to Mount Hope Bay associated with each option. Ultimately, the permit may also address these parameters with daily, monthly, and/or seasonal limitations. Nevertheless, this chart provides a useful gross comparison.

Table 7.3-1: Comparison Chart

Operating Scenario	Flow Rate (MGD)	Annual Heat Load Discharge (TBTU)
Current Permit	1452	97
MOA II	977	42
Enhanced Multi-Mode (20-cell cooling tower)	650 (annual) (750(summer)/600 (winter))	28
Closed-Cycle Unit 3	654	22.9
Closed-Cycle Entire Station (Units 1, 2, 3 and 4)	56 (Intake)	0.8
Closed-Cycle Units 1 or 2 & 3	350	14
Pumping Improvements in Combination with a Closed-Cycle Cooling Option (VSDs, Two-Speed Pumps, or Throttled Flow Operation)	844 - 860 (annual) 758 - 786 (winter) 1015 - 1037 (summer) (note: these figures represent reductions assuming no other flow reduction option was implemented, but are provided for illustration of the type of flow reductions provided by these technologies)	No Change.
Modified Traveling Screens for the Units 1, 2 and 3 Intake	No changes in flow or thermal discharge, but some improved impingement survival	

7.4 Economic Consideration of Technological Options

7.4.1 Introduction

As discussed in detail above, EPA has interpreted CWA § 316(b) to authorize it to consider the cost of the technological options for CWIS improvements when making determinations of what constitutes BTA for minimizing adverse environmental impacts. First, cost is considered in terms of whether an option is economically "practicable." This can be understood as part of meeting the "availability" component of BTA. Second, under EPA's current approach, the Agency also considers costs by determining whether or not the cost of the BTA requirements would be "wholly disproportionate to the environmental benefit to be gained." This comparison is not a cost/benefit analysis; rather, it is a particular type of consideration of costs that EPA has determined, and the courts have upheld, is consistent with Congressional intent under CWA § 316(b).[48]

In order to address these two sets of economic considerations (i.e., practicability and the wholly disproportionate cost test) in a case-by-case analysis, EPA must determine the appropriate cost for a particular option under consideration for satisfying the BTA requirement at BPS. EPA must assess the permittee's ability to afford the option. These analyses are presented below. In addition, for the wholly disproportionate cost test, EPA must assess the environmental benefits to be obtained from the different options. This analysis is presented in another section of this § 316(b) determination. Finally, EPA must bring the costs and the benefits together to apply the wholly disproportionate cost test. This analysis is presented in a separate section further below. As part of our application of the wholly disproportionate cost test, EPA also considered what effects, if any, possible improvements at BPS would have on consumer electric rates.

7.4.2 EPA's General Approach to Analyzing the Cost of Technology Options

EPA hired two contractors to provide expert analysis to assist with EPA's independent assessment of the cost of the various technology options under consideration. Working with EPA, these two expert contractors addressed different aspects of the cost analysis.

First, EPA retained Science Applications International Corporation (SAIC), working under subcontract

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[48] See *In re Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2)*, 10 ERC 1257, 1261 (NPDES Permit Application No. NH 0020338, Case No. 76-7; June 17, 1977) (Decision of the Administrator). The First Circuit Court of Appeals noted EPA's application of the "wholly disproportionate cost" test with approval and cited to Congressman Clausen's remarks for the proposition that "[t]he legislative history clearly makes cost an acceptable consideration in determining whether the intake design 'reflect[s] the best technology available.'" Seacoast Anti-Pollution League v. Costle, 597 F.2d 306, 311 (1st Cir. 1979).

to Tetra Tech, Inc., to assess the "engineering aspects" of the cost of the technology alternatives. The "engineering aspects" of the cost include the capital and annual cost to the permittee of each option. The annual expenses include operations and maintenance costs, the cost of any reduction in electrical generation efficiency due the particular cooling system option, and the cost of the auxiliary energy needed to run the alternative cooling technologies. These efficiency and auxiliary energy penalties are discussed in some detail above. In addition, SAIC also evaluated the extent to which generation unit outages might be necessary to allow installation of any particular option, because lost generation during any such outage was also considered part of the cost of that option. Finally, SAIC also evaluated the likely construction schedule for the options because it has a bearing on their cost.

Second, EPA retained Abt Associates, Inc. (Abt), to assess the "financial aspects" of the cost to USGenNE of the various alternatives. This involved several elements. Abt developed a model to determine the cost over time to the permittee of the various options, the net present value of these multi-year costs, and the equivalent annualized cost. The analytical approach mirrors that used by the permittee in the "Dynamic Cost Analysis." See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, Appendix G (Tab: Dynamic Cost Analysis). Thus, the results from Abt's analysis can be meaningfully compared with the results of the permittee's analysis. In other words, it provides an "apples-to-apples" comparison with the permittee's analysis.

Abt's analysis not only considers the capital costs and annual operations and maintenance costs for each option, but it also determines the cost of each option to the permittee in terms of lost revenue due to reduced electrical generation. Lost generation-related costs include one-time losses due to any generating unit outages needed to install a particular technology option (i.e., "construction outages") and annual losses due to energy efficiency and auxiliary energy penalties. In addition, Abt's analysis took into account the economic cost to the permittee from generating unit outages predicted by the permittee to be required due to vapor plume-related icing and fogging safety issues. Finally, Abt's analysis also considered *increased* revenues that the permittee would be able to obtain due to the installation of new cooling technologies that enable increased hours of operation during peak summer demand periods as a result of reduced discharge temperatures. EPA and the permittee agreed that this type of long-term economic/financial analysis was the most accurate way to assess the cost to the permittee of each option, as opposed to, for example, the "static cost analysis" approach that the permittee had used in several submissions prior to the December 2001 USGenNE 316(a) and (b) Demonstration. Abt's analysis relied on various "engineering cost" data from the SAIC reports in order to generate EPA's independent cost estimates. In instances where SAIC did not develop an independent value, or determined that the permittee's figures seemed reasonable, Abt used inputs based on the USGenNE analysis. All of this is described in detail in the Abt report dated April 5, 2002.

In evaluating the economic/financial issues, EPA and its contractors carefully considered the permittee's economic analyses as presented in the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, Appendix G (Tab: Dynamic Cost Analysis); Volume IV; Volume V; and Volume I (Executive Summary). EPA and its contractors also considered a substantial amount of additional information earlier submitted by the permittee, including, without limitation, the January 1997 NEPCO Report; various meeting handouts by the permittee, and a variety of information submitted by the permittee in response to EPA CWA § 308 information request letters.[49] The latter material includes data submitted by the permittee from Resource Data International and information submitted with an October 16, 2001 letter from the permittee's counsel Wendy Jacobs of Foley Hoag, to Mark Stein of EPA. EPA and its consultants also had several meetings and conference calls with the permittee and its consultants to discuss various factual and analytical issues related to the assessment of the costs of the options. Finally, EPA's consultants also did substantial research using a variety of sources of data independent from the permittee. These independent sources are described and referenced in the consultants' reports.

EPA has independently reviewed the reports submitted by SAIC and Abt and determined them to contain reasonable and appropriate analyses. As explained in the reports, these analyses are conservative in many important respects (i.e., analytical choices were made that would tend to produce higher cost estimates). Therefore, EPA adopts the analyses contained in the SAIC and Abt reports. The SAIC and Abt reports are available in the administrative record. Rather than repeat all the details of these two reports, in this section of the document we only discuss key aspects of the analyses.

7.4.3 Results of EPA Analysis of the Cost of the Technology Options

In general, EPA has concluded that the permittee has substantially overestimated the likely costs of the various technologies. The biggest component of this overestimation is the capital cost predictions, but excessive predictions for construction outages, energy efficiency penalties and water vapor plume abatement outages also materially contribute to the total overestimate. In addition, the permittee's overestimate of the costs of the options is affected by other aspects of the financial analysis, such as choice of discount rate, certain inappropriate tax treatments,[50] and unrealistically using 2001 as the start-date for construction of new facilities. These issues are discussed in detail in Appendixes B and C hereto. Key points and conclusions from EPA's analysis are presented below.

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[49] It should be noted that the permittee's analysis of the cost of various options has changed significantly over time. For example, the January 1997 NEPCO report estimated that the option of closed-cycle mechanical draft wet cooling towers for Unit 4 would have a capital cost of $27.8 million and would result in an annual loss of 12,000 MW-hrs of electricity, whereas the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 3.3.3, estimated the capital costs for this option to be $48 million with lost annual generation of 25,000 MW-hrs.

[50] Actually, Abt uncovered two calculation errors by the permittee in the Dynamic Cost Analysis. One incorrectly reduced costs, but this reduction was more than offset by another error that incorrectly increased costs. Abt's analysis corrected for both errors, as discussed in the Abt Report (April 5, 2002), pp. 39-40.

7.4.3a "Engineering Aspects" of Cost Analysis

i. Capital Costs

SAIC conducted an independent assessment for EPA of the capital costs of the cooling water intake structure capacity reduction options under consideration. To do this, SAIC conducted two separate analyses. Each approach is discussed below and their respective results are presented in a table along with the permittee's numbers.

SAIC's first analysis generated independent costs estimates by comparing USGenNE's detailed cost spreadsheets with an independent source of construction cost data (the "Independent Line Item Analysis"). SAIC reviewed and analyzed USGenNE's capital cost estimates, which were submitted in detailed cost spreadsheets included in Volume V of the December 2001 USGenNE 316(a) and (b) Demonstration, and discussed in the text of Volume IV of the December 2001 submission. SAIC then identified similar cost items in an independent data source, the RS Means Cost Works database for the third quarter 2001. Some of the Cost Works items were lower in cost than the USGenNE numbers, while others were higher. Because the Costs Works database is a construction cost estimating resource for general construction throughout the United States, many of the specific unit cost items in the USGenNE spreadsheets could not be matched
with similar cost items in Costs Works. However, for each item that could be matched, SAIC used the Cost Works value in its analysis. Thus, SAIC did not selectively use some matching items and disregard others; all matching items were used. Depending on the option being considered, between 16% and 23% of the cost items in the USGenNE spreadsheets were able to be matched with items in the Cost Works data.

In addition, it is important to note that the Cost Works database allows for selection of cost factors that reflect specific regions of the country. In developing the independent cost estimates, SAIC chose data that represented the highest union labor rates for Boston, which is the most costly region in Massachusetts. These adjusted costs take into consideration regional costs for materials and labor, including the effects of using unionized labor.

For each alternative, the independent estimate line item costs were compared to the USGenNE line items costs. The comparison indicated overall that the independent, Cost Works-based estimates were significantly less than the USGenNE estimates. The ratio of the total of independently estimated line item costs to the total of the corresponding USGenNE line item costs indicates the relative extent to which the independent estimates are less than the USGenNE estimates for each technology option (and inversely, the extent to which the USGenNE estimates appear to have overestimated capital costs). Assuming that the comparative relationship observed for the matched items is representative of all of the cost items, multiplying this ratio by the corresponding total of USGenNE costs for a technology option yields an independent estimate of capital cost. Although we cannot be certain that this assumption is correct, SAIC and EPA believe it is not unreasonable to make this assumption. As mentioned above, SAIC did not pick and choose among the matching cost items; all matching items were used. Moreover, SAIC points out that most of the difference between the independent estimates and the USGenNE estimates appear to be attributable to differences in labor rates and man hours for the matching line items. In most cases the Cost Works labor rate and man hour estimates are much lower than the USGenNE estimates. SAIC points out that these types of differences can also be expected for other line items. Finally, as mentioned above, SAIC used the Cost Works data for the third quarter of 2001 and for the Boston area, the most expensive area for Massachusetts. Thus, EPA believes SAIC's approach is unbiased, reasonable and appropriately conservative.

The second analysis conducted by SAIC developed capital cost estimates for the technology alternatives derived from EPA's costing methodology for estimating facility-level costs used in the development of EPA's CWA § 316(b) regulations that were recently promulgated for new facilities and recently proposed for large existing power plants (the "316(b) Rule-Based Analysis"). SAIC adjusted the results produced by the cost equations EPA developed for new facilities by the relevant cost factors used by EPA to account for retrofitting a technology to an existing facility, dealing with salt water (which is more corrosive than fresh water and necessitates the use of more expensive materials and better drift control), and using fiberglass cooling towers (as proposed by the permittee) rather than redwood towers (which is the base case for the 316(b) rulemaking cost analysis).[51]

SAIC notes that USGenNE estimated costs for the unit-specific options for multiple units by first estimating the cost of converting each individual unit and then adding the costs together. Thus, for example, the cost for the closed-cycle entire station option was calculated simply by summing the costs of separately converting units 1, 2, 3 and 4. SAIC noted that USGenNE's approach likely overestimated costs because there would likely be some "economy of scale" benefit for multiple unit conversion options. SAIC estimated the total for these benefits to be approximately 6% for the closed-cycle entire station option based on the EPA CWA § 316(b) costing methodology. SAIC followed USGenNE's approach, but made the appropriate adjustment for economy of scale. <u>See</u> Appendix B, p. 9. SAIC also noted that USGenNE increased the cost of the options by 10% for "contingencies" (and an additional 10% for indeterminate costs). SAIC commented that the contingency adjustment appears high because typical contingency allowances for heavy construction projects are more in the range of 4% to 7%. Nevertheless, SAIC ultimately concluded that the 10% factor might not be unreasonable due to possible site-specific factors. Therefore, SAIC also used USGenNE's 10% factors for both contingencies and indeterminate costs in its analysis. <u>See</u> Appendix B, p. 7.

In addition, because of the permittee's concern that the use of cooling towers at BPS will cause fog/ice

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[51] SAIC and Tetra Tech are also working for EPA on the 316(b) rulemaking effort for EPA and, thus, are well-versed in the 316(b) costing approaches. The 316(b) Rule costing methodology and costing equations are described in detail in the EPA TDD 2001 - New Facilities. <u>Id.</u> at 12. This document can be found on EPA's website at http://www.epa.gov/ost/316b/.

hazards that will require generating unit shutdowns for the unit-specific closed-cycle cooling options, SAIC also estimated costs for two approaches that would obviate any need for such generating unit shutdowns. First, SAIC adjusted the costs to account for pumping and piping necessary to allow the towers to function in a multi-mode fashion. In other words, SAIC determined a capital cost for equipping the cooling towers so that they could be by-passed to allow the generating units to be run in a once-through mode and eliminate any need for generating unit shutdowns. Second, SAIC also determined a cost for outfitting the cooling towers with plume abatement technology (i.e., traditional wet/dry hybrid cooling towers), rather than multi-mode capability, as another means of eliminating any possible need for generating unit shutdowns.

As SAIC explains, the cost analysis for the 316(b) regulations represents a conservative approach to estimating cooling tower costs (i.e., it will tend to err on the high side). Although this is a costing approach developed for a national, industry-wide cost assessment and, therefore, could fail to account for certain site-specific factors at a given site, SAIC and EPA believe that the results from this method appear to be reasonable and conservative for BPS because even lower numbers were generated by the more site-specific Independent Line Item Analysis discussed above.

The capital costs computed by USGenNE, the SAIC Independent Line Item Analysis, and the EPA/SAIC 316(b) Rule-Based Analysis are presented in the table below.

Table 7.4-1: Capital Costs

Technology Option	USGenNE	EPA/SAIC Independent Line Item Analysis	EPA/SAIC 316(b) Rule-Based Analysis
"Enhanced Multi-Mode"*	$57.4 million	$18.8 million	$29.3 million
Closed-Cycle Unit 3*	$56.4 million	$19.8 million	$27.0 million
Closed-Cycle Unit 3* (with Multi-Mode)	X	X	$31.3 million
Closed-Cycle Unit 3* (with wet/dry for Plume Abatement)	X	X	$68.3 million
Closed-Cycle Units 1 or 2 & 3*	X	X	$50.8 million
Closed-Cycle Entire Station*	$176.7 million	$63.9 million	$80.7 million

Technology Option	USGenNE	EPA/SAIC Independent Line Item Analysis	EPA/SAIC 316(b) Rule-Based Analysis
Closed-Cycle Entire Station* (with bypass)	X	X	$93.8 million
Closed-Cycle Entire Station* (with wet/dry for Plume Abatement)	X	X	$202.3 million

* Assumes retrofitting to the existing facility, use of fiberglass towers and equipped for use with salt water.

"X" indicates that no value was calculated for that cell of the Table.

In order to be more conservative in our economic analysis, EPA chose to proceed with our analysis using the numbers from the 316(b) Rule-Based Analysis (i.e., the far right-hand column of the above table) for the options under consideration. Therefore, EPA instructed Abt to use those figures in its economic/financial evaluations.

ii. Annual Costs for Auxiliary Power & Operations and Maintenance

SAIC independently assessed likely annual auxiliary power costs (principally to run pumps and fans necessary for the cooling tower systems) and annual operations and maintenance expenses for the various options.

To assess auxiliary power costs, SAIC determined likely hours of operation and capacity for the generating units at BPS based on various data from the permittee. SAIC assessed fan and pump power needs based on values from technical analyses supporting EPA's 316(b) rulemaking. SAIC indicates that the resulting figures may be "something of an overestimate" because a system would likely turn off fans for some of the cooling tower cells (or reduce their speed, if possible) during cold weather. See SAIC Report (March 15, 2002), p. 19. SAIC provides the auxiliary energy costs in both MW-Hrs and dollars. The values are converted from MW-Hrs to dollars using an electric energy cost factor of $35/MW-Hr based on the permittee's figures. SAIC explains that there was no way to refute or confirm the applicability of this figure, so it used the company's figure. SAIC also noted certain inconsistencies in the auxiliary power figures provided in various submissions by the permittee. SAIC and EPA agreed to resolve these conflicts by using the figures from the Dynamic Cost Analysis, which were the permittee's most recent figures. SAIC's auxiliary power consumption penalty estimate was somewhat less than that predicted by USGenNE for the Enhanced Multi-Mode option, but was higher than that predicted by the permittee for the unit-specific closed-cycle options. As a result, SAIC concluded that USGenNE's auxiliary power estimates were reasonable and could be used in EPA's independent analysis.

SAIC also estimated overall annual operations and maintenance costs, including annual auxiliary power costs, using the cost equations that EPA used to estimate such costs on a national basis for the 316(b) rulemaking. These cost equations are considered to be conservative and include material, labor and equipment necessary to keep the units operational. This includes preventive maintenance, overhaul maintenance and auxiliary power requirements, but does not include energy efficiency penalties. EPA costs were verified with field data. To compare these numbers with USGenNE's numbers, it was necessary to subtract energy efficiency values which the permittee had combined with auxiliary power and operations and maintenance costs. SAIC's overall annual operations and maintenance cost estimates, including auxiliary power costs, were slightly less for the Enhanced Multi-Mode option and significantly higher for the unit-specific closed-cycle options. On the basis of this analysis, SAIC concluded that USGenNE's annual operations and maintenance and auxiliary power costs estimates were reasonable and could be used in EPA's independent analysis.

On the basis of this analysis, EPA agreed that the permittee's costs estimates for annual operations and maintenance and auxiliary power needs were not unreasonable and directed Abt to use the permittee's values in its economic analysis. These USGenNE figures are presented in the following table:

Table 7.4-2: USGenNE Annual Maintenance and Auxiliary Power Costs

Technology Option	Maintenance Expense	Auxiliary Power Expense*
Enhanced Multi-Mode	$240,000/year	$2,542,610/year
Closed-Cycle Unit 3	$155,000/year	$1,923,005/year
Closed-Cycle Entire Station	$500,000/year	$5,632,550/year

* Figures derived from Table 12 in SAIC Report (March 15, 2002).

iii. Annual Costs from Energy Efficiency Penalties

As discussed above, retrofitting cooling towers to an existing power plant will result in a marginal loss of electrical generation efficiency. This lost generation has a cost to the permittee which USGenNE included in its assessment of the costs of the various cooling tower options. SAIC independently assessed the cost from efficiency penalties for EPA.

On the basis of its review, SAIC concluded that USGenNE had significantly overestimated the efficiency losses likely to result from installing cooling towers at BPS. SAIC conducted its analysis by applying the method used by EPA to calculate cooling tower efficiency losses for the Boston area for the recently promulgated CWA § 316(b) regulations for new facilities. SAIC then made the following adjustments to tailor the analysis to the particular circumstances of BPS: (1) used monthly average intake temperatures for the Taunton River for Units 1, 2 and 3, and for the Lee River for Unit 4; (2) used time-weighted wet bulb temperatures for the 9:00 am to 4:00 pm time period from Providence/T.F. Green Airport historical weather data (the permittee has used T.F. Green weather data for certain of its analyses); and (3) for Unit 4 adjustments were made to reflect 8 months of piggyback operations as currently practiced under the MOA II. By using wet bulb temperatures from the hours of 9:00 am to 4:00 pm, rather than an average over a full 24 hour day, SAIC's analysis will tend to produce a higher efficiency penalty (i.e., be more conservative economically). In addition, SAIC based its calculations on a design approach of 10° F, rather than the 8° F used in the USGenNE design, which will also tend to produce slightly higher efficiency penalty estimates. SAIC carried out calculations for both the 100% and 67% load cases, and then applied the results to the various technology alternatives based on the plant operating data presented earlier in the report (based on information obtained from the permittee).

The results of SAIC's analysis along with the USGenNE's values are presented in the tables below.

Table 7.4-3: Wet Tower Annual Efficiency Losses

	Units 1, 2 and 3	Unit 4 (Piggyback)
100% Load	0.29%	0.09%
67% Load	0.75%	0.18%

Table 7.4-4: Annual Efficiency Penalty Estimates by USGenNE and SAIC/EPA

Technology Option	USGenNE Efficiency Penalty Estimate (MW-Hrs/year)	SAIC/EPA Independent Efficiency Penalty Estimate (MW-Hrs/year)	Percent Difference in USGenNE and SAIC/EPA MW-Hr/year Estimates	SAIC/EPA Independent Efficiency Penalty Estimate Converted to $/year*
Enhanced Multi-Mode	25,278	10,673	- 58%	$373,555
Closed-Cycle Unit 3	64,108	16,629	-74%	$582,015
Closed-Cycle Entire Station	124,715	31,779	-75%	$1,112,265

* Figures derived for illustrative purposes only by EPA using SAIC efficiency penalty estimate

and the USGenNE figure of $35.00 per MW-Hr. The analysis conducted by Abt for EPA estimates more specifically what the actual cost of the efficiency penalty is likely to be over time taking into account the changes in cost of generation and price received over time.

It should be remembered that, as discussed above, BPS is also expected to experience certain annual economic *gains* as a result of being able to generate *more* electricity during the peak demand hot weather periods during the summer. Depending on the option being analyzed and the conclusions regarding certain other considerations, these gains are likely to either substantially offset, or more than offset, the auxiliary power and efficiency losses presented above. The issue of increased electrical generation allowed by cooling towers during hot weather periods is discussed further below.

iv. **Generating Unit Construction Outages**

The permittee has indicated that it believes that disconnection of the existing once-through cooling system and construction and connection of the cooling tower options will necessitate certain generating unit outages. The permittee has agreed with EPA that these outages should be scheduled to coincide with regular annual maintenance outages as much as possible, but the permittee has also concluded that generating unit outages extending beyond the duration of annual maintenance outages will be necessary for the unit-specific cooling tower options (though not for the Enhanced Multi-Mode option). As a result, the permittee has added a cost for this one-time loss of electrical generation from construction outages to the overall cost of the unit-specific options.

Specifically, the permittee determined that an 8-month outage would be required for installing unit-specific closed-cycle cooling towers for units 1, 2 and 3, and a 3-month outage for unit 4. These outages would run consecutively (i.e., back-to-back) for unit-specific cooling tower options for multiple units. In other words, down-time for converting the entire station to closed-cycle cooling would entail 27 unit-months. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, § 3.3.6.7. Since these outages would run concurrently with the 1-month annual maintenance outage for each unit, the cost of these outages in the permittee's Dynamic Cost Analysis are based on 7-months of outages for units 1, 2 and 3, and no cost was attributed to the outage for unit 4 because it is not typically on-line anyway.

SAIC evaluated the permittee's construction outage estimates and on the basis of a conservative analysis, concluded that the outages appeared to be excessive. SAIC determined that the principal reason for the relatively lengthy construction outages estimated by USGenNE is the permittee's "decision to install an entirely new set of pumping stations for the recirculation pumps for Units 1, 2 and 3 in a manner that interferes with the current once-through operation." SAIC Report (March 15, 2002), p. 25. SAIC further explained that, "[t]his decision is based in part on the conclusion that the current pumps, piping and condenser may not be capable of handling the additional hydraulic pressure that would occur with the system if the condenser outlet were to be simply re-routed to the top of the new cooling towers." Id.

In evaluating the permittee's approach, SAIC accepted USGenNE's concerns about piping and condenser pressure as valid. SAIC also reviewed four case studies involving large power plants that converted from once-through cooling to cooling with closed-cycle mechanical draft cooling towers (note: one plant uses the towers in a helper mode). See SAIC Report (March 15, 2002), Attachment A. The conversions in the case studies were undertaken with either no outages or far shorter outages than those estimated by the permittee, such as the 27 unit-months of outage that the permittee estimates for the Closed-Cycle Entire Station option. SAIC explains that these other plants have "mostly been able to incorporate the existing pumps and pump stations, the existing condensers and much of the existing piping into the closed cycle systems." Id. at p. 26. All but one of the four case study facilities were able to retain the existing once-through cooling water pumps and pumphouses and incorporate them into the wet cooling tower recirculation system, while "[t]he other facility kept the downtime brief by installing a separate new pumphouse and piping in a manner that did not interfere with the existing system while under construction." As a result of this approach, the latter facility only required downtime to "disconnect the existing once-through cooling water pipes and reconnect the new cooling water system pipes." Id. SAIC concluded that it is likely that either approach would be feasible for units 1, 2 and 3.

Nevertheless, SAIC took a conservative approach and assumed that the current once-through pumps would require replacement. Even still, SAIC concluded that unit outage time could be shortened by retaining the existing pumphouse, replacing the existing pumps and then connecting the discharge pipe to the cooling towers. SAIC explained that:

> [a]s with USGenNE's proposed engineering design, water would flow by gravity through the condensers but would then be piped back to the intake wet well of the existing intake pumping station. Such a pump and pipe configuration would require the closing off of the individual intake bays for each unit, the replacement of the intake pumps, installation of the cooling water return piping from the condenser, replacement of electrical and control equipment, and tie-in of the new pump outlet pipe to the cooling tower. Without more detailed information regarding the intake structure configuration, it cannot be determined what other modification to the intakes might be necessary. However, the savings in construction costs for replacing the pumphouse should more than offset any modification costs. Certainly, the case study facilities came to that conclusion.

Id., p. 27. SAIC further explained that this approach would eliminate various aspects of the permittee's downtime estimate and also potentially some items of cost. SAIC then added back in two weeks of time to account for the constraints of working within the existing pumphouses. As a result of this approach, SAIC concluded the outage could conservatively be reduced to 4 months. Indeed, SAIC felt that it might be possible to reduce the outage to the 3-month figure the permittee estimated for Unit 4, but due to unknowns about possible intake differences between the Unit 4 intake and the intake for units 1, 2 and 3, it retained the 4-month estimate for each unit. SAIC prepared a detailed construction-related unit downtime estimate for Unit 1 specifically, but concluded that the same approach and outage reductions could be achieved for units 2 and 3 as well. More details on the construction outage analysis are presented in Appendix B.

Table 7.4-5: USGenNE and Independent Construction Outage Estimates

Technology Option	USGenNE Construction Outage Estimate (total unit-months)	USGenNE Construction Outage Estimate (unit-months likely to cause generation losses in excess of normal maintenance outage)	EPA/SAIC Construction Outage Estimate (total unit-months)	EPA/SAIC Construction Outage Estimate (unit-months likely to cause generation losses in excess of normal maintenance outage)
Enhanced Multi-Mode	5.5 (broken into different periods for individual units)	0	5.5 (broken into different periods for individual units)	0
Closed-Cycle Unit 3	8 (for Unit 3)	7 (for Unit 3)	4 (for Unit 3)	3 (for Unit 3)
Closed-Cycle Entire Station	27 (made up of separate 8-month periods for Units 1, 2 & 3, and 3 months for Unit 4)	21 (made up of separate 7-month periods for Units 1, 2 & 3)	15 (made up of separate 4-month periods for Units 1, 2 & 3, and 3 months for Unit 4)	9 (made up of separate 3-month periods for Units 1, 2 & 3)

On the basis of the SAIC analysis, supported by the case studies, EPA believes the generating unit outage period of 4 months (i.e., three months in excess of the one-month annual maintenance outage) for units 1, 2 and 3 are reasonable and conservative and directed that these figures be used in the Abt economic analysis.

v. Period for Constructing the Closed-Cycle Entire Station Option

In light of the above-reductions in construction time for unit-specific cooling towers, SAIC also assessed the overall construction period estimated by USGenNE for the closed-cycle entire station option. USGenNE estimated 47 months for the overall construction period. SAIC concluded that the construction period could be shortened in light of the above reduced estimates for construction of the individual unit-specific cooling tower systems. The construction period could not, however, reasonably be reduced by the full amount of the reduction for each individual unit because of the necessary sequencing of various tasks for bringing each unit on-line. SAIC concluded that the construction period for the closed-cycle entire station could be reduced from USGenNE's 47-month estimate to an estimate of 39 months. EPA instructed Abt to use the 39-month construction period in its economic analysis.

7.4.3b "Financial Aspects" of Cost Analysis

Abt conducted a multi-faceted, independent analysis of the cost over time to the permittee of various technology options. This analysis took into account capital costs, the cost of one-time construction outages, various annual costs (e.g., operations and maintenance costs, auxiliary power cost penalties, reduced generation efficiency penalties, alleged vapor plume abatement outage penalties), and taxes. This analysis presents the overall accumulated costs over the specified time period both as a *total* present value, after-tax cash flow total cost and as an *equivalent annual* present value, after-tax cash flow cost.

There are numerous complexities involved in undertaking this type of analysis. For example, determining the cost of the various types of electrical generation reductions associated with each option (e.g., construction outages, auxiliary energy penalties), requires estimation of the additional profits that could have been made over time if that generation had not been lost, which in turn requires that estimates be developed of the cost of producing the electricity over time and subtracted from estimates of the price at which it could be sold over time. Despite these complexities, USGenNE, EPA and the MA DEP all agreed that this type of analysis was the most appropriate way to assess the cost to the permittee of the various technology options. (All the parties agreed this approach was a more accurate way of assessing costs than the "static cost" analysis that the permittee initially presented to the regulatory agencies in June 2001.) Thus, the permittee also conducted this type of analysis in its "Dynamic Cost Analysis," which was submitted to EPA as part of the December 2001 USGenNE 316(a) and (b) Demonstration, Vol. III, Appendix G (Tab: Dynamic Cost Analysis). Abt's analysis and the Dynamic Cost Analysis undertake equivalent assessments and their results can be meaningfully compared with each other.

One step in Abt's analysis was essentially to re-create the Dynamic Cost Analysis's financial assessment model. Abt did this to ensure that it correctly understood the permittee's analysis, to assess the validity of the permittee's approach, and to determine whether the permittee's results were accurate based on the model used and the inputs to it. As Abt stated, this represented a type of "due diligence" review.

Abt then went to vary inputs to the model as it deemed appropriate based on its independent expert opinion on financial/economic issues and as directed by EPA on the basis of the independent expert opinion of SAIC and EPA regarding engineering issues. An example of the former type of issue would be use of a discount rate different than that used by the permittee, whereas an example of the latter type of issue would be use of different capital costs than those used by the permittee. For a number of factors, Abt analyzed a variety of alternative scenarios in order to ensure that issues were considered from more than one perspective and to discern the overall effect on the results of the choices made with respect to these factors. For example, as discussed below, Abt looked at overall costs over both a 20-year and a 30-year equipment operating life.

The financial/economic analysis conducted by Abt is quite complex and it is explained and presented in detail in the report attached hereto as Appendix C and incorporated herein by reference. We will not repeat it in detail here. We will, however, present its key results and discuss some of the key factors that went into it.

i. Abt *"Replication"* of USGenNE Dynamic Cost Analysis Model

In order to analyze candidate technology options, Abt developed an analytic framework that essentially replicates USGenNE's analysis. Apart from presentation differences, Abt's analytic framework differs materially from the permittee's framework only in including the ability to adjust the time period of analysis and recognize explicitly the estimated schedule requirements for installation of capital equipment and subsequent operating periods for technology equipment. In constructing the analytic framework and validating the permittee's analysis, Abt was able to replicate the analyses presented in the "Dynamic Cost Analysis" in virtually all respects, including replication of the electricity price and input fuel cost schedules used in the permittee's analysis. However, while Abt was able to replicate the *growth rates* of the electricity price and input fuel cost schedules going forward in time, based on the electricity price and fuel cost forecasts developed by RDI (and submitted to EPA by USGenNE), including those that depend on a blending of on- and off-peak price schedules, Abt was not able to independently verify the first-year values of electricity prices and input fuel costs for these schedules. These first-year values are reported by the permittee to be the current – presumed 2001 – values observed in operation of the Brayton Point Station plant. Accordingly, while the projections of future electricity prices and input fuel costs track the RDI projections in terms of change over time, the absolute numerical values in these schedules depend on the permittee's reported baseline values. Again, Abt was not able to independently validate these baseline values which provide the "seed" for the future projection schedules. Therefore, Abt had to use these baseline values.

In addition, Abt's examination and replication of USGenNE's analyses, Abt Report (April 5, 2002), pp. 39-40, revealed the following two calculation errors by the permittee which materially affect its results:

1. *Spreadsheet cells improperly referenced in calculations*. In the permittee's model for the

Closed Cycle-All alternative, the spreadsheet row labeled “After-Tax Annual Cost” is improperly calculated. Specifically, the spreadsheet row titled “Tax Cost (Savings)” is added to the row labeled “Total Cost of Plume Abatement” instead of the proper row “Annual Cost” for the calculation of “After-Tax Annual Cost.” As a result, total after-tax annual costs are *understated* in all years of the analysis and the subsequent calculations of present value and equivalent annual cost carry forward this error. When corrected, the total present value of cost for this option under the permittee’s 15 percent discount rate increases by $15.7 million. The permittee’s analysis does not make this error in its analysis of the Enhanced Multi-Mode and Closed Cycle -Unit 3 options.

2. *Failure to account for the tax treatment of the construction outage income loss.* In its analysis of the Closed Cycle -Unit 3 and Closed Cycle -All options, the permittee does not account for the tax treatment of the income loss during construction outages: the construction outage causes a reduction in income, which in turn reduces the permittee’s tax liability during that operating period. This treatment is inconsistent with the permittee’s proper recognition of the tax treatment of other revenue and cost effects from installation and operation of technology equipment. As a result, the permittee’s analysis overstates the cost of the Closed Cycle -Unit 3 and Closed Cycle -All technology options by $21.3 million and $39.1 million, respectively. This error is irrelevant to the permittee’s analysis of the Enhanced Multi-Mode option, because the permittee anticipates no construction outage income loss from this option.

The net effect of these errors is that the permittee’s analysis overstates – within its own framework of calculations and cost estimates – the total present value of cost, in the permittee’s 15 percent discount rate case, by $21.3 million for the Closed Cycle -Unit 3 option, and by $23.4 million for the Closed Cycle -All option. These errors are material in the permittee’s analysis, representing approximately 17 percent of the permittee’s total present value of cost for the Closed Cycle -Unit 3 option and approximately 15 percent of the permittee’s total present value of cost for the Closed Cycle -All option.

In response to these two errors, when presenting the permittee’s cost estimates for the purpose of comparison with Abt’s independent estimates, Abt corrected the permittee’s numbers to fix the two errors. As a result, Abt’s *re-estimates* of the permittee’s cost and cost effectiveness values for the Closed Cycle-Unit 3 and Closed Cycle-All options are somewhat lower than the values actually reported by the permittee in the Dynamic Cost Analysis.

In addition, Abt noted that its calculations also yielded other small differences from the Dynamic Cost Analysis values and interpreted them to arise from rounding. Abt indicated that these differences amounted to no more than a few thousand dollars in any given instance and concluded that the differences were inconsequential in the aggregate.

ii. Elements of Abt's Independent Financial/Economic Analysis

Some of the key aspects of Abt's independent financial/economic analysis are discussed below.

Capital Costs. Abt used the capital costs from SAIC's independent CWA § 316(b) Rule costing methodology-based analysis. As explained above, EPA directed Abt to use these figures rather than the figures from SAIC's line-item approach, because the former were higher and would therefore result in a more conservative analysis.

Duration of Construction Outage. As discussed above, Abt used the construction outage figures calculated by SAIC.

Date for Commencement of Construction; Timing of Construction Outage. The time that one assumes construction would begin (and end) and the timing of the construction outages both impact the results of the economic analysis. USGenNE's Dynamic Cost Analysis assumed that construction began and ended in 2001 and valued the construction outage based on the "spark spread price" from 2001. Given that it was already early 2002 as Abt was working on its analysis, it is indisputable that construction could not begin and end in 2001. Therefore, EPA and Abt agreed to use mid-2002 as the time for construction to start. In addition, Abt assumed that construction outages would occur at the end of the construction period and, therefore, valued the outages based on the spark spread price estimated for those times.

Construction Duration. As discussed above, the timing of construction and any outages affects the financial/economic analysis. Abt used the construction duration calculated by SAIC for the closed-cycle Unit 3 option and the closed-cycle entire station option, but consistent with SAIC's recommendation used the USGenNE construction duration estimate for the Enhanced Multi-Mode option.

Operations and Maintenance. Consistent with SAIC's recommendation, EPA directed Abt to use the annual operations and maintenance expenses developed by USGenNE.

Auxiliary Energy Cost Penalties. Consistent with SAIC's recommendation, EPA directed Abt to use the annual auxiliary energy penalties (in MWHrs) developed by USGenNE. Like the permittee, Abt also valued these penalties on the basis of lost revenue.

Energy Efficiency Cost Penalties. As discussed above, EPA directed Abt to use the annual energy efficiency penalty figures(in MWHrs) developed by SAIC. Like the permittee, Abt valued these penalties on the basis of lost revenue.

Economic Gain from "Avoided Load Loss." As discussed above, the permittee acknowledges that the cooling tower options offer an economic benefit because they enable greater electrical generation during certain peak demand (and therefore peak sales price) hot weather periods during which the permittee currently must curtail (or cap) generation to avoid violating the 95° F maximum temperature discharge limit presently in its NPDES permit. Abt has referred to this benefit as the "avoided load loss." This benefit occurs because summer intake water temperatures can get high enough that heat added to the water by the power plant can push the discharge temperature over 95° F, but cooling towers can minimize this problem by rejecting heat to the atmosphere rather than back to Mount Hope Bay in the cooling water.

In its calculations, Abt used USGenNE's estimate of the extent of avoided load loss events, which was based in part on permittee historical data from 1989 to 1999. In light of data (discussed elsewhere in this document) indicating an upward, long-term trend in the temperature of the waters of Mount Hope Bay (and Narragansett Bay), EPA notes that using the 1989-1999 data is likely to result in a relatively conservative estimate of avoided load loss events henceforth. Further, Abt noted that if the permittee had used data that included the very warm summer of 2001, then its estimated value of the avoided load loss also would have been higher. While acknowledging the avoided load loss benefit, USGenNE also determined that if it discharged more heat during peak periods, then in order to remain within its overall permit limits it would have to offset the increases by reducing generation during off-peak (and therefore lower sales price) periods. Abt followed the permittee's approach to handling and estimating the value of this offset.

In addition, USGenNE estimated that the Enhanced Multi-Mode and closed-cycle entire station options would be able to capture all (100%) of the potential avoided load loss, but that the closed-cycle unit 3 option would only be able to capture part (48.6%) of the potential benefit. The permittee did not clearly explain how it came up with the 48.6% figure and Abt was unable to independently verify it. With no clear basis for an alternative figure, EPA and Abt decided to take the conservative approach of using the permittee's figures.

In order to place a dollar value on avoided load losses, the profits that would have been lost to generating load curtailment must be calculated. This is done by determining baseline figures for the fuel cost for producing the electricity and for the price at which that electricity could have been sold. Working from these baseline figures, future changes in electricity prices and fuel costs must then be estimated to determine the future value of the net loss in operating income to the permittee from the predicted curtailment in generation that would have occurred in the absence of a particular cooling tower option.

In reviewing both the USGenNE static economic analysis from July 2001 and the Dynamic Cost Analysis submitted to EPA in December 2001, Abt found that the permittee used different baseline spark spread price schedules in the two analyses. In its July 2001 analysis, USGenNE used a schedule based on wholesale electricity prices from the summer of 1999. In the Dynamic Cost Analysis, however, the baseline price schedule was reportedly based on price data from 1999 and 2000 (*but not from the very warm summer of 2001*). The schedule in the Dynamic Cost Analysis substantially reduced the price schedule from the July 2001 range of $20.00 to $400.00 per MWHr to a new range of $35.66 to $78.13 per MWHr. Abt found that this substantially reduces the value of the avoided load loss benefit (e.g., a 28% reduction in the baseline year). Abt also found that no data was provided by the permittee supporting a cap on the spark spread price at $78.13 per MWHr. Therefore, Abt conducted an independent analysis to judge the reasonableness of the spark spread price schedule by reviewing energy clearing price (ECP) data for the summers of 1999, 2000 and 2001 obtained from Independent System Operator-New England (ISO). Abt found that values ranged as high as $1000 per MWHr, with a maximum average for a given temperature of $409.06 per MWHr. Therefore, Abt concluded that it could not justify the $78.13 cap on the spark spread price schedule used in the Dynamic Cost Analysis, and that the baseline schedule from the permittee's July 2001 static analysis appeared to be more reasonable. As a result, in assessing the avoided load loss benefit for the independent financial/economic analysis, Abt used the baseline spark spread price schedule from the permittee's July 2001 static analysis.

Building off the baseline spark spread price schedule, the USGenNE Dynamic Cost Analysis estimated the operating effects over time of the avoided load loss benefit based on a forecast of year-to-year changes in on-peak wholesale electricity prices, fuel costs, and spark spread prices developed by Resource Data International (RDI). Abt concluded that the permittee's approach here was reasonable. Therefore, Abt used the "implied growth rates" from the Dynamic Cost Analysis to project future spark spread price values from the permittee's July 2001 (static analysis) baseline schedule.

Unit Outages to Abate Alleged Hazard from Cooling Tower Water Vapor Plumes. As discussed elsewhere in this document, the permittee has concluded that generating unit outages will be necessary for the unit-specific cooling tower options in order to abate potential fog and/or ice hazards from cooling tower water vapor plumes. Although a very small number of hours of potential cooling tower-induced fog or ice were predicted by its model, the permittee's analysis nevertheless concluded that hundreds of hours of outage would be needed to prevent these few hours of predicted tower-induced fog and/or ice. The cost of these outages is a significant element in the permittee's economic analysis. The permittee estimates that no such outages will be needed for the Enhanced Multi-Mode option because the cooling towers can be bypassed.

EPA has explained its skepticism about the permittee's conclusions elsewhere in this document. In light of this skepticism, EPA asked Abt to assess the financial ramifications of several different scenarios. First, we asked Abt to evaluate the matter assuming no plume abatement unit outages. For this scenario, however, we instructed Abt to use the SAIC capital cost estimates that include an upward adjustment for the cost of adding piping and pumping to enable the unit-specific option to be operated in a multi-mode fashion so that the cooling towers could be bypassed if necessary. Abt's analysis showed that these increased capital costs would be more than offset by the economic benefit of avoiding the permittee's predicted unit outages. Second, we asked Abt to evaluate costs assuming that

100% of the permittee's predicted outages would, in fact, be necessary. Third, we asked Abt to evaluate costs assuming that 50% of the permittee's predicted outages would be necessary. For the latter two scenarios, Abt used SAIC's estimated capital costs for the unit-specific options without the cost adjustment for modifications to operate in a multi-mode fashion. In order to determine the cost to the company of the outages, Abt followed the permittee's approach, including the use of RDI data to determine the future revenue losses due to the outages.

Life of Capital Equipment; Time Horizon for Economic Analysis. The permittee assumed a 20-year life for the capital equipment. It also assumed that construction began and ended in 2001 and did its present value calculations at 2001.

EPA, SAIC and Abt concluded that 20 years might underestimate the reasonable life of the capital equipment, including the likely remaining life of the major components of the entire Brayton Point Station, and concluded that 30 years might be a more reasonable figure. Indeed, for the CWA § 316(b) rulemaking, EPA has assumed a 30-year life for this equipment. Therefore, Abt did its analyses for two scenarios: one assuming a 20-year life and one assuming a 30-year life. As discussed above, Abt assumed that construction began in mid-2002, determined the first year of operation based on the particular option's construction schedule, and Abt did its present value calculations back to mid-2002.

Depreciation. USGenNE's Dynamic Cost Analysis used a 20-year straight-line depreciation schedule, with no depreciation recorded in the first year of operation (i.e., only 19 years of depreciation were included). Abt concluded that it was not reasonable to omit the first year of depreciation and, as a result, recorded a full year of depreciation in the first operating year. Abt noted that its approach yielded a lesser depreciation tax benefit than what would have accrued if a Modified Accelerated Cost Recovery Schedule (MACRS) had been used instead of the 20-year straight-line approach, and that a MACRS approach probably would be appropriate in this case. Therefore, Abt's decision to use a 20-year straight-line schedule, but to include depreciation in the first operating year, is a reasonable and conservative approach.

Discount Rate. USGenNE did not want to reveal its internal company discount rate/cost of capital, which it regards as highly confidential business information. As a result, the permittee used a range of discount rates that it stated would encompass the rate it would use in its assessment of investment opportunities. USGenNE then conducted its Dynamic Cost Analysis for two scenarios: one using a discount rate of 15% and one using a discount rate of 20%.

In order to test the reasonableness of the permittee's figures, Abt undertook a cost-of-capital analysis for six comparable merchant power producers. From this analysis, Abt estimated a market capitalization-weighted cost-of-capital of 11.8%. Abt then used this figure as the discount rate for its analyses.

iii. Results of Abt's Analysis Compared to USGenNE's Analysis

Abt's financial/economic analysis yielded costs that were substantially lower than the costs indicated by the USGenNE analysis. A number of factors played into this, but the most important was the difference in capital cost inputs, followed (in no particular order) by efficiency penalty inputs, treatment of the water vapor plume abatement issue, construction outage inputs and avoided load loss inputs. It should be noted that under Abt's 30-year cost assessment, the Enhanced Multi-Mode option would actually earn money for the permittee due to the combination of the avoided load loss benefit over time and the other factors previously mentioned. As described above, Abt also evaluated a number of different scenarios by varying certain elements in the analysis. The several tables below present a comparison of some of the key conclusions of Abt's analysis with that of the permittee.

Table 7.4-6: Comparison of Selected USGenNE and EPA/Abt Cost Scenarios

Technology Option	USGenNE 15% Discount Rate Figures (with calculation errors corrected by Abt) (over 20 years)[1]	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 20 years)	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 30 years)
Enhanced Multi-Mode			
Total After-Tax Cash Flow Cost, Present Value:	$38.233 Million	$1.077 Million	- $909 Thousand*
Annual Equivalent Cost:	$6.108 Million	$142 Thousand	- $111 Thousand*
Closed-Cycle Unit 3			
0% plume abatement[2]			
Total After-Tax Cash Flow Cost, Present Value:	Not Calculated	$23.574 Million	$23.031 Million
Annual Equivalent Cost:	Not Calculated	$3.117 Million	$2.817 Million
50% plume abatement[3]			
Total After-Tax Cash Flow Cost, Present Value:	Not Calculated	$29.710 Million	$30.337 Million
Annual Equivalent Cost:	Not Calculated	$3.928 Million	$3.710 Million
100% plume abatement[4]			
Total After-Tax Cash Flow Cost, Present Value:	$104.949 Million	$38.861 Million	$40.658 Million
Annual Equivalent Cost:	$16.767 Million	$5.138 Million	$4.973 Million

Technology Option	USGenNE 15% Discount Rate Figures (with calculation errors corrected by Abt) (over 20 years)[1]	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 20 years)	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 30 years)
Closed-Cycle Entire Station Units			
0% plume abatement[2]			
Total After-Tax Cash Flow Cost, Present Value:	Not Calculated	$68.385 Million	$67.975 Million
Annual Equivalent Cost:	Not Calculated	$9.041 Million	$8.314 Million
50% plume abatement[3]			
Total After-Tax Cash Flow Cost, Present Value:	Not Calculated	$71.685 Million	$72.747 Million
Annual Equivalent Cost:	Not Calculated	$9.477 Million	$8.898 Million
100% plume abatement[4]			
Total After-Tax Cash Flow Cost, Present Value:	$254.485 Million	$83.269 Million	$85.803 Million
Annual Equivalent Cost:	$40.657 Million	$11.009 Million	$10.494 Million

* Negative numbers indicate the permittee is gaining the indicated amount of money.

1 The USGenNE figures for Closed-Cycle Unit 3 and Closed-Cycle Entire Station Units reflect the permittee's capital costs and its assumptions for generating unit outages for water vapor plume abatement.

2 The Abt/EPA "0% plume abatement" figures reflect no generating unit outages for plume abatement, but do reflect the SAIC-estimated capital costs that were increased to reflect piping and pumping costs to allow the cooling towers to function in multi-mode fashion so that they could be bypassed to avoid generating unit outages for plume abatement.

3 The Abt/EPA "50% plume abatement" numbers reflect calculations including 50% of the plume abatement effect predicted by the permittee. However, these figures also reflect SAIC's capital cost estimates without the upward adjustment to equip the cooling towers for potential multi-mode functioning.

4 The Abt/EPA "100% plume abatement" numbers reflect calculations including 100% of the plume abatement effect predicted by the permittee. However, these figures also reflect SAIC's capital cost estimates without the upward adjustment to equip the cooling towers for potential multi-mode functioning.

Table 7.4-7: USGenNE Total & Annual Equivalent Costs (with & without Calculation Errors Corrected by Abt)

Technology Option	USGenNE Figures (15% Discount Rate/over 20 years) w/o Calculation Correction	USGenNE Figures (20% Discount Rate/over 20 years) w/o Calculation Correction	Abt-Replicated USGenNE Figures w/ calculation Correction (15% Discount Rate/over 20 years)	Abt-Replicated USGenNE Figures w/ calculation Correction (20% Discount Rate/over 20 years)
Enhanced Multi-Mode				
Total After-Tax Cash Flow Cost, Present Value:	$38,226,000	$41,981,000	$38,228,000	$41,983,000
Annual Equivalent Cost:	$6,107,000	$8,621,000	$6,107,000	$8,621,000
Closed-Cycle Unit 3				
Total After-Tax Cash Flow Cost, Present Value:	$126,289,000	$122,688,000	$104,964,000	$101,366,000
Annual Equivalent Cost:	$20,176,000	$25,195,000	$16,769,000	$20,816,000
Closed-Cycle Entire Station Units				
Total After-Tax Cash Flow Cost, Present Value:	$267,294,000	$268,717,000	$254,768,000	$250,638,000
Annual Equivalent Cost:	$42,703,000	$55,183,000	$40,702,000	$51,470,000

Table 7.4-8: Abt/EPA Cost Estimates Over 20- and 30-Year Periods

Technology Option (& Plume Abatement Assumption)	Abt/EPA Total After-Tax Cash Flow Cost, Present Value (20-Year Period)	Abt/EPA Annual Equivalent Cost (20-Year Period)	Abt/EPA Total After-Tax Cash Flow Cost, Present Value (30-Year Period)	Abt/EPA Annual Equivalent Cost (30-Year Period)
Enhanced Multi-Mode				
(No Plume Abatement)[2]	$1.077 Million	$142 Thousand	- $909 Thousand[1]	- $111 Thousand[1]
Closed-Cycle Unit 3				
0% Plume Abatement[3]	$23.574 Million	$3.117 Million	$23.031 Million	$2.817 Million
50% Plume Abatement[4]	$29.710 Million	$3.928 Million	$30.337 Million	$3.710 Million
100% Plume Abatement[5]	$38.861 Million	$5.138 Million	$40.658 Million	$4.973 Million
Closed-Cycle Entire Station				
0% Plume Abatement[3]	$68.385 Million	$9.041 Million	$67.975 Million	$8.314 Million
50% Plume Abatement[4]	$71.685 Million	$9.477 Million	$72.747 Million	$8.898 Million
100% Plume Abatement[5]	$83.269 Million	$11.009 Million	$85.803 Million	$10.494 Million

[1] Negative numbers indicate the permittee is gaining the indicated amount of money.

[2] USGenNE has concluded no plume abatement generating outages are needed for the Enhanced Multi-Mode option. EPA/Abt adopted this assumption as well.

[3] The Abt/EPA "0% plume abatement" figures reflect no generating unit outages for plume abatement, but do reflect the SAIC-estimated capital costs that were increased to reflect piping and pumping costs to allow the cooling towers to function in multi-mode fashion so that they could be bypassed to avoid generating unit outages for plume abatement.

[4] The Abt/EPA "50% plume abatement" numbers reflect calculations including 50% of the plume abatement effect predicted by the permittee. However, these figures also reflect SAIC's capital cost estimates without the upward adjustment to equip the cooling towers for potential multi-mode functioning.

[5] The Abt/EPA "100% plume abatement" numbers reflect calculations including 100% of the plume abatement effect predicted by the permittee. However, these figures also reflect SAIC's capital cost estimates without the upward adjustment to equip the cooling towers for potential multi-mode functioning.

Table 7.4-9: Detailed USGenNE and EPA/Abt Costs for Enhanced Multi-Mode Option

Parameter	USGenNE (15% Discount Rate) (w/ Calculation Errors Corrected by Abt) (20-Year Period)	EPA/Abt (using 11.8% Discount Rate and other Independent Elements) (20 Years)	EPA/Abt (using 11.8% Discount Rate and other Independent Elements) (30 Years)
Capital Costs	$57.406 Million	$24.054 Million	$24.054 Million
Construction Outage Cost	$0	$0	$0
Total Initial Cost, Net Depreciation Tax Benefit	$50.112 Million	$20.324 Million	$20.324 Million
Maintenance	$1.186 Million	$1.070 Million	$1.207 Million
Auxiliary Energy and Efficiency Penalties	$13.775 Million	$9.896 Million	$10.965 Million
Avoided Load Loss Benefit	- $26.840 Million[1]	- $30.212 Million[1]	- $33.405 Million[1]
Cost of Plume Abatement	$0	$0	$0
Total of Annual Expenses, After Tax	-$11.879 Million[1]	- $19.246 Million[1]	- $21.232 Million[1]
Present Value Total After-Tax Cash Flow	$38.233 Million	$1.077 Million	- $909 Thousand[1]
Equivalent Annual Cost	$6.108 Million	$142 Thousand	- $111 Thousand[1]

[1] Negative numbers indicate the permittee is gaining the indicated amount of money.

Table 7.4-10: Detailed USGenNE and EPA/Abt Costs for Closed-Cycle Unit 3 Option

Parameter	USGenNE (20 Years) 100% Plume*[1]	EPA/Abt (20 Years) 0% Plume*[2]	EPA/Abt (20 Years) 50% Plume*[2]	EPA/Abt (20 Years) 100% Plume*[2]	EPA/Abt (30 Years) 0% Plume*[2]	EPA/Abt (30 Years) 50% Plume*[2]	EPA/Abt (30 Years) 100% Plume*[2]
Capital Costs	$56.4 Million	$25.692 Million	$22.123 Million	$22.123 Million	$25.692 Million	$22.123 Million	$22.123 Million
Construction Outage Cost	$30.688 Million	$7.349 Million	$7.349 Million	$7.349 Million	$7.349 Million	$7.349 Million	$7.349 Million
Total Initial Cost, Net Depreciation	$79.921 Million	$29.057 Million	$26.042 Million	$26.042 Million	$29.057 Million	$26.042 Million	$26.042 Million
Maintenance	$0.766 Million	$0.691 Million	$0.691 Million	$0.691 Million	$0.780 Million	$0.780 Million	$0.780 Million
Aux. Energy & Efficiency Penalties	$16.747 Million	$8.501 Million	$8.501 Million	$8.501 Million	$9.419 Million	$9.419 Million	$9.419 Million
Avoided Load Loss Benefit	- $13.036 Million[3]	- $14.674 Million[3]	- $14.674 Million[3]	- $14.674 Million[3]	- $16.225 Million[3]	- $16.225 Million[3]	- $16.225 Million[3]
Cost of Plume Abatement	$20.566 Million	$0	$9.151 Million	$18.302 Million	$0	$10.321 Million	$20.642 Million
Total Annual Expenses, After Tax	$25.043 Million	- $5.482 Million[3]	$3.669 Million	$12.819 Million	- $6.026 Million[3]	$4.295 Million	$14.616 Million
Present Value Total After-Tax Cash Flow	$104.964 Million	$23.574 Million	$29.710 Million	$38.861 Million	$23.031 Million	$30.337 Million	$40.658 Million
Equivalent Annual Cost	$16.769 Million	$3.117 Million	$3.928 Million	$5.138 Million	$2.817 Million	$3.710 Million	$4.973 Million

* USGenNE figures for the Closed-Cycle Unit 3 option reflect the permittee's capital cost estimates and predicted generating unit outages for water vapor plume abatement. Abt/EPA figures for the "0% Plume" case reflect no unit outages for plume abatement, but do reflect the SAIC estimates of capital costs that were increased to reflect piping and pumping to equip the cooling towers to function in multi-mode fashion so that they could be bypassed to avoid any plume abatement outage. Abt/EPA figures for the "50% Plume" and "100% Plume" reflect the stated percentage of the permittee's predicted plume abatement outages, but also reflect the SAIC capital cost estimates that were not adjusted for multi-mode capacity.

[1] USGenNE figures reflect its analysis using a 15% discount rate, with calculation errors corrected by Abt.

[2] Abt/EPA figures reflect a discount rate of 11.8%, as explained above.

[3] Negative numbers indicate the permittee is gaining the indicated amount of money.

Table 7.4-11: Detailed USGenNE and EPA/Abt Costs for Closed-Cycle Entire Station Units Option

Parameter	USGenNE (20 Years) 100% Plume*[1]	EPA/Abt (20 Years) 0% Plume*[2]	EPA/Abt (20 Years) 50% Plume*[2]	EPA/Abt (20 Years) 100% Plume*[2]	EPA/Abt (30 Years) 0% Plume*[2]	EPA/Abt (30 Years) 50% Plume*[2]	EPA/Abt (30 Years) 100% Plume*[2]
Capital Costs	$176.676 Million	$70.592 Million	$60.788 Million	$60.788 Million	$70.592 Million	$60.788 Million	$60.788 Million
Construction Outage Cost	$56.290 Million	$13.325 Million	$13.325 Million	$13.325 Million	$13.325 Million	$13.325 Million	$13.325 Million
Total Initial Cost, Net Depreciation	$210.517Million	$72.971 Million	$64.686 Million	$64.686 Million	$72.971 Million	$64.686 Million	$64.686 Million
Maintenance	$2.347 Million	$1.945 Million	$1.945 Million	$1.945 Million	$2.195 Million	$2.195 Million	$2.195 Million
Aux. Energy & Efficiency Penalties	$40.182 Million	$20.805 Million	$20.805 Million	$20.805 Million	$23.055 Million	$23.055 Million	$23.055 Million
Avoided Load Loss Benefit	- $26.840 Million[3]	- $27.336 Million[3]	- $27.336 Million[3]	- $27.336 Million[3]	- $30.245 Million[3]	- $30.245 Million[3]	- $30.245 Million[3]
Cost of Plume Abatement	$28.278 Million	$0	$11.584 Million	$23.169 Million	$0	$13.056 Million	$26.112 Million
Total Annual Expenses, After Tax	$43.968 Million	- $4.586 Million[3]	$6.998 Million	$18.583 Million	- $4.995 Million[3]	$8.061 Million	$21.117 Million
Present Value Total After-Tax Cash Flow	$254.485 Million	$68.385 Million	$71.685 Million	$83.269 Million	$67.975 Million	$72.747 Million	$85.803 Million
Equivalent Annual Cost	$40.657 Million	$9.041 Million	$9.477 Million	$11.009 Million	$8.314 Million	$8.898 Million	$10.494 Million

* USGenNE figures for the Closed-Cycle Unit 3 option reflect the permittee's capital cost estimates and predicted generating unit outages for water vapor plume abatement. Abt/EPA figures for the "0% Plume" case reflect no unit outages for plume abatement, but do reflect the SAIC estimates of capital costs that were increased to reflect piping and pumping to equip the cooling towers to function in multi-mode fashion so that they could be bypassed to avoid any plume abatement outage. Abt/EPA figures for the "50% Plume" and "100% Plume" reflect the stated percentage of the permittee's predicted plume abatement outages, but also reflect the SAIC capital cost estimates that were not adjusted for multi-mode capacity.

1 USGenNE figures reflect its analysis using a 15% discount rate, with calculation errors corrected by Abt.

2 Abt/EPA figures reflect a discount rate of 11.8%, as explained above.

3 Negative numbers indicate the permittee is gaining the indicated amount of money.

iv. Screening and/or Pumping Options

As discussed above, the permittee has indicated that it intends to implement certain improvements to the pumping and screening systems to further minimize flow and enhance impingement survival. EPA has explained above that it does not regard any of these alternatives to constitute BTA by themselves, but that they could be part of a BTA option. The permittee also did not propose that these technologies would constitute BTA by themselves.

With respect to pumping/flow changes, the permittee did not indicate a clear preference among the two-speed pump, variable speed pump drive and throttled flow operations alternatives. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, pp. 3.5-14; 4-6. The costs for these options are small on a relative basis, with capital costs ranging from $600,000 to $2.5 million and maintenance costs ranging from $2,000 to $100,000 per year. See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Table 4-1. With respect to screening system improvements, it appears, but is not entirely clear, that the permittee is proposing to implement the modified conventional traveling screen design for Units 1, 2 and 3. See Id. at p. 3.6-16. These improvements may include, for example, improved fish buckets and spray washes. The permittee estimates capital costs for this option to be $1.3 Million with no increased annual maintenance costs. See Id. at Table 4-1.

Given that the above costs are low relative to the cooling tower system-related costs, and given EPA's desire to conserve financial resources for expert contractor assistance on more significant issues, we did not ask our contractors to independently evaluate the costs of these options or to work them into the overall financial analysis. Therefore, EPA accepts the permittee's estimates of the costs for these options and considers them to be easily affordable add-ons to whatever larger BTA option is selected.

7.5 Biological Impacts of Cooling Water Intake

Section 316(b) of the Clean Water Act addresses the adverse environmental impact of cooling water intake structures at facilities requiring NPDES permits. Adverse environmental impact by cooling water intake structures results from the entrainment of fish eggs and larvae and other marine life through the plant's cooling system and the impingement of fish and other marine life on the intake screens. Adverse impacts can also result in some areas from a power plant's use of limited public water resources for cooling.

EPA has considered a wide range of data and analyses from many sources including the permittee. We note, however, that on July 3, 2002, the permittee submitted three new papers presenting biological analyses by its hired contractors. As a result of the late date of the submission, EPA was not able to consider the new studies prior to issuance of the draft permit. EPA does, however, look forward to giving these analyses careful evaluation during the public comment period, along with any other public comments and/or new information that may be submitted.

7.5.1 Impingement

Impingement of organisms occurs when water is drawn into a facility through its cooling water intake structures and organisms too large to pass through the protective screens and unable to swim away become trapped against the screens and other parts of the intake structure. The quantity of organisms impinged is a function of the intake structure's location, design, capacity and approach velocity, and the abundance of organisms of various species in the general vicinity of the cooling water intake structures.

Intake structure location can vary by geographic location and water depth. EPA's Guidance Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact (1976) recommends selecting locations to avoid important spawning areas, juvenile rearing areas, fish migration paths, shellfish beds or areas of particular importance for aquatic life. Estuaries and shallow coastal waters are well known to be productive nursery areas for finfish in the northeast. For example, winter flounder, tautog, windowpane and scup are all known to spawn in shallow estuarine waters, such as those of Mount Hope Bay (Able and Fahay, 1998). In addition, anadromous fish runs occur in the Taunton, Lee, Cole and Kickamuit Rivers, all of which are part of the Mount Hope Bay estuary, and all of which enter the Bay in relatively close proximity to the intake structures of Brayton Point Station. Mount Hope Bay has been recognized as one of the more *historically,* biologically productive areas in New England. [52]

Water depth is another important consideration for siting water intake structures. Structures that rest directly on the bottom may tend to impinge more fish than intakes that are drawing water from mid-water column. This is typically because pelagic fish are stronger swimmers than benthic fish. In addition, mobile benthic invertebrates, in particular decapod crustaceans and lobsters, will walk into intake structures seeking refuge if the intake is flush with the bottom. Brayton Point Station, for example, has had problems with large numbers of horseshoe crabs becoming impinged (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 2-3). Schiller Station in New Hampshire, as another example, had past problems with lobster impingement when siltation filled in the area below its intake so that it lay directly on the bottom of the Piscataqua River.

The speed of water entering the intake structure through the screens is called the approach velocity. Typically, the greater the approach velocity, the greater the potential for impingement. Some species of fish actually cue to water movement and will be attracted to fast moving water.

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[52] Memorandum from Russell A. Isaac to John R. Elwood, "Subject: Brayton Point Permit Modification Hearing at Somerset High School on June 30, 1976" (July 2, 1976) ("Dr. George Mathieson of Marine Research, Inc., who has conducted studies at the plant for the company during the past 6 years,...stated that Mount Hope Bay continues to rank among the most productive estuaries in the Northeast."

Thus, intakes with high approach velocities may artificially attract fish to these structures. In addition, high approach velocities reduce the ability of a fish to escape, once it is pulled into the structure. Once impinged, the pressure of the high flowing water holds the fish and other organisms in place against the screens causing injury and frequently death.

The seasonal abundance of fish and other creatures effects the quantity of organisms impinged. During times of high abundance of juvenile fish, impingement rates can be expected to increase. Juvenile fish are more susceptible to impingement than adults, because they are generally present in greater quantities than adults and are weaker swimmers.

Brayton Point Station presently operates with 2 separate intake locations (Figure 7.3-1), one on the Taunton River that supplies Units 1, 2 and 3, and a second on the Lee River that supplies Unit 4. Several of the alternatives now under consideration would significantly reduce the use of the separate intake for Unit 4. For example, the permittee estimates that the Unit 4 intake would be used around 500 hours per year or less for the Enhanced Multi-Mode Option. (See December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 3.1-18). However, the intake for Units 1, 2 and 3 is flush with the bottom and does not possess a sill or any other structure that would deter bottom or demersal creatures from entering the intake. Details regarding the design of the existing Brayton Point Station intake structures are discussed elsewhere in this document and are also discussed in the permittee's December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, Section 2.2.2. Furthermore, as discussed above, impingement is reduced by minimizing intake velocities through the screens and an approach velocity of 0.5 fps has been identified as a target for appropriately minimizing impingement. However, the approach velocities at the intake trash racks for Units 1 and 2, and the intake trash racks for Unit 3, are reported to be 1.35 fps and 1.56 fps, respectively (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 2-5) and is even higher through the intake screens. Comparatively, the approach velocity at the Unit 4 intake bar racks is reported by the permittee to be 0.5 fps, and approximately 1.0 fps approaching the traveling screens (1997 NEPCO Report, p. 2-6; December 2001 USGenNE 316(a) and (b) Demonstration, Vol. IV, p. 2-5). Therefore, it does not appear that approach velocities at the Brayton Point Station CWISs are optimal for minimizing impingement at BPS.

The Brayton Point Station intakes for all four units have traveling screens with a mesh of 0.375 in^2 . Id. at pp. 2-2, 2-6. The Unit 4 intake, however, has an angled screen configuration that the permittee has stated reduces impingement as compared to the non-angled screens used in the intake of Units 1, 2 and 3. Objects caught on Units 1, 2 and 3 intake screens are rinsed off with a high pressure spray system that delivers water at a pressure of 120 pounds per square inch (psi), which may cause serious injury to impinged organisms. Comparatively, the Unit 4 intake has a low pressure spray (5-10 psi) for less traumatic removal of fish from the screens. Id. at pp. 2-3, 2-5, 2-6. Objects rinsed off the traveling screens at both intakes travel approximately 300 feet in their respective fish return sluiceways or pipes back to the waters of the estuary. Id. at pp. 2-3, 2-5. On low tide, fish leave the sluiceway above the water line and fall back into the bay. The distance of this fall is dependent on the height of the low tide. Fish dropped from significant heights back to the water can be easily stunned and injured making them more susceptible to predation. From

May through October, fixed screens with a mesh of 1.5 in^2 are placed upstream of the traveling screens for Units 1, 2 and keep horseshoe crabs off the traveling screens. Id. at p. 2-3.

The permittee conducted an impingement survival study for only the Unit 4 intake structure from 1984-1986 to calculate survival rates for different species of impinged fish (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F-70). The results of this study are interesting, but not relevant for estimating impingement survival rates at the cooling water intakes for Units 1, 2 and 3, because of the major differences discussed above. Moreover, the two intakes have different fish return systems. The study measured survival, it did not discuss the general condition and vitality of the fish after being impinged. Finally, EPA personal observed on February 14, 2002, large numbers of sea gulls around the end of the fish return sluiceway. They appeared to be feeding on fish that were coming out of the fish return system. EPA has taken the conservative approach of assuming 100% mortality of fish that are impinged, because the long-term health and viability of impinged fish remains in question. In other words, fish may initially survive injury suffered from being impinged, retained on the screens by large volumes of water, rinsed off the screens and dropped from the sluiceway back into the bay, but their long-term health and viability has certainly been compromised.

Impingement rates have been monitored at Brayton Point Station since 1972. The quantity of fish impinged at the plant in any given calendar year varies as a function of the intake approach velocity, plant operations, cooling water flows, and the type and abundance of organisms present in the bay. Thus, if other factors remained stable, one would generally expect impingement rates to increase as plant cooling water flows increased. Conversely, if other factors remained stable, and fish abundance declined, one would generally expect impingement rates to decline. Interestingly, with respect to Brayton Point Station and Mount Hope Bay, fish abundance in Mount Hope Bay has dramatically declined, but plant operations and cooling flows have increased. Impingement rates, however, have generally followed the trajectory of the fish abundance date in the bay, with a steady decrease through time (Gibson, 2002A).

7.5.1a Impingement Losses

Monitoring of impingement losses has been an ongoing effort since mid 1972 at Brayton Point station. Over that period of time the 19 most common species of finfish that have been impinged are listed in Table 7.5-1, with 10 of those being considered commercial species.

Table 7.5-1: Most Common Finfish Species That Have Been Impinged at BPS

Common Name	Scientific Name	Commercial	Recreational	Forage
Alewife	*Alosa pseudoharengus*			X
American sand lance	*Ammodytes americanus*			X
Atlantic menhaden	*Brevoortia tyrannus*	X		
Atlantic silverside	*Menidia menidia*			X
Bay anchovy	*Anchoa mitchilli*			X
Blueback herring	*Alosa aestivalis*			X
Butterfish	*Peprilus triacanthas*	X		
Hogchoker	*Trinectes maculatus*			X
Rainbow smelt	*Osmerus mordax*	X		
Scup	*Stenotomus chrysops*	X	X	
Seaboard goby	*Gobiosoma ginsburgi*			X
Silver hake	*Merluccius bilinearis*	X		
Striped killifish	*Fundulus majalis*			X
Tautog	*Tautoga onitis*	X	X	
Threespine stickleback	*Gasterosteus aculeatus*			X
Weakfish	*Cynoscion regalis*	X	X	
White perch	*Morone americana*	X	X	
Windowpane	*Scophthalmus aquosus*	X		
Winter flounder	*Pleuronectes americanus*	X	X	

Routine impingement monitoring occurs 3 times a week for Units 1, 2 and 3. A trap has been placed in the fish return sluiceway downstream of the traveling screens. The frequency of monitoring increases when station operators detect an "unusual impingement event". An unusual impingement event is defined as an impingement rate of greater than 25 fish per hour. These events typically happen when schools of forage fish get impinged. EPA personnel observed a recent unusual impingement event (2/14/02) with Atlantic menhaden. The trap in the fish sluiceway became clogged with the bodies of fish and on this occasion, fish were escaping over the top of the trap, resulting in an underestimate of the actual number of fish impinged. It is possible that this has occurred on other occasions during large impingement events.

To derive annual estimates of impingement, the company extrapolates from 3 weekly samples to derive a weekly total. These weekly totals are then summed to derive an annual estimate of impingement losses. To assess whole plant impingement rates, losses from Unit 4 operation must be accounted for as well.

In the following analysis, we present 2 different estimates of annual impingement losses. The first is USGenNE's estimate of impingement losses. The company derives average impingement densities using impingement density data from 1990-1999. The company, using a simulation that mimics specific plant operating conditions and corresponding average impingement densities, calculated an annual impingement estimate for multiple control technologies (Table 7.5-2). It should be noted that these values represent impingement rates and are comprised of fish of multiple ages. These values do not represent Age 3 adult equivalents. To assess impingement losses, EPA assumes 100% mortality for all fish impinged.

Table 7.5-2: USGenNE's Estimates of Annual Impingement Rates Under 5 Different Station Operating Scenarios

Species	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All units CC[3]
Alewife	4,970	4,848	3,420	3,540	365
American sand lance	0	0	0	0	0
Atlantic menhaden	14,879	14,326	10,169	10,445	1,009
Atlantic silverside	16,051	14,829	10,315	10,926	1,142
Bay anchovy	175	152	106	110	11
Bluefish	22	20	14	14	1
Hogchoker	398	395	254	268	26
Rainbow smelt	807	729	543	577	60
Scup	64	58	39	40	4
Seaboard goby	1	1	0	0	0
Silver hake	964	924	627	652	68
Striped bass	25	24	17	18	2
Tautog	317	285	192	198	21

Threespine stickleback	5,019	4,680	3,292	3,518	367
Weakfish	45	41	30	28	3
White perch	1,003	865	613	642	69
Windowpane	98	90	61	63	7
Winter flounder	2,602	2,326	1,603	1,701	178

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and New England Power, former owners of Brayton Point Station
[2] USGenNE's preferred alternative Enhanced Multi- Mode Option
[3] Closed Cycle wet cooling

Stratus Consulting Inc., also prepared an analysis of impingement losses for EPA. For this analysis, only impingement data from 1974 to 1983 was considered. This time period was selected for several reasons:

1. Comprehensive (year round for all species) entrainment sampling began in 1972 and was ended in 1985. Entrainment and impingement losses are totaled for the final 316(b) determination, thus it is appropriate to be comparing these losses from the same time periods;

2. Time periods that did not include the use of "piggyback" cooling were considered more representative of plant impacts for the purposing of predicting future impacts from technologies that obviate the need for "piggyback" cooling. Therefore, 1984 and 1985 were not considered for this analysis because "piggyback" cooling was used for periods of time in both of these years;

3. Unit 4 did not go into service until 1974, so data from 1972 and 1973 were not included for consideration; and

4. This time period is prior to the dramatic decline in fish populations previously discussed, beginning in 1985.

Consequently, Stratus used impingement densities from 1974-1983 and then adjusted for the facility's current technologies and operations. For example, impingement rates were adjusted for the greater cooling water flow that the plant operates at now. Rates were also adjusted to consider the effectiveness of the angled screens on Unit 4, which has been estimated to reduce impingement by approximately 55%. Taking both of these factors into consideration, EPA estimates that impingement rates are 6.4% greater than during 1974-1983. Estimates of impingement losses are presented as Age 3 equivalents for each species in Table 7.5-3 for each control technology. To estimate impingement losses, EPA assumes 100% mortality for all fish that are impinged. EPA's impingement estimates represent losses from predicted station operation with fish populations at levels prior to the dramatic collapse. However, it can be fairly stated that even this estimate represents a conservative or low loss number, because power plant impacts had been occurring since the mid to late 1960s, thus no true unimpacted baseline data exists.

Table 7.5-3: EPA's Estimates of Annual Impingement Losses in Age 3 Equivalents under 5 Different Station Operating Scenarios

Species	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All units CC[3]
Alewife	1,943	1,313	867	880	52
American sand lance	0	0	0	0	0
Atlantic menhaden	889	600	396	402	24
Atlantic silverside	8	1	<1	<1	0
Bay anchovy	107	72	48	49	3
Bluefish	N/A	N/A	N/A	N/A	N/A
Hogchoker	862	582	384	390	23
Rainbow smelt	287	194	128	130	8
Scup	0	0	0	0	0
Seaboard goby	0	0	0	0	0
Silver hake	4,953	3,347	2,213	2,243	134
Striped bass	N/A	N/A	N/A	N/A	N/A
Tautog	1,528	1,033	682	692	42
Threespine stickleback	282	190	126	128	8
Weakfish	450	304	201	204	12
White perch	1,011	683	451	458	27
Windowpane	672	454	300	304	18

Winter flounder	2,925	1,976	1,304	1,324	79

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and New England Power, former owner of Brayton Point Station

[2] USGenNE's preferred alternative Enhanced Multi-Mode Option

[3] Closed Cycle wet cooling

Periodically, about 1 to 15 times a year, Brayton Point Station experiences what is called an "unusual impingement event" (DeHart, 1997). These events are defined to occur, when the station impinges 25 or greater fish per hour. These events can result in large numbers of fish being impinged and killed in a fairly short period of time. A month long event occurred in from mid-August of 1999 to mid-September resulting in the loss of approximately 76,400 fish (Ketschke, 1999). Two separate events this past winter resulted in the combined loss of over 40,000 fish (Simas, 2002). These large events tend to occur primarily with schooling fish. Though the results provided by both the company and Stratus are calculated as annual averages, for species such as Atlantic menhaden, bay anchovy, alewives and other schooling fish, these losses tend to occur all at once in large discrete events rather than continuous losses throughout the year. Individual schools of these fish could be entirely eliminated in these events.

7.5.2 Entrainment

Fish eggs and larvae, along with many other organisms, are entrained when cooling water is drawn into the facility and organisms small enough to fit through the mesh of the intake screens pass through the plant cooling system with the cooling water flow. Organisms that transit the plant cooling system are typically exposed to high sheer stress as the water moves through the system, high quantities of heat as the water absorbs heat from the plant's condenser, and occasionally high concentrations of chlorine or biocides. These stresses are easily sufficient to kill the entrained organisms. Generally, the quantity of entrained organisms is a function of cooling water flow through the plant and the concentration of organisms in the source water that are small enough to pass through the intake structure's screening system. As explained above with respect to impingement, the location of the intake can have a major influence on entrainment. Different types of ecosystems may have greater or lesser concentrations of entrainable fish eggs and larvae. Estuaries are well known to be spawning and nursery areas for many different species of fish and invertebrates, thus intake structures located in estuaries are especially prone to entraining large concentrations of eggs and larvae. To further illustrate this point, Mount Hope Bay, including the Massachusetts portion and significant sections of the lower Taunton, Cole, Lee and Kickamuit Rivers, has a surface area of about 14 square miles, while the surface area of all of Rhode Island state waters is approximately 280 square miles. Thus, Mount Hope Bay constitutes only 0.05% of the total surface area of Rhode Island State waters, yet USGenNE has estimated that entrainment and impingement losses associated with Brayton Point Station operation constitute a quantity equal to almost 2% of the commercial winter flounder catch (USGenNE, 2002). This two order of magnitude disparity is due to the importance of estuaries as producers of fish eggs and larvae and the large impact of Brayton Point Station operations.

The BPS cooling water intakes are located in the Mount Hope Bay estuary which should be, and historically has been, a biologically productive spawning and nursery area for fish. Fish eggs and larvae of the species present in Mount Hope Bay are easily small enough to fit through the 0.375-inch mesh of the intake screens at BPS. Moreover, data collected by USGenNE clearly show that large numbers of fish eggs and larvae are entrained at BPS (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F 26-27).

In assessing the impact of entrainment at BPS, EPA assumes that eggs and larvae that pass through the plant's once-through cooling water system do not survive. In other words, we assume 100% mortality from entrainment, because of the multiple stresses inherent in these systems that are capable of killing the organisms. This is a conservative assumption, but one that we believe is reasonable and appropriate and one that has often been used in evaluating power plant entrainment effects.

The permittee conducted an entrainment survival study in 1997 and 1998 at Brayton Point Station (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F16-24) This study was conducted without a prior review or endorsement of its methodology by EPA or the BPS Technical Advisory Committee (TAC), which include biologists from the various relevant state and federal regulatory agencies. See 1993 Permit, Fact Sheet, p. 10. In general, the permittee's study concluded that a substantial quantity (approximately 60%) of larval winter flounder survived the entrainment process. However, EPA believes the methodology used in this study was flawed and that its conclusions are not supported.

EPA hired experts Dr. Chuck Coutant and Dr. Mark Bevelheimer from the Oak Ridge National Laboratories to independently review the entrainment survival study. Coutant and Bevelheimer (2001) found numerous flaws in the basic study design that render the results of the permittee's study unreliable and inconclusive. Some of the major flaws include:

1. *Representativeness of samples* - Larval fish concentrations were consistently higher in the discharge than in the intake. This suggests two possible problems: (1) that samples taken in the intake do not correspond to samples taken in the discharge; or (2) that handling of intake samples killed some percentage of the fish larvae in the sample. Either way, the representativeness of the samples is compromised and any further comparison between the intake and discharge samples is invalid. Thus, estimates of entrainment survival rates are rendered unreliable; and

2. *Sampling location* - Discharge samples were taken at the beginning of the discharge canal and then immediately transferred to ambient bay water conditions in the lab for observation. In reality, the larval fish would be exposed to an additional 20 minutes of hot water as the thermal plume transits the discharge canal and mixes out into the bay. This again calls into question the representativeness of the sampling regime.

Based on these and other concerns identified by Coutant and Bevelheimer, EPA has decided to continue to use the assumption of 100% mortality of any organism that passes through the facility. While this may be a conservative approach, EPA believes it is reasonable and appropriate in lieu of any credible alternate survival rates based on site-specific data for the power plant cooling system in question and the affected species of concern. EPA also believes this conservative approach is reasonable and appropriate in light of the depressed condition of fish populations in Mount Hope Bay and our obligation to implement Clean Water Act § 316(b) to minimize adverse environmental impacts.

USGenNE has also suggested that larval fish survival rates are density dependent, so that the "cropping" of fish eggs and larvae by Brayton Point Station entrainment would actually *improve* natural survival rates of larvae left in the bay (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F-63). This theory might be true if larval fish survival is only being limited by access to prey. This has not been shown for Mount Hope Bay and in recent years, larval densities have dropped dramatically (MRI, 2002), thus competition for prey resources by larval fish would likely be reduced and "cropping" of additional larvae would have no positive effect on remaining larvae. Additionally, this argument ignores the ecological value of having a large number of fish eggs and larvae produced and residing in the Mount Hope Bay ecosystem. Natural mortality rates, due to predation, are typically high for most fish eggs and larvae. They serve an important role as prey for a variety of other organisms in the food web. Removing them from the system due to entrainment losses represents a lost food opportunity for other organisms in the bay. Finally, the naturally large quantity of fish eggs and larvae presents opportunities for years of high recruitment to the adult fishery. EPA defines recruitment, in this context, as the number of fish of the same age that enter the exploitable phase of a fish stock, in a given time period, as a result of the growth and survival of the smaller younger individuals. There are numerous factors that control recruitment and they can vary dramatically on an annual basis. Some combination of these factors come together to vary natural survival and/or growth rates of fish to make some years good recruitment years and other years unfavorable. The relative magnitude of recruitment events may be dampened by the "cropping" of significant numbers of eggs and larvae due to entrainment. This could serve to reduce the resilience of a population, making it more susceptible to a decline and prevent or inhibit the recovery of a particular population that is depressed, such as, for example, the winter flounder population in Mount Hope Bay.

7.5.2a Entrainment Losses

To assess entrainment losses at BPS, icthyoplankton sampling has been conducted in the discharge canal from 1972-1985 and 1993 to the present time. Sampling from 1972-1985 was conducted January through December for all species, while sampling from 1993 to the present has focused on winter flounder. Thus, samples from 1993 to the present are only collected between February to mid-May, because this time period represents peak abundance of winter flounder eggs and larvae in Mount Hope Bay.

For the following analysis, two estimates of entrainment losses are presented. USGenNE used entrainment rates from 1972-1985 for all species, except winter flounder. For winter flounder, data on entrainment rates from 1993-1999 were used. Similar to the impingement estimates, simulations were run for various plant control options and entrainment losses were estimated. Similar to EPA, the company assumed 100% mortality for all species. For winter flounder, they also presented an estimate with variable through-plant mortality. Table 7.5-4 presents the USGenNE's estimate of larvae and eggs entrained through the plant. Table 7.5-5 presents USGenNE's estimate of Age 3 adult equivalent entrainment losses.

Table 7.5-4: USGenNE's Estimate of Annual Entrainment Totals of Eggs and Larvae Under 5 Different Station Operating Scenarios

Species	Life Stage	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All units CC[3]
Alewife	Egg	439,045	282,227	210,219	265,158	20,418
	Larvae	1,180,603	1,024,084	595,551	611,277	57,695
American sand lance	Egg	107,074	77,337	38,404	32,372	5,495
	Larvae	112,861,678	90,824,398	63,691,321	65,082,486	7,299,955
Atlantic menhaden	Egg	551,216,666	492,040,224	262,079,664	271,917,014	27,758,424
	Larvae	209,201,258	222,772,805	123,559,555	133,183,938	12,582,365
Atlantic silverside	Egg	395,378	338,310	261,541	254,144	23,692
	Larvae	28,871,677	29,501,926	17,961,624	19,022,933	1,742,189
Bay anchovy	Egg	4,907,759,053	4,693,187,848	3,288,723,135	3,309,720,188	304,100,847
	Larvae	7,856,152,561	7,119,626,718	5,147,887,171	5,022,738,920	467,841,071
Bluefish	Egg	0	0	0	0	0
	Larvae	0	0	0	0	0
Hogchoker	Egg	96,286,365	96,161,641	63,821,864	66,283,573	6,079,803
	Larvae	7,958,804	7,467,128	5,231,163	5,198,545	485,176
Rainbow smelt	Egg	1,071,777	1,026,153	723,499	778,030	82,262
	Larvae	3,807,775	3,077,093	1,883,715	1,941,379	212,499
Scup	Egg	7,272,690	8,417,876	3,662,637	4,069,976	436,524
	Larvae	233,374	229,973	157,234	161,278	14,816

Seaboard goby	Egg	562,665	533,649	350,024	376,038	34,214
	Larvae	671,399,305	633,456,759	444,567,414	445,605,559	41,068,438
Silver hake	Egg	21,690	25,715	9,938	11,402	1,345
	Larvae	30,096	30,028	22,504	24,666	2,274
Striped bass	Egg	0	0	0	0	0
	Larvae	0	0	0	0	0
Tautog	Egg	3,529,810,091	3,491,783,200	1,981,600,616	2,108,291,977	199,023,946
	Larvae	44,256,809	44,256,809	28,830,657	29,376,343	2,709,320
Threespine stickleback	Egg	0	0	0	0	0
	Larvae	19,314	16,842	13,561	14,492	1,475
Weakfish	Egg	94,475,334	99,119,571	57,455,141	61,344,344	5,697,139
	Larvae	21,851,073	22,139,052	14,268,639	14,883,971	1,364,261
White perch	Egg	643,795	757,474	303,811	339,623	38,631
	Larvae	93,369	78,441	46,136	48,368	5,209
Windowpane	Egg	375,888,042	362,734,696	214,381,175	226,812,836	21,190,832
	Larvae	13,682,593	13,472,888	8,246,770	8,522,301	800,223
Winter flounder	Egg	63,215,121	58,394,355	42,565,233	45,456,047	4,646,753
	Larvae	254,416,824	192,988,834	152,639,826	160,026,899	17,020,740

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and New England Power, former owner of Brayton Point Station
[2] USGenNE's preferred alternative Enhanced Multi-Mode Option
[3] Closed Cycle wet cooling

Table 7.5-5: USGenNE's Estimate of Entrainment Losses of Age 3 Equivalent Adults Under 5 Different Station Operating Scenarios

Species	1993 Permit	MOA II[1]	EMM[2]	Units 3 CC[3]	All Units CC[3]
Atlantic menhaden	15,625	15,614	8,543	9,094	882
Bluefish	0	0	0	0	0
Scup	554	628	292	320	34

Silver hake	0	0	0	0	0
Striped bass	0	0	0	0	0
Tautog	7,126	7,045	4,039	4,285	404
Weakfish	371	384	232	246	23
White perch	0	0	0	0	0
Windowpane	1,002	971	577	608	57
Winter flounder	24,608	27,438	15,408	12,214	2,443

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and New England Power, former owner of Brayton Point Station
[2] USGenNE's preferred alternative Enhanced Multi-Mode Option
[3] Closed Cycle wet cooling

EPA estimated entrainment losses in a similar fashion as calculated for impingement losses, using USGenNE's estimates of flow reductions achievable by the various technological options. Entrainment data from 1974-1983 was used (See section on impingement for explanation of this time period) and entrainment rates were adjusted for the operation of Unit 4 and the effectiveness of angled screens. It was estimated that entrainment rates are 14% greater under current operations than during 1974-1983. Table 7.5-6 presents EPA's estimate of plant entrainment losses in Age 3 equivalents. These figures represent a conservative estimate of what entrainment losses for current plant operations would be if fish populations did not collapse. This estimate is conservative (i.e. low), because even the 1974-1983 dataset represents fish populations on the decline. These numbers are presented for comparative purposes with USGenNE's estimates.

Table 7.5-6: EPA's Estimate of Annual Entrainment Losses in Age 3 Equivalents at Brayton Point Station under 5 Different Operating Scenarios

Species	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All Units CC[3]
Alewife	101	68	45	46	3
American sand lance	83,771	56,602	37,357	37,923	2,264
Atlantic menhaden	3,566	2,409	1,590	1,614	96
Atlantic silverside	<1	<1	<1	<1	0

Bay anchovy	21,681	14,650	9,669	9,815	586
Bluefish	N/A	N/A	N/A	N/A	N/A
Hogchoker	23	15	10	10	<1
Rainbow smelt	9,337	6,309	4,164	4,227	252
Scup	417	282	186	189	11
Seaboard goby	13,440	9,081	5,994	6,084	363
Silver hake	<1	<1	0	0	0
Striped bass	N/A	N/A	N/A	N/A	N/A
Tautog	37,466	25,315	16,708	16,961	1,013
Threespine stickleback	67	46	30	31	2
Weakfish	369	249	164	167	10
White perch	0	0	0	0	0
Windowpane	3,752	2,535	1,673	1,698	101
Winter flounder	109,051	73,683	48,631	49,368	2,947

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and New England Power, former owners of Brayton Point Station
[2] USGenNE's preferred alternative Enhanced Multi-Mode Option
[3] Closed Cycle wet cooling

7.5.3 Ecological Significance of Entrainment and Impingement Losses

To assess the ecological significance of entrainment and impingement losses, EPA compared Age 3 adult equivalent losses to estimates of existing fish populations in Mount Hope Bay. In addition, production foregone modeling was done to assess the impact of the loss of forage species.

USGenNE, in its variance request, compares Age 3 adult equivalent losses from entrainment and impingement to commercial and recreational fisheries landings for all of Massachusetts and Rhode Island waters (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F-74-76). The landings numbers USGenNE cites include catches from all coastal waters out to the 3-mile limit and it is inappropriate to compare losses attributed to Brayton Point Station in Mount Hope Bay to fish landings numbers from all of Rhode Island waters. A more appropriate comparison, for each target species, would be between the entrainment and impingement losses in Mount Hope Bay and the estimated population of Age 3 or adult fish in Mount Hope Bay.

EPA believes that Mount Hope Bay is the appropriate frame of reference for the impingement and entrainment losses, because this area represents a distinct subpopulation of the Rhode Island winter flounder stock. RIDFW's tagging study demonstrated a high level of fidelity to Mount Hope Bay as a spawning location (Reitsma, 2002). In addition, Crawford and Carey (1985) showed an extremely high level (over 90%) of fidelity by winter flounder to their spawning sites in Rhode Island coastal ponds. Thorrold et al.(2001) also documented high fidelity to natal spawning sites in the highly migratory weakfish.

EPA has compared Brayton Point Station's projected impingement and entrainment losses for winter flounder to a Mount Hope Bay winter flounder population estimate. Gibson (1993) estimated a pre-1985 winter flounder population size for Mount Hope Bay using 4 different techniques. First, he used an area-swept by trawl method utilizing the MRI trawl catches from 1972-1983. In this method, a mean catch per tow from February to April in the MRI trawl survey was used from the years prior to the collapse. Area swept by the trawl was calculated using the net dimensions, vessel speed and tow duration. The mean catch per tow figure was then scaled up by the appropriate factor to correspond to the total area of Mount Hope Bay deeper than two meters. A catch rate of 75% was assumed and mean catch per tow was corrected for this. In addition, the standing stock estimate was multiplied by a factor of three to account for the wave type spawning that occur with winter flounder. This spawning strategy involves the fairly rapid movement of large numbers of fish into and out of an area during spawning. The factor of three was derived by multiplying the length of the spawning season (3 months) by the mean residence time of any one fish (1 month).

A second population estimate was derived using a mark and recapture study. A tag return rate is determined and a Petersen estimate was derived using commercial and recreational catch estimates for Mount Hope Bay.

A third estimate was derived from the VPA estimate of the Narragansett Bay-Rhode Island Sound winter flounder population. Assuming a similar density of fish per unit area, scaling down the larger population number of all of Narragansett Bay-Rhode Island Sound to the area of Mount Hope Bay produced a winter flounder population estimate for Mount Hope Bay.

For the final estimate, Gibson applied a regression model representing the relationship between primary spawning and production areas and adult population size to develop a population number for Mount Hope Bay. These four estimates with the corresponding 95% confidence intervals are presented in Table 7.5-7. The arithmetic mean population estimate for these four methods is 378,957 winter flounder in Mount Hope Bay prior to the collapse of the fishery.

USGenNE cites Gibson's (1993) winter flounder population estimates and attributes values in its Table 7-7 in Appendix F of Volume II of their 316(a) and 316(b) Variance request to his 1993 report. However, two of the values they cite are incorrect and as a result the mean of the population estimates is also incorrect. They substitute values for the Gibson estimate for the VPA and the Area Swept Method and calculate a mean value of 349,033 fish. This number is lower than Gibson's actual mean population estimate, but it is also arithmetically incorrect for the data USGenNE presents in their own table. The mean value for the data presented in their table is actually 318,563 fish.

Table 7.5-7: Estimated Adult (Age 3+)Winter Flounder Population Size in Mount Hope Bay (Gibson, 1993)

Method	Population Size	95% Confidence Intervals
Area Swept Method	90,236	84,422-96,061
Mark-Recapture	279,953	230,926-328,980
VPA	869,320	681,605-1,057,035
Acreage Model	276,320	44,814-1,703,777
MEAN	378,957	40,258-717,656

Gibson (2002B) updated his winter flounder population estimate for Mount Hope Bay through time based on a mean population, from 1972-1985, of 378,957 fish and scaled this value based on fish abundance data from the standard trawls (Figure 7.5-1). This analysis produces a year 2001 population estimate of approximately 2,300 winter flounder in Mount Hope Bay. EPA conducted a sensitivity analysis on Gibson's population estimate. Changing the pre-1985 population estimate has a fairly minimal effect on year 2001 fish population estimates. For example, increasing the pre-1985 population estimate to 700,000 fish, results in a year 2001 estimate of just over 4,000 fish. Table 7.5-8 compares the combined Age 3 adult equivalent annual losses for entrainment and impingement of winter flounder for several of the control technology options. The loss numbers assume 100% mortality from impingement, but represent the company's variable survival rate for entrainment for all operating scenarios except for the whole plant closed cycle. USGenNE did assume 100% mortality for all eggs and larvae that would be entrained in a whole plant closed cycle scenario. Thus, loss values represent a conservative or low estimate of the annual Age 3 adult equivalent losses for the following reasons:

1. The Age 3 adult equivalent entrainment losses were derived using some quantity of through plant survival for eggs and larvae for all options except the whole plant closed cycle. USGenNE did not calculate losses of Age 3 adult equivalents assuming 100% mortality of eggs and larvae that are entrained for winter flounder. They made this assumption for every other species, but treated winter flounder differently. EPA has not yet derived Age 3 adult equivalent losses for winter flounder assuming 100% mortality from entrainment, thus we are temporarily relying on the USGenNE's current entrainment loss estimates. Obviously, if 100% mortality were assumed, as EPA believes it should be, winter flounder adult equivalent losses would be higher.

2. The Age 3 adult equivalent impingement losses may be an underestimate as a result of the difficulty in determining the quantity of fish over 3 years of age. It is not clear what assumptions USGenNE made for fish age with individuals that were clearly larger and older than Age 3 fish. These larger and older fish can represent a significant number of Age 3 equivalents depending on their assumed age.

To calculate the impact to the winter flounder population, the total (entrainment + impingement) Age 3 adult equivalent losses are divided by the total losses plus 7,428 (population estimate of winter flounder in Mount Hope Bay from 1993-1999 modified from Gibson 2002B). Table 7.5-8 shows the percentage of the population that is lost with each operating condition with losses ranging from 26 to 80%. By comparison, the Atlantic States Marine Fisheries Commission set a fishing induced mortality rate target of 30% for 1997 (NMFS, 1999). In addition, stocks in Mount Hope Bay are dramatically depressed, thus mortality rates may need to be lowered even further to promote a recovery.

Table 7.5-8: Estimated Winter Flounder Age 3 Equivalent Adult Impingement and Entrainment Annual Losses Under 5 Different Station Operating Scenarios

	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All Units CC[3]
Annual Flow (MGD)	1,440	975	650	653	56
Entrainment	24,608	27,438	15,408	12,214	2,443
Impingement	2,602	2,326	1,603	1,701	178
Total	27,210	29,764	17,011	13,915	2,621
% of population	79	80	70	65	26

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and NEP
[2] USGenNE's preferred alternative Enhanced Multi-Mode
[3] Closed Cycle

EPA apprised USGenNE of this analysis of entrainment impacts and USGenNE responded in writing (April 4, 2002 Meredith Simas to Phil Colarusso, U.S. EPA) with the following 6 points of disagreement.

1. *Inappropriate comparison of numbers*: USGenNE suggests that the entrainment and impingement losses were conservative estimates to be used only for economic analysis. USGenNE claims these values are not appropriate for any ecological assessment, though in the variance request document USGenNE tries to put this loss figure in context by comparing it to commercial fish landings. USGenNE states that Rhode Island fishermen catch 1.3 million pounds of winter flounder annually and impacts from Brayton Point

Station operations constitute 1.6% of that total. The 1.3 million catch figure represents winter flounder caught from all of the State of Rhode Island waters. The majority of the 1.3 million pounds of catch come from the offshore waters of Rhode Island, with none of this total coming out of Mount Hope Bay.

In a meeting on February 14, 2002, a USGenNE consultant suggested comparing the entrainment losses to "Gibson's Mount Hope Bay winter flounder population estimate of 300,000". EPA believes that comparing entrainment and impingement losses incurred by Brayton Point Station operations to fish population numbers in Mount Hope Bay is the appropriate ecological comparison. EPA's reasoning in selecting Mount Hope Bay as the proper frame of reference is due to the high level of site fidelity to natal spawning sites seen in winter flounder, weakfish and anadromous fish (Thorrold et al., 2001; Crawford and Carey, 1985) and the large size of the bay itself (35 km^2). Independent of the site fidelity questions, EPA does not believe that an alternative that results in the significant decline of biomass from all finfish species (Gibson, 1996) in an embayment of 35 km^2 represents a minimization of impacts under the spirit of §316(b) of the Clean Water Act. Unlike an open ocean or well-flushed system, Mount Hope Bay is a fairly self-contained water body with obvious geographic constraints and limited water exchange with Narragansett Bay. Considering the impacts to the larger Narragansett Bay or all of Rhode Island waters, at the expense of Mount Hope Bay, is contrary to the intent of the Clean Water Act.

Finally, USGenNE in its 316(a) and (b) Demonstration document, provide its assessment of entrainment losses using the Empirical Transport Model on a hypothetical population in Mount Hope Bay. Thus, the permittee in its own analysis chooses the same frame of reference for considering impacts as EPA does, which is Mount Hope Bay.

2. *EPA's population number is in error*: USGenNE suggests that the population estimate produced by Mark Gibson and utilized by EPA is in error. The only information that USGenNE provided to rebut EPA's population estimate is the claim that it would require 40,000 adult winter flounder to produce the quantity of Stage-3 larvae that have been estimated to be entrained. Several possible explanations exist to explain the apparent discrepancy between Stage-3 larval abundance and resulting Age 3 adult abundance. It is possible that some larvae from Narragansett Bay may be imported into Mount Hope Bay, though the rate and quantity of that exchange is currently unknown. EPA has refined its original estimate of winter flounder abundance in Mount Hope Bay to approximately 7,500 fish. This adjustment was made to simply match in time the entrainment losses and the annual population estimates in the bay. Specifically, based on Gibson's scaled population estimates, the average annual winter flounder population from 1993 to 1999 is 7,500 adults. Population estimates for 2001 result in a total of approximately 2300 fish.

Further winter flounder population analysis by MA DEP using an area swept methodology estimated an adult fish population number of approximately 1,800 fish per year from 1993-1999 (Appendix B). EPA still believes the actual estimate of adult winter flounder in Mount Hope Bay is less than 10,000 fish, however, even considering USGenNE's estimate of 40,000 fish would represent entrainment loss figures equal to 30% of the bay's winter flounder population. This level of impact would not allow for winter flounder stock rebuilding. In addition, one must keep in mind that the entrainment and impingement impacts do not occur in isolation. Thermal impacts are added to these, so the total plant impact on the winter flounder population would be even greater than the 30% from entrainment and impingement alone.

3. *EPA ignored the Empirical Transport Model*: EPA reviewed the assumptions that USGenNE made for this model and had several points of disagreement, which are detailed below:

A. In deriving the *W*-factor (this is the ratio of the quantity of particular life stage in the bay to the quantity of that life stage that is entrained) for winter flounder eggs, USGenNE use the Gibson adult winter flounder population estimates for Mount Hope Bay. These estimates represent a pre-collapse situation and would result in a dramatic overestimate of the number of eggs produced in Mount Hope Bay. The egg production numbers form the denominator of the *W*-factor. Currently, the adult winter flounder population in Mount Hope Bay is dramatically reduced compared to Gibson's original estimates. In addition, 80% of the adults found in the bay, are found at one station in front of the intake. A *W*-factor that incorporates current population estimates and distribution would certainly obtain a much greater *W*-factor than what USGenNE has calculated.

B. In deriving the *W*-factor for Stage-4 winter flounder larvae, USGenNE uses the following equation:

$$W = (0.5 * \P\ r^2)/ A$$

r = the radius of the Stage-4 home range
A = area of the bay immediately in front of the intake

USGenNE assumes that Stage-4 larvae have limited mobility and will only move approximately 200 feet (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. F-58). USGenNE attributes this mobility estimate to Saucerman and Deegan (1991). Saucerman and Deegan (1991) studied the movement of young-of-the-year winter flounder, which is the life stage after the Stage-4 larval stage. Stage-4 larvae are still found throughout the water column as data presented by MRI at recent TAC meetings show. Stage-4 larvae can be more numerically abundant in the upper half of the water column than the bottom half. The implication of these findings are that

Stage-4 larvae will move or be carried by currents significantly greater distances than the truly demersal young-of-the-year stage. By significantly underestimating the home range of Stage-4 larvae, USGenNE substantially underestimates the true value for the *W*-factor. A lower *W*-factor for Stage-4 larvae results in a lower estimate in the number of Stage-4 larvae impacted and a significantly lower entrainment mortality estimate for the stock.

C. USGenNE does not assume 100% mortality for larvae and eggs entrained by the plant. As stated earlier in this document, EPA assumes 100% mortality for entrained organisms, unless credible site-specific evidence demonstrates adjustments are warranted. USGenNE has not provided a scientifically credible site-specific study to alter EPA's assumption of 100% mortality. An assumption of significant through plant survival, would dramatically reduce entrainment mortality estimates.

D. USGenNE uses data on ichthyoplankton distribution from 1978 and 1979. This is well before the collapse and likely does not represent the current distribution of winter flounder larvae in Mount Hope Bay.

As a result of these inappropriate assumptions, EPA believes that USGenNE's application of the Empirical Transport Model to estimate entrainment impacts from the Enhanced Multi-Mode scenario greatly under predicts the impact on the winter flounder population in Mount Hope Bay.

4. *Mount Hope Bay is not a closed or sealed system*: Obviously, Mount Hope Bay does have exchange of water and some quantity of fish larvae with Narragansett Bay. The relative magnitude of this exchange is unknown, however, and it is not clear if this exchange of larvae results in the net importation into/or exportation out of Mount Hope Bay. Finally, if there is a general infusion of winter flounder larvae into Mount Hope Bay from Narragansett Bay, it makes the lack of subsequent recruitment to the adult population all the more troubling. Infusion of large numbers of larvae from Narragansett Bay should result in large numbers of subsequent juveniles and adults. The fact that adult numbers in Mount Hope Bay have stayed extremely low, even with fishing pressure reduced, suggests one of two things:

1. large quantities of larvae are not being imported into Mount Hope Bay; or

2. larval mortality rates are elevated in Mount Hope Bay.

5. *Regional Effects*: USGenNE suggests that region-wide stressors have reduced winter flounder stocks in Mount Hope Bay and have kept stocks low since the mid 1980s. As already stated in other parts of this document, fish populations in Mount Hope Bay have shown unique changes in abundance. This is true for the entire species complex and for several individual species (winter flounder, tautog, windowpane and hogchoker). Gibson's (2002A) comparison of trawl data from Mount Hope Bay with other geographic locations shows that the

scope of the decline in Mount Hope Bay is a site-specific phenomenom.

Total losses for species other than winter flounder under various operating scenarios are listed in Table 7.5-9. Unfortunately, unlike winter flounder there has not been an extensive analysis of Mount Hope Bay population estimates for other species. However, recorded catch rates for windowpane and tautog are as low as, if not lower than, those for winter flounder (Figure 7.5-2 and Figure 7.5-3). This suggests that their population numbers in Mount Hope Bay are at as equally low levels as winter flounder.

Table 7.5-9: Estimated Annual Finfish Entrainment and Impingement Equivalent Adult Losses Under 5 Different Station Operating Scenarios for Certain Species Other Than Winter Flounder

Species	1993 Permit	MOA II[1]	EMM[2]	Unit 3 CC[3]	All Units CC[3]
Atlantic menhaden	36,504	29,940	18,712	19,539	1,891
Bluefish	22	20	14	14	1
Scup	618	686	331	359	38
Silver Hake	964	924	627	652	68
Striped bass	25	24	17	18	2
Tautog	7,443	7,330	4,231	4,483	425
Weakfish	416	425	262	274	26
White perch	1,003	865	613	642	69
Windowpane	1,100	1,061	638	671	64

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and NEP
[2] USGenNE's preferred alternative Enhanced Multi-Mode
[3] Closed Cycle

Production Foregone: Production foregone is an estimate of the quantity of biomass that would have been realized by fish killed by a particular stressor, if they had not been killed. The stressor in this situation is entrainment and/or impingement by Brayton Point Station. This analysis is typically done to estimate production for forage fish, as they tend to be the most numerous and serve as a critical component of the food chain for numerous predatory fish.

For EPA's analysis, Stratus Consulting derived Age 1 equivalents for each forage species based on age specific mortality rates taken from the scientific literature. Biomass estimates are derived for each species based on established relationships between length, age and weight ratios from the scientific literature. EPA's estimate of production foregone from entrainment and impingement losses are depicted in Table 7.5-10.

Table 7.5-10: EPA's Estimate of Annual Production Foregone (in lbs) From Entrainment and Impingement Losses at Brayton Point Station

Species	Impingement	Entrainment	Total
Alewife	168	584	752
American sand lance	0	1,737	1,737
Atlantic menhaden	225	546,168	546,393
Atlantic silverside	2	8,748	8,750
Bay anchovy	1	1,501,808	1,501,808
Butterfish	3	0	3
Hogchoker	6	81,576	81,582
Rainbow smelt	7	4,276	4,283
Scup	1,707	0	1,707
Seaboard goby	0	731	731
Silver hake	1,026	108	1,134
Striped killifish	4	0	4
Tautog	0	60,371,893	60,371,893
Threespine stickleback	1	28	29
Weakfish	137	2,440,664	2,440,801
White perch	81	72	153
Windowpane	61	181,291	181,352
Winter flounder	879	4,380,576	4,381,455

The summed production foregone total (in pounds) of all species is presented in Table 7.5-11 with 5 different operating scenarios for the plant. Annual production foregone ranges from 3 million pounds of fish to almost 122 million pounds of fish depending on the operating scenario. These estimates represent production foregone from entrainment and impingement of fish species, but they do not address total ecosystem production foregone. Many invertebrate species have planktonic lifestages that are vulnerable to entrainment. Additionally many of the mobile benthic fauna are susceptible to impingement, as evidenced by USGenNE erecting additional screens from May to October to prevent horseshoe crab impingement (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p. D-3). Entrainment and impingement losses of invertebrates at Brayton Point Station have not been measured, but these organisms tend to be lower on the food chain than most if not all fish. Thus, their numerical abundance and the biomass they comprise will greatly exceed that of just the nekton (fish) community alone. Thus, the total ecosystem production foregone actually greatly exceeds the value calculated for the nekton community and as a result it is hard to envision this quantity of biomass being removed from the system without significantly impacting normal trophic dynamics and ecosystem diversity.

Table 7.5-11: Annual Total Production Foregone in Pounds for Brayton Point Station Under 5 Different Operating Scenarios

Operating Scenario	Impingement	Entrainment	Total
1993 permit	4,926	121,968,640	121,973,566
MOA II[1]	3,343	82,764,440	82,767,783
EMM[2]	2,211	54,741,834	54,744,045
Unit 3 CC[3]	2,246	55,617,704	55,619,950
Whole plant CC[3]	134	3,312,155	3,312,289

[1] Memorandum of Agreement II signed between EPA, MA DEP, RI DEM and NEP
[2] USGenNE's preferred alternative Enhanced Multi-Mode
[3] Closed Cycle

7.5.4 Summary of Entrainment and Impingement Losses

Currently, Brayton Point Station withdraws close to 1 billion gallons of cooling water a day from Mount Hope Bay. This results in the entire volume of Mount Hope Bay being cycled through the plant about 7 times a year. Associated with this water withdrawal is the entrainment and impingement of trillions of organisms, the vast majority of which are killed. In addition to large losses of individual organisms, the facility has taken large percentages of the Mount Hope Bay population of a variety of commercially and recreationally important fish species (e.g. winter flounder, tautog). Furthermore, EPA concludes that losses from entrainment and impingement have significantly contributed to the collapse of the overall indigenous community of fish in Mount Hope Bay and prevention of the recovery of that assemblage of organisms to a healthy condition. In sum, these constitute severe adverse environmental impacts.

Under the proposed Enhanced Multi-Mode scenario, Brayton Point Station would still entrain and impinge large quantities of fish eggs, larvae, juveniles and adults of numerous species. Putting these losses in context, the entrainment and impingement losses from the Enhanced Multi-Mode scenario represent a figure equal to 70% of the winter flounder population in Mount Hope Bay. Similarly, large percentages of the Mount Hope Bay populations of windowpane, tautog and hogchoker are lost through entrainment and impingement with the Enhanced Multi-Mode scenario. Finally, with the Enhanced Multi-Mode scenario, well over 54 million pounds of the nekton production is foregone due to entrainment and impingement. Total ecosystem production foregone, which would include invertebrates and phytoplankton, from entrainment and impingement would greatly exceed the 54 million pounds per year figure. The large quantity of biomass lost from the system due to entrainment and impingement undoubtedly significantly affects normal trophic dynamics. Additionally, the large impact of entrainment from the Enhanced Multi-Mode scenario would continue to retard the recovery of specific species, such as winter flounder, tautog, windowpane and hogchoker. EPA considers these to be severe adverse impacts and draws the same conclusions on environmental impact for the Closed-Cycle Unit 3 option, which (using USGenNE's flow estimates) achieves very similar levels of reduction to the Enhanced Multi-Mode option.

In order to give the Mount Hope Bay ecosystem a chance to recover, the total number of organisms taken via entrainment and impingement by Brayton Point Station must be dramatically reduced. Such large-scale reductions can be accomplished by the Closed-Cycle Entire Station option, which achieves flow reductions by 96% over the current condition, achieving similar degrees of reduction in entrainment and impingement. Coupling these reductions with current fishing restrictions and water pollution controls (including the substantial reductions in Brayton Point Station's thermal discharges that will accompany the Closed-Cycle Entire Station option) will result in the increased survival of large numbers of individual organisms. EPA believes this level of increased survival of individuals will foster the recovery of specific fish populations and the Mount Hope Bay ecosystem as a whole.

7.6 Qualitative and Quantitative Assessments of the Value of Reduced CWIS Impacts at BPS

The biological analysis presented above characterizes the adverse environmental impacts resulting from operation of the BPS cooling water intake structures. It also describes the degree of biological improvement that EPA expects will result from particular reductions in cooling water intake structure capacity or changes in intake structure design.

Beyond the strictly biological analysis, under CWA § 316(b), EPA also must consider the costs and benefits of implementing technological options for minimizing adverse impacts from the cooling water intake structures at BPS. As explained above, EPA is not required to conduct a cost/benefit analysis to support its case-by-case CWA § 316(b) determinations. EPA has, however, interpreted CWA § 316(b) to authorize EPA not to impose BTA requirements for minimizing adverse environmental effects when the cost of meeting those requirements would be wholly disproportionate to their benefits. As a result, EPA must consider both the costs and the benefits of these steps within the "wholly disproportionate cost test."

Above we have presented EPA's assessment of what the cost would be *to the permittee* of implementing various technological improvements to the cooling water intake structures at BPS. The cost *to society* of implementing particular options is discussed in Section 7.7 of this document. In this section we discuss the *benefits to society* from the reduced adverse environmental effects that would accompany cooling system improvements at BPS. Neither the CWA, EPA regulations, nor applicable EPA guidance under CWA § 316(b) dictate how EPA should assess the significance of these benefits in applying the wholly disproportionate cost test under § 316(b). EPA believes that a variety of factors should be considered in EPA's assessment of whether or not the costs of a particular option are wholly disproportionate to its benefits. These factors are discussed below.

7.6.1 Summary of Flow Reduction Improvements

CWA § 316(b) requires that the "capacity" of cooling water intake structures reflect the Best Technology Available for minimizing adverse environmental impacts. Entrainment and impingement of aquatic life are two of the key adverse environmental impacts from cooling water intake structure operations and they can be minimized by reducing intake flow volume (or "capacity") as much as possible.

The different technological alternatives investigated in this § 316(b) determination document achieve different levels of flow reduction. The Closed-Cycle Entire Station option reduces cooling water intake flow by approximately 96% (to around 56 MGD). An option that provided closed-cycle cooling for Units 1 or 2 & 3 would result in a reduction in intake flow of approximately 63% (to around 350 MGD). The permittee's preferred Enhanced Multi-Mode option reduces intake flow by approximately 33% (to around 650 MGD). The permittee estimates that a Closed-Cycle Unit 3 option would achieve a flow reduction similar to that of the Enhanced Multi-Mode option (down to around 650 MGD), though EPA is unclear how that figure was derived.[53] (The Closed-Cycle Entire Station option also would provide the greatest reduction in the discharge of heat (from approximately 42 Trillion Btu/year to approximately 0.8 Trillion Btus/year), as compared to a Closed-Cycle Units 1 or 2 & 3 option (at approximately 14 Trillion Btus/year), the Closed-Cycle Unit 3 option (at approximately 23 Trillion Btus) and the Enhanced Multi-Mode Option (at approximately 28 Trillion Btus/year).)

7.6.2 Summary of the Biological Gains from Various Technology Options

[53] Since the Unit 3 cooling tower handles 280,000 gpm, while the Enhanced Multi-Mode cooling tower handles only 260,000 gpm, EPA would have generally expected greater flow reductions from the Closed-Cycle Unit 3 option. It may be that USGenNE has calculated that this expected difference is offset by the Enhanced Multi-Mode option's ability to handle flows from Unit 4 when Unit 3 is not operating, though this has not been indicated clearly. If that is the case, however, then EPA would expect that equipping the Closed-Cycle Unit 3 option with multi-mode capability would enable that option to yield greater flow reductions than the Enhanced Multi-Mode option.

As presented in detail above, EPA has concluded that CWIS operation at BPS has caused, and is causing, severe adverse environmental impacts. These adverse impacts include the loss of both vast numbers of individual organisms and a significant percentage of the local populations of various fish species. We believe that these losses have contributed to significant adverse population-level effects for specific species of fish and have contributed both to causing the collapse of the overall community of fish species in Mount Hope Bay and to inhibiting or preventing their recovery.

The technological options under consideration would yield different levels of flow reduction, as described above, but all allow BPS to generate nearly the same amount of electricity for sale that it does now. These flow reductions would essentially provide corresponding, proportional reductions in the number of individual organisms, and the percentage of each species' population, being entrained and impinged by the BPS CWISs. (The biological analyses presented above indicate the actual numbers of organisms involved.) Thus, from the perspective of minimizing losses of absolute numbers of organisms and percentage reductions in populations of particular species of fish, the Closed-Cycle Entire Station option is the preferred alternative. The Closed-Cycle Units 1 or 2 & 3 option would provide the next greatest level of improvement. The least improvement would be provided by the Enhanced Multi-Mode option. According to the permittee's estimate the Closed-Cycle Unit 3 option would provide a similar level of improvement to the Enhanced Multi-Mode option, though if the Closed-Cycle Unit 3 option were equipped with multi-mode capability we would expect it to provide somewhat greater improvements than the Enhanced Multi-Mode option.

In addition, from the perspective of the recovery of populations of various fish species and the overall ecological health of the Mount Hope Bay and Greater Narragansett Bay ecosystem – as opposed to the simple perspective of the numbers of individual organisms directly saved from the intake – EPA has concluded that the Closed-Cycle Entire Station option would provide biological benefits markedly *greater* than indicated solely by its proportionally greater reduction in flow. In particular, EPA has concluded that the Closed-Cycle Entire Station option is the only option under consideration that will offer sufficient reductions in entrainment and impingement mortality – together with other important steps such as thermal discharge reductions and fishing restrictions – to allow the likely recovery of the severely depleted populations of winter flounder and other species (e.g., tautog, scup, windowpane flounder) in Mount Hope Bay. The other options under consideration – the Closed-Cycle Units1 or 2 & 3, the Closed-Cycle Unit 3, and the Enhanced Multi-Mode options – will not reduce intake capacity sufficiently to allow the likely recovery of the collapsed fish species populations in Mount Hope Bay. The increased likelihood of the fishery recovering adds an important additional quantum of benefit to the Closed-Cycle Entire Station option.

In EPA's view, the Closed-Cycle Entire Station option is also the only option under which entrainment and impingement of organisms by the plant's cooling water intake structure would not interfere with the satisfaction of Massachusetts and Rhode Island water quality standards. Massachusetts has classified the western portion of the estuarine waters of Mount Hope Bay as Class SA and the eastern portion, bordering the City of Fall River, as Class SB. 314 CMR 4.06, Figure 15. These classifications are the highest and second-highest recognized by the Commonwealth's Water Quality Standards. SA waters are to provide "excellent habitat" for fish and other aquatic life as a designated use, while SB waters are to provide "a habitat" for fish and other aquatic life. 314 CMR 4.05(4)(a) and (b). Similarly, Rhode Island has classified the western portions of the Rhode Island segment of Mount Hope Bay as Class SA and the eastern segment as Class SB, the two highest classifications under the state's Water Quality Standards. Rhode Island's SA and SB waters are to provide "habitat for fish and wildlife." State of Rhode Island Water Quality Regulations (as amended June 23, 2000), Rule 8.B.(2)(a) and (b). In addition, Rhode Island's Water Quality Standards specify water quality criteria stating that "all waters shall be free of . . . anthropogenic activities subject to these regulations that: i. Adversely affect the composition of fish and wildlife; ii. Adversely affect the physical, chemical, or biological integrity of the habitat; iii. Interfere with the propagation of fish and wildlife; [or] iv. Adversely alter the life cycle functions, uses, processes and activities of fish and wildlife . . .." Id. at Rule 8.D.(1)(a)(i - iv).

EPA believes these state water quality standards are being violated as a result of entrainment and impingement by the current BPS cooling water intake structures and that the Closed-Cycle Entire Station option is the only alternative currently under consideration that will satisfy these standards in the future. Each of the other options would also reduce the number of organisms killed by the plant's cooling system, but to a significantly lesser degree. These options would still take large numbers of individual organisms, large percentages of species populations, and would not provide sufficient improvement to support recovery of the fishery. Therefore, we believe that these options would not satisfy applicable state water quality standards. Of course, EPA will carefully review the water quality determinations by each state under CWA § 401 in order to verify how the states interpret and apply their own water quality standards to this situation.

Having said all this, EPA also acknowledges that predicting the trajectory of future fish populations under different scenarios is difficult and unavoidably full of uncertainty due to scientific unknowns and data issues. Thus, while EPA has concluded that only the Closed-Cycle Entire Station option is likely to be sufficient to allow the recovery of the damaged fish populations, EPA also recognizes that there is at least some chance that one of the other options might also prove to be adequate in this regard. This chance decreases, however, to the extent that an option provides lesser reductions in flow and associated entrainment and impingement mortality. Each fish population suffers from numerous sources of mortality; some are natural and others anthropogenic. To restore depleted fish populations, total mortality rates for the population need to be sufficiently reduced. For the winter flounder population in Mount Hope Bay, fishing restrictions have reduced fishing-induced mortality. BPS operations are another significant source of anthropogenic mortality to winter flounder and other species. EPA has concluded that the only way to reduce total mortality on fish stocks in Mount Hope Bay to a point that will allow them to recover is to require a major reduction in BPS intake flows.

It must also be remembered that to the extent an option reduces thermal discharges, in addition to reducing flow, it provides an additional critical biological benefit by improving habitat quality and suitability for indigenous organisms and possibly reducing predation rates. In this respect, the Closed-Cycle Entire Station option again provides the greatest benefit, followed in order by the Closed-Cycle Units 1 or 2 & 3 option, the Closed-Cycle Unit 3, and the Enhanced Multi-Mode option.

7.6.3 Public Policy Significance or Import of the Biological Improvements

The public policy significance or import of the biological gains from cooling water intake structure improvements at Brayton Point Station can be assessed in a number of ways. EPA has applied several approaches to develop relevant information to consider in applying the wholly disproportionate cost test under CWA § 316(b). This work is discussed below.

7.6.3a Qualitative, Public Policy-Level Assessment

As the courts have recognized, in enacting the Federal Clean Water Act, Congress plainly understood that it was not necessarily possible to quantify in dollar terms all the benefits of restoring and maintaining the health of the Nation's waters or all the detriments of allowing those waters to be degraded. See, e.g., American Iron and Steel Institute v. E.P.A., 526 F.2d 1027, 1075 (3d Cir. 1975) (citing to Legislative History of the CWA of 1972); E.I. du Pont de Nemours & Co. v. Train, 541 F.2d 1018, 1030 (4th Cir. 1976). Cf. State of Ohio v. U.S. Dept. of Interior, 880 F.2d 432, 457 (D.C. Cir. 1989) (in case involving judicial review of Department of Interior natural resource damages regulations, court states that Congress "recognizes that natural resources have value that is not readily measured by traditional means"). Nevertheless, even unquantifiable benefits could be significant to the public and should be considered.[54] Looked at outside of a strictly monetary framework, EPA believes that the

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[54] In discussing CWA § 302 – which mandates effluent limits more stringent than technology standards if required to achieve water quality necessary for, among other things, "the protection and propagation of a balanced population of fish, shellfish, and wildlife," but also allowed for a temporary extension of time to achieve this level of water quality where, among other things, the cost of doing so is determined to have "no reasonable relationship" to the benefit of doing so – the Senate Report on S. 2770 stated the following:

> Balancing economic costs against what may be considered intangible social benefits is difficult. Some economic benefits can be calculated with reasonable accuracy. These include savings of the costs to public health of polluted waters, the costs of lowered property values along polluted lakes and rivers, the cost to the community of lower tax revenues and an unattractive business climate, the loss of future industry and jobs because of severe pollution problems, as well as the expansion of recreation opportunities available to the general public, including lower-income persons who rely heavily on public recreation facilities; transportation and other savings through the provision of recreation sites in close proximity to densely populated areas; and the impact of not imposing proposed effluent controls and strategies on neighboring

public benefits of implementing the Closed-Cycle Entire Station option are highly significant. The benefits of the other options also have some significance but the degree of significance declines as the amount of entrainment/impingement allowed to continue increases and the corresponding chance that the improvements will be sufficient to facilitate a recovery of the collapsed Mount Hope Bay fishery is diminished.

The central objective of the CWA, as stated by Congress, is "to restore and maintain the chemical, physical and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). Congress also stated that "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983 . . .." 33 U.S.C. § 1251(a)(2). Clearly, these national goals have not been attained in Mount Hope Bay. The Mount Hope Bay fishery is in dire condition and the natural thermal profile of the Bay has been dramatically altered by the thermal discharge from Brayton Point Station. Replacing BPS's old, once-through cooling water system with a modern closed-cycle system will dramatically reduce the damage done to the Bay's chemical, physical and biological integrity by the power plant's cooling water intakes (and thermal discharges). A large reduction in cooling water flow (and thermal discharge) – as would be provided by the Closed-Cycle Entire Station option – will also substantially reduce the plant's impact on the bay's water quality. Furthermore, EPA believes that the Closed-Cycle Entire Station option (in conjunction with other measures) is likely to be sufficient to give the collapsed Mount Hope Bay fishery a reasonable chance to recover over time. The other options are unlikely to be sufficient in this regard, with the chance of recovery declining rapidly and becoming remote as the level of flow reduction decreases below that projected to be achieved by the Closed-Cycle Entire Station option.

> communities. Benefits more difficult to calculate such as long-term improvement of water quality and reduction of estuarine and ocean pollution should not be ignored.
>
> . . . Any balancing of costs and benefits should take into account the nature of the receiving waters and the feasibility of their use for recreational purposes, and the recreational and aesthetic values of maintaining a balanced population of shellfish, fish and wildlife in the particular waterway.
>
> The Committee recognizes that no mathematical balance can be achieved in considering relative costs and benefits nor would any precise formula be desirable, but in each case the Administrator or the State will be able to determine whether there is any reasonable connection at all between the costs which a particular effluent limitations would impose and any benefits (including the attainment of natural water quality) which might be derived.

1972 Legislative History, p. 1466. While CWA § 302 is not at issue in this case, the above passage provides an indication of how Congress thought about the issue of assessing the costs and benefits of water quality improvements under the CWA.

Restoring the biological integrity of the Mount Hope Bay ecosystem has substantial environmental importance because the Mount Hope Bay estuary is an important part of the larger Narragansett Bay estuary ecosystem. The Mount Hope Bay estuary was once a productive nursery area for fish. The collapse of the Mount Hope Bay fishery not only damages the Mount Hope Bay estuary ecosystem, but also harms the overall Narragansett Bay estuary ecosystem of which it is a part. In the 1987 amendments to the CWA, Congress established the National Estuary Program because the "Nation's estuaries are of great importance for fish and wildlife resources and recreation and economic opportunity . . .[, and] maintaining the health and ecological integrity of these estuaries is in the national interest . . .." Water Quality Act of 1987 (P.L. 100-4), § 317(a)(1)(A) and (B) (adding § 320 to the CWA, 33 U.S.C. § 1330).[55] See also *Atlas of Narragansett Bay Coastal Habitats* (Narragansett Bay Estuary Program Report # 01-118, October 2001), p. 1. Congress expressly directed that Narragansett Bay receive priority consideration by EPA for designation under the National Estuary Program and it was one of the first estuaries to have been so designated. See 33 U.S.C. § 1330(a)(2)(B); EPA Website for National Estuary Program (www.epa.gov/owow/estuaries/nb.htm). (So far, there are 28 estuaries designated under the National Estuary Program.) As a result of this designation, substantial federal and state resources have been directed to the Narragansett Bay Estuary Program to help enhance knowledge about, and the conservation of, the Narragansett Bay estuary, which includes the Mount Hope Bay estuary. EPA estimates that since 1984 some 15 million dollars in federal and state matching funds have been spent under this program to benefit the health of the Narragansett Bay estuary.

Another indicator of the great public importance of the Mount Hope Bay ecosystem are the water quality designations given to the waters of this estuary by both Massachusetts and Rhode Island. As mentioned above, Massachusetts has classified parts of Mount Hope Bay as Class SA and other parts as Class SB. 314 CMR 4.06, Figure 15. These classifications are, respectively, the highest and second-highest recognized by the Commonwealth's Water Quality Standards. SA waters are to provide "excellent habitat" for fish and other aquatic life as a designated use, while SB waters are to provide "a habitat" for fish and other aquatic life. 314 CMR 4.05(4)(a) and (b). Similarly, Rhode Island has also classified portions of the Rhode Island segment of Mount Hope Bay as Class SA and other portions as Class SB, the two highest classifications under its Water Quality Standards. Rhode Island's SA and SB waters are to provide "habitat for fish and wildlife." State of Rhode Island Water Quality Regulations (as amended June 23, 2000), Rule 8.B.(2)(a) and (b). As also mentioned above, Rhode Island's Water Quality Standards further specify water quality criteria stating that "all waters shall be free of . . . anthropogenic activities subject to these regulations that: i. Adversely affect the composition of fish and wildlife; ii. Adversely affect the physical, chemical, or biological integrity of the habitat; iii. Interfere with the propagation of fish and wildlife; [or] iv. Adversely alter the life cycle functions, uses, processes and activities of fish and wildlife . . .." Id. at Rule 8.D.(1)(a)(i - iv).

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[55] See also, generally, Section 102(1) of the Estuary Restoration Act of 2000 (P.L. 106-457), the purposes of which include "to promote the restoration of estuary habitat . . .." 33 U.S.C. § 2901(1). Cf. Executive Order No. 13158 ("Marine Protected Areas").

The great value placed on the health of Mount Hope Bay and its fishery by the State of Rhode Island is also indicated by Resolution (No. 2001-H 6304) passed by the House of the Rhode Island State Legislature on April 4, 2001, which stated, among other things, the following:

> WHEREAS, Mount Hope Bay is a valuable natural resource for the citizens of Rhode Island and Massachusetts; and
>
> WHEREAS, Populations of marine fish in Mount Hope Bay have declined dramatically since 1986 and remain at historic low levels; and
>
> * * *
>
> WHEREAS, The importance of the preservation of Mount Hope Bay is immeasurable. This beautiful and vital body of water contains numerous aquatic species indigenous to the New England area and the State of Rhode Island. Mount Hope Bay is an indelible part of our exceptional state and quality of life that Rhode Islanders enjoy; . . ..

The public importance of restoring Mount Hope Bay as a healthy ecosystem for fish is further reflected in the concern expressed regarding the condition of the Bay by the New England Fishery Management Council (NEFMC). See May 7, 2001, Letter from Thomas R. Hill, Chairman, NEFMC, to Ira Leighton, EPA. The NEFMC notes, among other things, that the waters of Narragansett Bay and Mount Hope Bay have been designated as Essential Fish Habitat (EFH) for several species managed by the NEFMC. (EPA is consulting with the National Marine Fisheries Service to satisfy the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act. 16 U.S.C. § 1801, et seq.) The public importance of restoring this fishery is further reflected in the aggressive actions that have been taken by Federal and State resource agencies to reduce fishing pressure in the waters of Mount Hope Bay, Narragansett Bay and elsewhere in our region. These steps include strict fishing restrictions imposed by Rhode Island and Massachusetts in their respective portions of Mount Hope Bay. Restrictions have also been imposed in greater Narragansett Bay. Meanwhile the federal government is taking regional steps that have included measures such as buying back fishing licences, and even fishing vessels, at substantial public expense. Fishing restrictions not only impose limitations on those who wish to make a living from fishing, but limit the public's beneficial use of its waterways and require some to travel longer distances (i.e., outside of Mount Hope Bay) in order to fish. Such additional travel distances may also pose additional personal risk to the fishermen involved. These difficult steps are necessary to enable our fisheries to recover their health and the fact that we are taking these steps in Mount Hope Bay and more broadly reflect the public importance of achieving that recovery.

Another indication of the public importance of restoring the ecological health of the Mount Hope Bay estuary is the fact that the City of Fall River, Massachusetts, has undertaken significant sewage treatment plant upgrades, and is currently in the midst of implementing a large-scale combined sewer overflow (CSO) abatement program. These efforts have been expensive, with the CSO program estimated to cost approximately $150 million of public funds. The CSO program has been implemented under the CWA to attain compliance with state water quality standards. The importance to the public of not allowing Brayton Point Station's cooling water intake (and thermal discharge) to prevent the recovery of the bay's fish populations is highlighted when this type of public expenditure is being undertaken to meet water quality standards.

It should also be noted that the National Oceanic and Atmospheric Administration (NOAA) of the United States Department of Commerce has designated a National Estuarine Research Reserve (NERR) in Narragansett Bay not far from the mouth of Mount Hope Bay. The National Estuarine Research Reserve (NERR) System was established by the Coastal Zone Management Act of 1972. See 16 U.S.C. § 1461. The NERR System is managed by NOAA in cooperation with States that manage the individual sites. The Narragansett Bay NERR in Rhode Island was designated in 1980 and is one of 25 sites in the National network. It provides an opportunity for scientists to conduct research, and educators to communicate information, to enhance public awareness and understanding of estuarine areas. See 16 U.S.C. § 1461(b). The site is managed by the RI DEM and has strong partnerships with the Audubon Society of Rhode Island and the Prudence Conservancy. Through integrated research and education, NERRs such as the Narragansett Bay NERR help communities and managers develop strategies to deal successfully with coastal resource issues, such as point and non-point source pollution, habitat restoration and invasive species. The Narragansett Bay NERR site encompasses a total of approximately 4,000 acres including 60 percent of Prudence Island, Patience and Hope Islands and the recently acquired Dyer Island, as well as the water adjoining the islands out to 18 feet. The island complex supports a major rookery for colonial nesting wading birds, one of the densest herds of white tailed deer in the northeast and, on certain of the islands, access for the public to enjoy nature trails and woodlands. Reserve staff estimate that since 1980 approximately $10.5 million has been spent on land acquisition and Federal and State operations to further our understanding, and improve the management, of this nationally significant area.

EPA's biological assessment indicates that a very major reduction in the plant's cooling water flow (and thermal discharge) – such as provided by the Closed-Cycle Entire Station option – is a threshold requirement to allow recovery of the Bay's fishery and restoration of related ecosystem services. Without meeting this threshold condition for recovery, the other efforts underway to improve Mount Hope Bay's water quality and aquatic habitat and restore its fishery are unlikely to be successful and these expensive societal efforts will be undermined.

7.6.3b Monetary Assessments

EPA is not required to conduct a cost/benefit analysis in determining requirements for the new NPDES permit for BPS under CWA § 316(b). Instead, EPA must consider the cost of the BTA requirements. In doing so, EPA applies a "wholly disproportionate" cost test and retains broad discretion in determining how to apply that test. Of course, this must be done within the confines of the Administrative Procedures Act's (APA) dictate against "arbitrary or capricious" action by government agencies.

As discussed above, Congress and the courts have in various contexts noted our present inability to accurately or fully value natural resources or environmental quality in monetary terms. This is, in part, because not all environmental services, amenities or values are traded in markets and, as a result, it is not possible to observe directly the value – via conventional market prices – that the public assigns to these resources. Nevertheless, there are a number of methods of trying to "monetize" the value of the type of fishery, habitat and water quality resources adversely effected here by the BPS cooling water intake structures. EPA has considered a number of these methods and attempted to apply several of them. EPA recognizes that each of these methods of "monetizing" the biological or environmental benefits of cooling water intake structure improvements has certain flaws and weaknesses, and that none is able to provide a truly complete or fully accurate assessment. Thus, in some instances discussed below, EPA applied a method of economic analysis and produced a numeric estimate of the monetary value of the environmental resources in question. In other instances, EPA discusses the economic analyses conducted by other parties. In still other cases, EPA simply discusses a method of analysis that neither EPA nor any other party applied. Typically, these latter methods were not applied by EPA because they were too expensive and time-consuming to apply for the development of this NPDES permit. In all cases, EPA has tried to briefly discuss some of the advantages and disadvantages of the analytical method in question.

Because of the limitations of these methods for monetizing the value of environmental resources, it is not possible to quantify with exact precision the monetary value of the environmental improvements offered by various technological options. As a result, EPA has *not* conducted these analyses to provide numeric values that will be strictly determinative of the appropriate conditions for the BPS permit. Rather, EPA has developed various types of admittedly rough *estimates* of the value of these benefits in order to provide an array of potentially relevant information for decision-making officials to consider in applying the wholly disproportionate cost test. EPA believes that this approach is consistent with the dictates of CWA § 316(b).

Furthermore, EPA also believes this approach is consistent with a correct, balanced understanding of the proper role of economic analysis in many types of environmental decision-making. Even economists who strongly support efforts to estimate the monetized benefits of protecting "environmental services" in order to support cost/benefit analysis or other economic analyses also caution that precise monetization of benefits may not always be possible, that uncertainties should be acknowledged, that the numeric results of these analyses should *not* be regarded as strictly determinative of the policy decisions at hand to the exclusion of other relevant considerations, and that "care should be taken to assure that quantitative factors do not dominate important qualitative factors in decision-making." Arrow, Kenneth J., et. al., "Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?, " in <u>Economics of the Environment: Selected Readings</u> (Robert N. Stavins, Ed., 4th

Ed. 2000), p. 321-23.[56]

It should be understood that EPA does not intend to present in this CWA § 316(b) determination a detailed discussion of the economic theory underlying various methods of estimating monetized benefits of environmental resources. Such a discussion is not necessary for this permit determination and is beyond the scope of this document. For a discussion of some of the basics of environmental benefits assessment, EPA directs the reader to review Chapters A9 ("Economic Benefit Categories and Valuation Methods") of the "Case Study Analysis for the Proposed Section 316(b) Phase II Existing Facilities Rule" (EPA-821-R-02-002, February 2002) (the "EPA February 2002 Case Study Analysis").

In the following discussion, EPA - New England reviews three separately developed economic assessments related to the benefits of intake flow reduction and reduced impingement and entrainment at BPS. These include two analyses performed by EPA Headquarters in collaboration with the Region as part of the development of both the new proposed CWA § 316(b) regulations for large existing power plants and the new NPDES permit for BPS, and a third analysis prepared directly for EPA - New England for the BPS permit development process. Following its review of these EPA-developed analyses, EPA - New England then reviews analyses conducted by USGenNE and the Rhode Island Department of Environmental Management.

In carrying out our economic analysis of the environmental benefits of various technological options for BPS, EPA's New England Region coordinated its effort with EPA Headquarters in the following manner. EPA Headquarters is working on the development of new CWA § 316(b) regulations. In support of this work, EPA developed estimates of the monetized benefits of environmental improvements from the new regulations. As part of this effort, the Agency conducted "case studies" of the benefits that might flow from various levels of improvements at a number of specific power plants. One of the plants selected was Brayton Point Station because of its northeastern location, its placement within an estuary, its large flow, and because of the availability of a significant amount of data regarding plant operations and their possible environmental effects. EPA Headquarters and EPA's New England Regional office cooperated in developing this analysis. Both offices agreed that preparing a case study on BPS promised informational benefits and cost efficiencies to both offices. Stratus Consulting, Inc.

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[56] It should be noted that there are also expert commentators who question or oppose the use of cost/benefit analysis and other analytical methods relying on efforts to monetize environmental or human health benefits on both theoretical and methodological grounds. See See, e.g., Nicoll, James L., "Environmental Restoration: Challenges for the New Millennium: The Irrationality of Economic Rationality in the Restoration of Natural Resources," 42 Ariz. L. Rev. 463 (Summer, 2000); Heinzerling, Lisa and Ackerman, Frank, "Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection" (Georgetown Environmental Law and Policy Center, c. 2002). Cf. State of Ohio, 880 F.2d at 456, 457, n. 40 (D.C. Cir. 1989). This debate, however, is beyond the scope of analysis necessary to support this permit development.

(Stratus), was retained to help with this work.

The EPA February 2002 Case Study Analysis, including the Brayton Point case study, is part of the administrative record for the proposed CWA § 316(b) regulations for existing power plants published on April 9 2002, and is also part of the administrative record for the Brayton Point Station draft NPDES permit.[57] It is available on the EPA Headquarters website (at www.epa.gov/waterscience/316b/casestudy/).

The Brayton Point Case Study presents location, economic, and background information on the power plant and Mount Hope and Narragansett Bays. The case study then discusses impingement and entrainment losses at the facility (Chapter F3). The analysis does not, however, consider the effect of thermal discharges on organisms in Mount Hope Bay because regulation of thermal discharges is not a directly a part of the national § 316(b) rulemaking process, and time and resource constraints prevented the Agency from including thermal reductions as an secondary benefit of regulatory options involving flow reductions by recycling cooling water. (The Region does, however, consider thermal discharge benefits in its case-by-case analysis for the BPS permit.) The Case Study then uses two different approaches to generate values to use in estimating benefits: (1) the "Benefits Transfer" approach (Chapter F4); and (2) the "Habitat Replacement Cost Method" (Chapter F5).

In addition, as mentioned above, EPA's New England Regional Office has also conducted additional analyses of the benefits of possible cooling water intake improvements beyond the analyses presented in the EPA February 2002 Case Study Analysis. These analyses were conducted by the Region with the assistance its contractor Abt Associates, Inc. (Abt).

i. EPA "Benefits Transfer" Analysis

One set of approaches to valuing environmental benefits seeks to place a monetary value on those benefits by using various measures and surrogate measures for determining how much a relevant population of people would pay in dollars to obtain or preserve that environmental resource. A benefits analysis should try to capture all the benefits derived from the targeted environmental resources or condition. Using fish conservation as an example, direct use values should be quantified (e.g., what the fish saved would be worth at market), indirect use values should be quantified (e.g., the monetary value of species of fish that are not themselves commercially valuable but support the propagation of other species that are commercially valuable, or provide other types of valuable ecological services), and non-use (or "passive") values should be quantified (e.g., "existence value," which represents the value that people receive from knowing that healthy fish populations are being conserved in a waterway, and "bequest value," which represents the value people place on knowing that healthy fish populations have been preserved *for future generations*). In addition to trying to monetize all the benefits, it is also

[57] A Revised Chapter A11 of the Case Study (EPA/Stratus, May 23, 2002) is also available as part of the administrative record for the permit.

important to avoid "double-counting" benefits. See EPA February 2002 Case Study Analysis, at p. A9-3.

There are a variety of ways of trying to estimate the monetary value of environmental benefits and each has its analytical shortcomings. Furthermore, some approaches are more expensive and time-consuming than others. In light of time and budget limitations, EPA implemented a relatively simple, inexpensive and conventional method of trying to monetize the benefits of the fish that might be saved by implementing flow reduction technologies at BPS. EPA refers to the approach it followed as the "Benefits Transfer Analysis." This analysis is presented in Chapter F4 ("Value of I&E Losses at the Brayton Point Station Based on Benefits Transfer Techniques") of the EPA February 2002 Case Study Analysis. First, we will describe how the analysis was conducted and what it attempted to assess. Second, we will provide the results of the analysis. Third, we will describe some of its weaknesses and limitations.

Analytical Method. EPA evaluated the most numerically abundant species of fish entrained and/or impinged at Brayton Point Station. These include species of commercial and/or recreational importance as well as forage species. EPA generally explains the analysis as follows:

> Recreational fishery impacts are based on benefits transfer methods, applying results from nonmarket valuation studies. Commercial fishery impacts are based on commodity prices for the individual species. The economic value of forage species losses is determined by estimating the replacement cost of these fish if they were to be restocked with hatchery fish, and by considering the foregone biomass production of forage fish resulting from I&E [(i.e., impingement and entrainment)] losses and the consequential foregone production of commercial and recreational species that use the forage species as a prey base. All of these methods are explained in further detail in . . . [the Case Study Analysis].

EPA February 2002 Case Study Analysis, p. F4-1.

To avoid double-counting for fish that are exploited by both commercial and recreational fishing, EPA allocated portions of the overall losses of particular species to the recreational and commercial components of the analysis based on National Marine Fisheries Service data indicating the proportions of state landings of that species that come from recreational and commercial fishing, respectively. Id. at p. F4-1, Table F4-1. EPA used its estimates of the mean numbers of "Age 1 Equivalent" fish impinged and entrained at BPS *annually* as the basis for its economic assessment. Id. at p. F4-2, Tables F4-2 and F4-3. Thus, EPA looked at the numbers of fish lost to the intake structures of the BPS once-through cooling system *in the past* and assumed that the same number of fish would be saved *in the future* from eliminating cooling water intake flow at the plant. These numbers were then adjusted, however, to reflect commercial and recreational catch rates. EPA then calculated a monetary value for the adjusted figures. (Fish that escape commercial or recreational capture are *not* valued.)

To determine the monetary benefit of various levels of intake capacity reduction, EPA made the simple assumption that fish losses would be reduced by the same percentage that intake flow is reduced. Therefore, the value of flow reductions could be calculated by multiplying the monetary value of all the fish by the percentage by which flow would be reduced.

Recreational Fishing Results: EPA explains that "[t]he benefits of recreational fishing cannot be tracked in the market, since much of the recreational activity associated with fisheries occurs as nonmarket events." Id. at p. A9-7. Therefore, EPA looked to the literature providing "willingness-to-pay values" for increases in recreational fishing catch rates. Id. at p. F4-3. Because none of the studies reviewed pertained to Mount Hope Bay directly, and because the lack of site-specific data could lead to inaccurate estimates (either low or high), EPA presents a range of annual values for the fish lost to entrainment and impingement at BPS based on the range of values in the literature. Id. at p. F4-4, Table F4-5. The resulting value for each species depends on the number of individual members of that species entrained or impinged at the plant and the value from the literature for an individual member of that species.

Using this method, the value of the *annual* recreational losses of all species combined was found to range from $1,056 to $1,737 for impingement and from $22,641 to $38,794 for entrainment. Id. at Tables F4-5, Table F4-6.

Commercial Fishing Results: EPA estimated the value of commercial fishing losses due to the BPS cooling water intake structures based, in part, on the dockside market landings. Id. at pp. F4-5 to F4-6. The total annual losses to commercial fishing were $2,713 from impingement and $69,321 from entrainment. Id. at Tables F4-7 and F4-8. These values do not, however, encompass the adverse economic effects that these losses would have for producers, wholesalers, retailers and consumers in the multi-tiered commercial fishery market. Therefore, based on values in the literature, EPA used adjustment factors to derive a range of values reflecting the "total economic surplus" lost to the commercial fishery market annually as a result of entrainment and impingement of commercially important species by Brayton Point Station. Id. at p. F4-6. These losses ranged from $4,900 to $8,600 per year from impingement and from $126,000 to $220,600 per year for entrainment. Id. at p. F4-7. EPA did not, however, consider adverse secondary economic ripple effects from fishery losses (e.g., effects on marinas, bait shops, property values).

Forage Fish Results: Many species lost to entrainment and impingement at BPS are not fished on a commercial or recreational basis. We will refer to these species as "forage fish." Although they are not regarded to have direct market-based economic value, these species provide important ecological services within the Mount Hope Bay and Narragansett Bay estuarine ecosystem and food web. In an effort to estimate a monetary value for these fish, EPA used two different methods.

First, EPA attempted to estimate a monetary value for the forage fish lost to the BPS cooling water intake structure utilizing a "production foregone" approach. This approach presumes that the fish have no value other than the extent to which they contribute to the production of other species of fish that are subject to recreational and/or commercial exploitation and whose value can, therefore, be monetized. This, of course, ignores a variety of other ecological services that may also provided by these organisms. This approach then uses estimates of trophic transfer efficiency to determine the loss of commercial and recreational species resulting from the loss of forage species. Using this method, the losses from impingement were estimated to range from $73 to $204 *per year*, and the losses from entrainment were estimated to range from $3,381 to $4,747 *per year*. Id. at p. F4-8.

Second, EPA also applied a "replacement cost" approach that sought to quantify the cost of producing and stocking these fish as part of a hatchery/restocking program. Strictly speaking, this approach does not quantify the "monetary benefit" of the forage fish; rather, it calculates the cost of trying to "replace" those fish in the environment. EPA explains, however, that the numbers are useful if understood in the following manner, Id. at p. F4-7:

- "[I]f the fish are not caught in the commercial or recreational fishery, but are important as forage or bait, the replacement value can be used as a lower bound estimate of their value (it is a lower bound because it would not consider how reduction in their stock may affect other species' stocks)."

- "[W]here there are not enough data to allow calculation of value losses to the recreational and commercial fisheries, replacement cost can be used as a proxy for lost fishery values."

EPA also explains that, "[t]ypically the consumer or producer surplus is greater than fish replacement costs, and replacement costs typically omit problems associated with restocking programs (e.g., limiting genetic diversity)." Id.

Understanding that these replacement cost numbers do not represent a direct estimate of the true monetary value of the forage fish, EPA believes these numbers are nevertheless of interest as a possible lower bound for that true monetary value. The replacement cost estimates developed also represent an underestimate because they did not include the "transportation costs" involved in getting the fish from a hatchery to the habitat in question. These costs involve personnel, fuel, water, chemicals, vehicles, containers, and nets, and can be substantial. However, EPA was unable to obtain data to support a reasonable estimate. Therefore, EPA conservatively did not include a transportation cost value in the estimates. Id. at pp. F4-7 to F4-8. In addition, EPA was able to find hatchery cost estimates for only two of the forage species impinged/entrained by BPS. For other species, EPA used an average value across a number of species. This analysis estimated replacement costs for impinged fish of $398 *per year* and for entrained fish of $17,860 *per year*.

Non-Use Value Results: All of the above analyses were directed at estimating direct and indirect "use" values of implementing flow reduction technologies at BPS. In addition to estimating the "use" values of flow reduction, as part of its "benefits transfer" case study, EPA also estimated non-use values from flow reduction and reduced impingement and entrainment of species at BPS.

In addition to the "use value" of natural resources, such as the value that fish provide for commercial fishing, these resources also provide "non-use" or "passive use" values to the public. Id. at pp. A9-2 to A9-3, A9-10. Passive or non-use values represent the value that people place on a natural resource unrelated to actual use of that resource. These non-use values include such items as the "existence value" (the value a person places on simply knowing that a particular resource has been protected, whether or not she (or anyone) ever uses it), the "bequest value" (the value a person places on protecting a resource for future generations), and the "option value" (the value a person places on preserving the resource to ensure the opportunity to use it in the future).[58] See, e.g., Id. at Figure A9-1, pp. A9-3, A9-10, and A11-3. Cf. State of Ohio, 880 F.2d at 462-64 ("natural resources have values that are not fully captured by the market system" and "non-consumptive" (i.e., non-use or passive) values need to be assessed in order to completely value a resource).

As part of the benefits transfer case study analysis, EPA estimated non-use values using a crude "rule of thumb" identified in certain papers in the literature. Specifically, this rule of thumb assumes that non-use values are "at least equivalent to 50 percent of the recreational use impact." Id. at p. F4-9. EPA noted in the Case Study Analysis that this rule of thumb has been used in a number of past EPA assessments of the benefits of water quality-related improvements. Id. at p. A9-10. It should be understood that this rule of thumb approach does not represent an effort to directly estimate all non-use values; instead, it is a "quick and dirty" approach to developing a low estimate of non-use values that is preferable to ignoring non-use values entirely. Completely ignoring non-use values would be even more inaccurate because there is a large body of information indicating that many people hold substantial non-use values for protecting or conserving environmental quality and natural resources.

While using the rule of thumb in the Case Study Analysis, EPA also identified several possible problems that may undermine use of the 50% factor, including (a) that the literature on which the factor is based is dated and more recent literature exists which must be reviewed and assessed, (b) that the studies underlying the literature have a variety of important differences, which could undermine support for the rule of thumb, and (c) that there are issues concerning how to properly apply the conclusions from the literature to other specific cases. Id. The rule of thumb also may only provide a rough estimate of the non-use value *for recreational fishermen*, and does not necessarily provide a non-use value for nonusers themselves (or for commercial anglers or other users apart from recreational fishermen). This makes it, at best, a highly conservative estimate of total non-use values. EPA also explained that:

> [t]he overall reliability and credibility of applying the 50 percent rule approach is, as for any benefits transfer approach, dependent on the credibility of the underlying study and the comparability in resources and changes in conditions between the research survey

58 See EPA February 2002 Case Study Analysis, p. A9-3, n. 2.

> and the § 316(b) rule's impacts at selected sites. The credibility of the non-use value estimate also is contingent on the reliability of the recreational angling estimates to which the 50 percent rule is applied.

Id.

As a result of these issues, EPA Headquarters indicated that it would use the rule of thumb for the present Benefits Transfer analysis, but that, as it continued working on the development of the new CWA § 316(b) regulations for existing facilities, it would conduct additional research to determine whether the rule-of-thumb estimate remained supportable even as a quick way of deriving a conservative estimate of non-use value that is better than ignoring non-use values entirely. Id.

Applying the 50% of recreational value factor, EPA produced estimates of non-use values ranging from $528 to $869 *per year* for mean annual impingement and from $11,320 to $19,397 *per year* for mean annual entrainment. Id. at p. F4-9.

Range of Total Value Results: The sum of the individual values stated above are presented in the following table.

Table 7.6-1: Sum of Benefits Transfer Estimates
(Source: EPA February 2002 Case Study Analysis, Table F4-13)
(with figures adjusted to Year 2002$)

Summary of Economic Valuation of Mean Annual I&E at BPS (Year 2002$)
(Figures Represent Sum of Commercial + Recreational + Forage + Non-Use Values)

	Impingement	Entrainment	Total
Low Estimate:	$6,917	$171,454	$178,293
High Estimate:	$12,212	$311,275	$323,487
Mid-Point of Range:	$9,564	$241,364	$250,890

To estimate the economic significance of the biological improvements from each technological option using this method, EPA simply determined the percentage flow reduction associated with an option and, assuming a proportional reduction in impingement and entrainment, EPA multiplied the dollar values from the above table by that percentage. Thus, for example, using the mid-point of the range values, an option that would reduce flow by 33% would yield an annual monetary benefit of 33% of $250,890 (i.e., $82,793), while an option that would reduce flow by 96% would produce a monetary benefit of

96% of $250,890 (i.e., $240,854). See, id., at Table F6-2 (note: numbers in this text have been adjusted to Year 2002$).

Limitations/Inadequacies of "Benefits Transfer" Analysis. This section of the document discusses limitations and inadequacies of the above analysis.

As described above, EPA's Case Study Analysis used a simple approach to monetizing benefits that assumed that reductions in flow would achieve like reductions in fish mortality. The number of fish "saved" was then used as the basis for the monetary calculations. As a straightforward, general analytical approach for the Case Study for EPA Headquarters' CWA § 316(b) rulemaking, this approach is reasonable.

EPA's New England Region believes, however, that when applied to the Brayton Point Station/Mount Hope Bay situation, this approach is likely to significantly underestimate the value of technology options that achieve very high levels of flow reduction (such as the 95% reductions achieved by the Closed-Cycle Entire Station option). A principal concern is EPA- New England's belief that the method for quantifying the fish mortality losses materially understates the restorative effect on fish populations that would result from the substantial flow reductions of the Closed-Cycle Entire Station option. This material understatement principally stems from reliance on previously observed impingement and entrainment loss rates as the measure of the fish population losses that would be avoided by implementing the Closed-Cycle Entire Station option. In fact, these previously observed loss rates reflect a depleted and declining fish population.

This is, at least in part, because entrainment and impingement monitoring did not begin until 1972, well after BPS began operations and after the Mount Hope Bay fishery already appears to have been in decline. As noted previously, EPA's biological assessment indicates that implementation of the Closed-Cycle Entire Station option is essential for the recovery of the collapsed Mount Hope Bay ecosystem. As a result, EPA believes that the steady-state fish population implied by the impingement and entrainment loss estimates is actually markedly smaller than the population that would be achieved through a major reduction in intake flow at BPS. Consequently, estimates based on the previously observed impingement and entrainment losses are believed to materially understate the loss that would be observed *if the current intake flows were imposed on this larger, more robust fish population that the bay supported in the past*. EPA - New England believes this higher loss rate would be the appropriate measure for judging the cost to society from operation of BPS's current intake system and, therefore, the benefit that would be achieved from implementation of the Closed-Cycle Entire Station system

It is also true that estimates of the value of the options involving lesser reductions in flow may overestimate the benefits of such steps. This is because although such lower-level flow reductions will save a certain number of fish, they will not likely be sufficient to allow stocks to recover to the degree that current severe fishing restrictions will actually be able to be lifted from Mount Hope Bay. Thus, it seems inappropriate to attribute a fishing-related benefit to all the saved fish from these options if the savings are unlikely to be sufficient to actually allow fishing to be fully restored as an activity in the bay. These fish would still provide value of many types, such as various ecological services, but the value to commercial and recreational fishing would be considerably limited as the resource improvements would likely not be sufficient to permit full exercise of the use benefit activities themselves.

Another principal concern relates to the estimate of non-use value. It is well recognized in the literature that the public values environmental quality well beyond direct use benefits. See id. at p. A11-2. As discussed above, there are many questions about the validity of the 50% of recreational value rule of thumb used to derive a minimum estimate of non-use value. Id. at p. A9-10. Even putting such questions aside, the rule of thumb was only developed in the first place to provide a crude, lower-bound estimate of non-use values that would be preferable to ignoring them altogether. This approach may be especially questionable when applied to natural resources of exceptional public importance, such as the Mount Hope Bay fishery. Moreover, it only clearly addresses the non-use values of recreational fishermen.

Additional shortcomings of the benefits transfer-based method for estimating the monetary value of the biological/fishery improvements from new cooling water intake structure technologies are discussed below. Generally, this conventional technique ignores or does a poor job of valuing a number of important services provided by the organisms lost to the BPS cooling water intake structure.

1. For various reasons, the benefits transfer analysis does not place a value on a majority of the organisms lost to the BPS cooling water intake structures. The valuations based on expected recreational and commercial fishing impacts rely on indirectly derived nonmarket value estimates (e.g., consumer surplus per angling outing as estimated by travel cost models) and direct market values, respectively. In both instances, all benefits are based solely on direct use values of the impacted fish, and the physical impacts are characterized by the adult life stage of the species targeted by the recreational and commercial anglers. However, I&E losses at BPS include vast numbers of eggs and larvae, which play a vital role to a well-functioning ecological system, but have no obvious direct use value in and of themselves to humans. In addition, commercial and recreational losses constitute only a small subset of the species lost to I&E at BPS. See id. at p. A11-1. Even when losses of early life stages are converted to adult equivalents, the ecological services and associated public values provided by early life stages that do not make it to adulthood in the environment are omitted. Id. See also Figures F6-2 and F6-3. In addition, as mentioned above, numbers were adjusted to reflect commercial and recreational catch rates so that fish that escape commercial or recreational capture are *not* valued.

2. The benefits transfer figures may underestimate the value of fishery losses because they are based on estimates of the number of organisms lost to entrainment and impingement derived from data collected from 1974 - 1983. The plant began operations approximately a decade

earlier but did not begin monitoring entrainment and impingement until 1972. Thus, there is no true baseline data. Moreover, there is data suggesting that the Mount Hope Bay fishery was declining before 1974 due, at least in part, to plant operations. Thus, the estimated numbers of organisms lost to BPS do not appear to reflect losses from a healthy fishery. As a result, these figures are believed to represent an underestimate of the impact of the BPS CWISs. Obviously, larger numbers of organisms lost to the plant would produce higher monetary estimates. Id. at Table F6-4. Other potential problems with the entrainment and impingement data include the fact that monitoring did not take place for all species in all years that monitoring did occur; since 1985, entrainment monitoring has been conducted only for winter flounder.

3. In addition, thermal discharges from BPS are also likely to have reduced the number of individual organisms that would otherwise have been subject to impingement and entrainment as a result of altering the temperature regime of the bay. This would also mean that estimates of the numbers of organisms to be taken by the cooling water intake structure that are based on data from 1974 to 1983 would tend to be underestimates. These, in turn, would lead to underestimates of the value of the lost resources.

4. EPA did not analyze the interaction of the effects from the cooling water intake with other environmental stressors. For example, annual losses of organisms to the intake may leave the assemblage of species or specific species more vulnerable to serious harm from other environmental stresses, such as water pollution. Conversely, EPA also did not assess whether improvements with respect to these other stresses, such as water pollution reductions and fishing pressure reductions, would result in larger numbers of organisms being killed by the plant's intakes over time. Id.

5. The EPA estimate of recreational benefits using this method only reflects the anticipated increase in value per outing, without accounting for any potential increases in the level of participation that might result from improved fishery conditions. Id. at Table F6-4, p. A9-7.

6. EPA only considered recreational impacts to fishing and did not consider other recreational activities that might benefit from improved fish stocks, such as boating or bird-watching (e.g., for fish-eating birds), or other near-water recreational activities. Id. at Table F6-4.

7. Due to a lack of site-specific recreational value data for various species, EPA used recreational values from various locations outside the Mount Hope Bay region. This may inject inaccuracy into the estimates. Id.

8. The benefits transfer analysis did not consider adverse secondary economic ripple effects from a degraded fishery (e.g., effects on marinas, bait shops, property values).

Thus, there are a host of issues that serve to undermine the confidence that EPA has in the results of the benefits transfer analysis. These issues for the most part tend to suggest the analysis will greatly underestimate the monetary value of the fishery resource of Mount Hope Bay and the monetary benefits of aiding in its recovery by reduced entrainment and impingement by BPS.

ii. EPA Per-Person Recreational and Non-Use Value Analysis

Background. As explained above, EPA does not have confidence that the benefits transfer analysis provides a complete assessment of the total value of the fish resources that could be saved by cooling water flow reductions at BPS. Therefore, EPA requested its consultant, Abt Associates, Inc. (Abt), to consider whether there was another valid approach to estimating the non-use values of the fish that would be saved by reduced cooling water intake flow at BPS that would be less expensive and time-consuming than a site-specific "contingent valuation" study. Contingent valuation studies involve surveys of a relevant population to try to discern non-use values for particular environmental amenities. Such studies provide site-specific information but are extremely expensive and time-consuming to carry out properly.

In response, Abt concluded that another approach could "provide[] meaningful insight into the non-use values that could be reasonably expected from improved protection of aquatic resources in Mount Hope Bay." May 23, 2002, Memorandum titled, "Assessment of Benefits to Recreational User and Non-User Populations from Reduced Adverse Environmental Impacts of Cooling Water Intake System Operation at Brayton Point Station," from Dr. Elena Besedin, Michael Fisher, Ryan Wardwell, Abt, to Mark Stein and Phil Colarusso, EPA, Region I, pp. 2 (May 23, 2002, Per-Person Recreational/Non-Use Analysis). Abt further stated that, ". . . absent the ability to undertake the considerably more resource intensive event-specific non-use value analysis, we believe that the benefit ratio approach applied here provides a reasonable and valid basis for estimating the non-use benefit value from improved protection of aquatic resources in Mount Hope Bay." Id. EPA has reviewed this analysis and concluded that it represents a reasonable approach, within the time and budgetary constraints faced by EPA in developing the BPS NPDES permit, to providing estimates of the non-use values of the natural resources in question.

Method. This assessment considers the benefit to identified user and non-user constituencies from improved protection of aquatic resources in Mount Hope Bay. May 23, 2002, Per-Person Recreational/Non-Use Analysis, at pp. 1-2. These benefits stem from reduced impingement and entrainment (I&E) of aquatic organisms in the operation of cooling water intake structures (CWIS) at Brayton Point Station (BPS). BPS's withdrawal of water from Mount Hope Bay for its cooling system impinges and entrains fish species sought by recreational anglers and, as well, numerous other aquatic species. Although these other species don't have direct recreational or commercial use values, they play an important role in the overall Mount Hope Bay ecosystem and support the viability of species with recognized recreational and commercial value. Improved quality of recreational fishing for species sought by anglers visiting affected fishing sites can be expected to generate substantial user benefits. In addition, improving protection of Mount Hope Bay will also likely have a large non-use value, given the importance of the affected resources, as discussed above. Because the non-use value for improved protection of the Mount Hope Bay aquatic resources is likely to be large, both absolutely and in relation to estimated use values, underestimating the non-use values could lead to inappropriate, ill-considered policy decisions.

This analysis estimates both use and non-use values of improved protection of aquatic resources in Mount Hope Bay from reduced Brayton Point impingement and entrainment (I&E). It is similar in concept to, but different in analytic approach from, the Brayton Point "Benefits Transfer" case study analysis performed by the U.S. EPA Office of Water for the Clean Water Act 316(b) national rule. The principal difference is in the development of use and non-use benefit values on a *per-person* basis for identified benefit constituencies. Non-use benefit values were estimated by applying an adjustment to the estimated per-person use benefit values and then multiplying the resulting estimated per-person non-use benefit values by the number of persons in the estimated non-use benefit constituencies. The adjustment to per-person use benefit values to generate per-person non-use benefit values was based on an *average ratio of per-person non-use benefit to use benefit* from six prior studies of the value to both users and non-users of protecting water resources. These calculations were performed for non-use constituencies at both the New England regional and national levels.

The "benefit ratio approach" for estimating per-person *non-use benefit* values from *use benefit* values is inevitably less precise than a site- and policy event-specific analysis of the estimates of *non-use benefit* values from improved protection of aquatic resources in Mount Hope Bay. However, such specific studies of non-use value, which are typically based on contingent value surveys, are quite expensive and require considerable calendar time. Given budget and time constraints for the current effort, this approach was not possible. The alternative *non-use benefit* to *use benefit* ratio approach applied herein provides meaningful insight into the non-use values that could be reasonably expected from improved protection of aquatic resources in Mount Hope Bay. Indeed, the prior studies on which the adjustment ratio is based found a relatively narrow range of ratios of per-person *non-use benefit* to *use benefit* value. The consistency of the benefit ratio range found in these studies provides confidence in the findings from the benefit ratio approach as applied herein. Accordingly, absent the ability to undertake the considerably more resource intensive event-specific non-use value analysis, the benefit ratio approach applied here provides a reasonable and valid basis for estimating the non-use benefit value from improved protection of aquatic resources in Mount Hope Bay.

This assessment relied on the following: information developed as part of the BPS case study analysis performed by EPA for the CWA 316(b) national rule; recreational fishing data from the National Marine Fisheries Service (NMFS); values from the environmental economics literature; and membership information from various environmental organizations.

The analysis involved the following steps:

- Identifying the geographical area where fish abundance is likely to be increased by reduced

I&E of aquatic species at BPS (impact area);

- Characterizing recreational fishing in the impact area;

- Estimating improvement in impact area recreational fishing site quality from reduced I&E at BPS;

- Estimating recreational user benefits from increased catch rate at recreational fishing sites in the impact area; and

- Estimating non-use benefits from improved protection of aquatic resources in the impact areas.

Further discussion of each of these steps is provided in the May 23, 2002, Per-Person Recreational/Non-Use Analysis.

Results. This analysis estimated *annual* New England regional *non-use* benefit values from elimination of I&E at BPS ranging from $17.7 to $58.1 million (2002$). Id. Table 7. These values are based on multiplying the estimated per-person non-use values for eliminating I&E at BPS by the number of members of a selection of New England environmental organizations who have natural resource protection as a part of their mission, and the estimated number of saltwater anglers in New England. Id. pp. 12 -14. The range of values reflects different figures based on the low and high ends of a range of per-person values for the environmental improvements, see id. at p. 12, n. 10, and different values depending on whether one assumes an environmental group membership represents one person or 1.9 people (the average number of adults in a New England household). See id. at pp. 12 - 13.

Non-use benefit values were also estimated for *non-*New England benefit constituencies, by performing the same calculations using the number of members of a selection of national environmental organizations who have natural resource protection as a part of their mission, and the estimated number of saltwater anglers nationally. Id. at pp. 14 -16. The range of non-New England figures were combined with the range of New England figures to produce a range of *national* estimates, which included estimated *annual* values ranging from $53.3 to $195.6 million. Id. at Table 8. Again, the range of values reflects different figures based on the low and high ends of a range of per-person values for the environmental improvements, and different values depending on whether one assumes an environmental group membership represents one person or 1.9 people (the average number of adults in a New England household). See id. at p. 15.

Limitations of the Analysis. As with the benefits transfer analysis, the Per-Person Recreational and Non-Use Value Analysis also has a number of limitations and potential uncertainties. Many of these issues are discussed in the text of the May 23, 2002, Per-Person Recreational/Non-Use Analysis, including an explanation of how the uncertainties were handled and why they were handled in a particular manner. On the whole, EPA believes that these issues were handled reasonably and that it is as likely as not that the analysis *underestimates* the total non-use value for eliminating entrainment and impingement from BPS.

Some of the more significant issues are discussed below:

– The analysis, based on recreational species, only considers improvements for winter flounder and tautog. Due to data limitations, improvements for other recreational fish such as bluefish, striped bass, and windowpane flounder, were not considered. This is likely to underestimate the total non-use value. See Id. at pp. 3 (n. 4), 7, 9 - 10.

– This analysis only used the lower non-use value ratio calculated for non-users (as opposed to the higher non-use value ratio for users). However, it was believed that this possible source of underestimate would not have a significant material effect because the number of affected non-users is so much greater than number of affected users. See Id. at p. 11.

– Various calculations made in this analysis rely on values from studies conducted by other parties. For example, recreational fishing data comes from surveys conducted by the National Marine Fisheries Service (NMFS), id. at pp. 6 - 7, and per-person non-use values come from a selection of studies. See Id. at pp. 10 - 11. As with the reliance on studies in the benefits transfer analysis, to the extent there are flaws in the studies relied upon here, they could affect the results of this analysis. However, with respect to the non-use values from the studies relied upon here, six studies were used and they indicate a relatively narrow range of values. This gives some confidence in the reasonableness of the estimates produced using these figures. Id. at pp. 2, 10, 12, n. 11.

– As with the benefits transfer analysis, estimates of the number of organisms lost to entrainment and impingement were derived from data collected from 1974 to 1983. This approach would tend to lead an underestimate of the number of organisms that would be lost to the plant from a healthy ecosystem and a corresponding underestimate of their value. These points are discussed in the section addressing limitations of the benefits transfer analysis.

– Due to the absence of data, several assumptions had to be made for different factors. If these assumptions rendered the estimates less accurate, we cannot tell which direction the error would lie. For example, in the absence of data regarding willingness-to-pay for an additional fish by so-called no-target anglers (anglers who do not have a stated preference for catching particular species or types of fish), the analysis assumes their willingness-to-pay is 50% of that of anglers who specifically target tautog or winter flounder. See Id. at p. 9. As another example, the percent of anglers targeting winter flounder specifically was unknown, so the number was estimated based on percent of anglers targeting flounder in general, which was known, and the ratio of winter flounder catch to total flounder catch. See Id. at p. 10.

– The relationship of willingness to pay for environmental improvement and protections and the distance a person is from the affected resources is unknown. Abt concluded that the willingness-to-pay is likely to be less outside of New England and, therefore, made the rough assumption that the benefit for those outside New England would be 10% of that for those within New England. See Id. at p. 14. EPA believes this is likely a reasonably conservative assumption, especially given the significance of the Mount Hope Bay fishery resources involved. However, it is impossible to know whether this approach leads to an underestimate or an overestimate.

– With respect to both the New England and national environmental group memberships used in the analysis, it was impossible to tell from the data whether the memberships in the organizations represented one or more than one person. As a result, Abt did two calculations: one assuming each membership represented one person and one assuming each membership represented 1.9 people (the average number of adults in a New England household). EPA believes this constituted a reasonable approach to the uncertainty. EPA also agrees with Abt that it is reasonable to expect that the one person per membership calculation is likely to be an underestimate, as some memberships clearly represent more than one person. EPA also agrees that the 1.9 persons per membership calculations could represent an overestimate, but are more likely to be closer to accurate given the expected likelihood that adult members of a household are likely to share similar views on environmental protection. See Id. at pp. 12-13, 15.

– Due to lack of data, the analysis did not adjust for the possibility of an individual being a member of multiple environmental organizations either across the selected New England organizations, or across the New England and national organizations. This could result in an overestimate due to double-counting of some individuals. However, as Abt points out, such individuals may also have a higher non-use value than individuals who are members of only one organization. See Id. at pp. 14, 15. Still, the non-use values of these types of individuals may already be reflected in the average non-use values used from the literature. See Id. at p. 10. On the whole, it is impossible to tell the effect of these elements. (See Item 9 below.)

– Due to lack of data, the analysis also could not determine how many of the New England and national environmental group members were also reflected in the number of saltwater anglers. See Id. at pp. 14, 15, n. 15. This could result in some degree of overestimation as a result of double-counting. Any such double-counting, however, is likely offset to an unknown degree by the fact that the non-use value to anglers was conservatively calculated using the lower non-use value for non-users. See Id. at pp. 14. Furthermore, in order to minimize any potential double-counting for the national environmental organizations, Abt excluded the membership figures for the following three groups on the list who typically would be expected to have a significant number of anglers (Trout Unlimited, Fish Unlimited, and the National Wildlife Federation). See Id. at p. 15, n. 15.

– Various possible sources of overestimate are also likely offset by two important sources of possible underestimate: (1) the analysis assumes that people who are not members of the selected environmental organizations would garner no non-use value from the environmental improvements at issue here; and (2) the list of environmental organizations is not an exhaustive list. See Id. at pp. 14, 15, Attachment A. EPA believes it is reasonable to conclude that these two factors will largely offset, and perhaps more than offset, the possible sources of overestimate, such as those cited in numbers 7 and 8 above.

iii. EPA "Habitat Restoration Cost" Analysis

Background. In light of the many limitations and issues related to the conventional benefits transfer analysis described above, EPA was also interested in conducting additional analyses to provide further potentially pertinent information for consideration in decision-making. As stated above, budgetary and time constraints precluded undertaking a full contingent valuation-style study to derive willingness to pay-based estimates of the value to the public of the fishery resources lost to the BPS cooling water intake structures. Therefore, EPA not only undertook the "per-person" analysis described above, but also worked with Stratus to prepare an alternative economic assessment referred to as a "Habitat Replacement Cost" (HRC) analysis. EPA February 2002 Case Study Analysis, Chapters A11, F5 and F6; see also Revised Chapter A11 (EPA/Stratus, May 23, 2002). EPA believed that this method, which was more affordable and less time-consuming than a full contingent valuation study, offered promise for providing pertinent information for both the development of the BPS permit and the new CWA § 316(b) regulations.

The HRC analysis seeks to identify the cost of habitat restoration efforts sufficient to replace the same number of equivalent-aged fish of each species that is lost to entrainment and impingement by the Brayton Point Station intake. Id. at p. F5-1. The HRC analysis does not actually measure the value, expressed as willingness to pay (or sell), that people place on the fish of Mount Hope Bay; rather, it assesses the cost of actions that would be needed to create or restore the natural environment to a condition where it would naturally produce (or replace) the number of fish otherwise lost to the power plant. EPA believes this information is useful for the Agency to consider in determining whether or not the costs of a BTA alternative are wholly disproportionate to its benefits.

The HRC results are relevant in several ways. They are a measure of what it would cost society to replace the fishery resources lost to the plant in an effective, ecologically sound manner. This is pertinent information in light of the CWA goals of restoring and maintaining the biological integrity of the Nation's waters and rendering them suitable for maintaining balanced, indigenous populations of fish that can support fishing. It is also pertinent in light of the public importance of these resources, as indicated in the above discussion of "qualitative" considerations, including that large public expenditures have been made and fishing restrictions put in place in an effort to restore the fishery and meet applicable water quality standards in Mount Hope Bay. The HRC results are also relevant in that the cost of trying to restore the damaged natural resources through public restoration efforts can be compared to the costs of doing so through technological improvements at BPS.[59]

Finally, there is some evidence indicating that at least in cases involving the type of resource damage we see from impingement and entrainment loss at BPS, HRC results appear to be less than the total value of damage to those resources that would be revealed in a total value assessment. In this light, the HRC cost estimate may provide a conservative, albeit indirect, estimate of the value to society from restoration of the damaged resource. In other words, if used as a "stand-in" for a total value analysis, the HRC results would be unlikely to overshoot the result that a total value analysis would reach. This conclusion is suggested by two cases known to EPA in which both HRC and total value analyses were conducted. Both of these cases found that HRC estimates were lower than the total value estimates. See May 23, 2002 Revised Chapter A11, pp. A11-6 to A11-7. See also May 23, 2002 Revised Chapter A11, Table A11-2 (results of various total valuation studies). In addition, a comparison of the HRC results in this case to the "per-person" non-use value results discussed above tends to suggest the same conclusion. Of course, EPA recognizes that while these results are suggestive, the relative magnitude of HRC and total value results could well vary from case to case and more research would be desirable in the future to further examine this relationship in more, and different types of, cases. See Id. at pp. A11-8 to A11-10, A11-16 to A11-17. Still, these results are worthy of consideration as part of the information currently available to EPA as we move forward at this time to make the CWA § 316(b) determination for the new BPS NPDES permit.

Derivation of the HRC Method. The HRC method is derived from replacement cost estimation methods, including the Habitat Equivalency Analysis (HEA) method, used in certain natural resource damage contexts. The HEA method for determining appropriate restoration costs is well established and has been upheld in federal court in natural resource damages cases under certain federal statutes. See United States v. Great Lakes Dredge & Dock Company, 259 F.3d 1300, 1305 (11th Cir. 2001); United States of America v. Melvin A. Fisher, Kane Fisher, Salvors, Inc., 977 F. Supp. 1193, 1197-98 (S.D. Fla. 1997). For example, under the National Marine Sanctuaries Act (NMSA), the Federal Government is expressly entitled to the restoration of the illegally damaged natural resources or the replacement costs for those resources. Great Lakes Dredge, 259 F.3d at 1304. The HEA method is used to "scale" the amount of restored or created natural resources necessary to replace the environmental services lost on an interim and/or permanent basis from the damaged resources.[60] Great

[59] This is, of course, an artificial comparison because even if the restoration actions were actually taken, EPA believes Mount Hope Bay fish populations would not truly be restored as long as BPS continues killing huge quantities of organisms by its water withdrawals and adversely altering the bay's habitat through its thermal discharges.

[60] This is also similar in concept to the approach to mitigation for damage to wetlands used in the CWA § 404 permitting context. Under CWA § 404, after first avoiding or minimizing any impacts to wetlands as much as possible, mitigation (in terms of off-site restored or created wetlands) for any damage to wetlands that occurs is scaled to offset the lost "functions and values" of the damaged

Lakes Dredge, 259 F.3d at 1304; Fisher, 977 F. Supp. at 1197-98. In Fisher, 977 F. Supp. at 1197, the court explained that it is appropriate to use the HEA method "when 1) the primary category of lost on-site services pertains to the ecological/biological function of an area; 2) feasible restoration projects are available that provide services of the same type, quality and comparable value to those that were lost; and 3) data on the required HEA input parameters exist and are cost effective to collect."[61]

Replacement cost as a measure of damages has also been upheld by the federal courts in the context of natural resource damages claims under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the oil spill-related provisions of the Clean Water Act. State of Ohio v. U.S. Department of Interior, 880 F.2d 432, 444-46, 448, 450, 459 (D.C. Cir. 1989). CERCLA provides that natural resource damages recovered shall be used only to "restore, replace, or acquire the equivalent of such [damaged] natural resources" and that the "measure of damages . . . shall not be limited by sums which can be used to restore or replace such resources." State of Ohio, 880 F.2d at 444 (quoting 42 U.S.C. § 9607(f)(1)). The court explained that Congress intended these two clauses to be read together so that the guiding Congressional purpose of achieving restoration of damaged resources would not be interpreted to make restoration costs a "ceiling" on damages recovery, though they would provide the measure of damages in most cases. State of Ohio, 880 F.2d at 444, n. 8, 445-46 (also noting that any recovery in excess of restoration costs would be directed to acquiring equivalent resources).

The State of Ohio court states that in most cases restoration costs for damaged natural resources will be greater than their "use" value (but not their *total* values). 880 F.2d at 441, 445, 446, n. 13. The court explains that:

> [t]he fatal flaw of Interior's approach[, which favored use values over restoration values], however, is that it assumes that natural resources are fungible goods, just like any other, and that the value to society generated by a particular resource can be accurately measured in every case – assumptions that Congress apparently rejected. As the foregoing examination of CERCLA's text, structure and legislative history illustrates, Congress saw restoration as the presumptively correct remedy for injury to natural resources. To say that Congress placed a thumb on the scale in favor of restoration is not to say that it foreswore the goal of efficiency. "Efficiency," standing alone, simply means that the chosen policy will dictate the result that achieves the greatest value to society. Whether a particular choice is efficient depends on *how the various alternatives are valued*. Our reading of CERCLA does not attribute to Congress an irrational dislike of "efficiency"; rather, it suggests that Congress was skeptical of the ability of human beings to measure the true "value" of a natural

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wetlands.

[61] The HRC analysis for BPS satisfies these three criteria.

> resource. . . . Congress' refusal to view use value and restoration cost as having equal presumptive legitimacy merely recognizes that natural resources have value that is not readily measured by traditional means.

State of Ohio, 880 F.2d at 456-57 (emphasis in the original). Thus, the court concluded that Congress recognized that traditional measures of use value did not fully monetize the total value (including non-use value) of natural resources.

The court in State of Ohio also noted that many scholars shared Congress' skepticism concerning our ability to adequately monetize the total value of natural resources. 880 F.2d at 457, n. 40. One of these scholars is quoted at some length by the court as follows:

> Cross explains how the use of restoration cost as a presumptive measure of damages does not repudiate the goal of economic efficiency:
>
> > At first glance, restoration cost appears to be inferior, because it is a cost-based, supply-side measure, rather than a demand-side, value-based measure of natural resource value. For this reason, when natural resource economics advances far enough to provide an adequate demand-side measure, reliance on restoration cost will become inappropriate. At present, however, the economic tools for valuing natural resources are of questionable accuracy . . . [Using restoration costs as the measure of damages] acknowledges the current ignorance of economic valuation of resources by adopting a cautious, preservationist approach.
>
> Cross, [*Natural Resource Damage Valuation*, 42 Vand. L. Rev. 269,] 331-32 [(1989)]. Others agree that restoration cost can generally be estimated more accurately and easily than can the value of an injured resource.

880 F.2d at 457, n. 40 (additional citations omitted). This discussion suggests that when traditional demand-side measures are inadequate to fully value resources and restoration costs are estimated more easily and cheaply, restoration costs may provide a useful substitute for traditional demand-side measures.

While the above analysis is presented in the context of natural resource damages cases where restoration of the resources is required by law, this thinking can be applied *by analogy* to the CWA § 316(b) context where adverse impact to environmental resources is to be minimized. This analogy may be particularly strong when the resources in question are of special importance, such as the Mount Hope Bay ecosystem. Like the HEA method, the HRC method indicates how much of what type of restoration is necessary to offset the resources lost to a cooling water intake structure.

As stated above, EPA believes that estimating what it would cost to replace the lost fishery resources by implementing ecologically sound restoration actions is relevant information for us to consider in applying CWA § 316(b)'s wholly disproportionate cost test. We understand that this is not a natural resource damages case under the NMSA, CERCLA or the oil spill provisions of the CWA. We also understand that no statute declares that the cost of restoring the fishery resources destroyed by the power plant must be recovered. Nevertheless, the wholly disproportionate test under CWA § 316(b) is not a cost/benefit analysis and does not require one. It allows broad discretion to EPA to consider a range of "costs" and "benefits" in making a reasoned, articulated policy decision. As discussed above, HRC results provide a measure of what it would cost society to replace the fishery resources lost to the plant in an effective, ecologically sound manner. The HRC results also enable a comparison of the cost of trying to restore the damaged natural resources through public or private restoration efforts to the cost of doing so through technological improvements at BPS.

Furthermore, as also discussed above, HRC results may provide a conservative figure to use for a benefit estimate in place of a total value analysis. Conventional demand-side measures that are reasonably available to permitting agencies in light of budget and time constraints, such as the benefits transfer analysis, are unable to fully value these fishery resources. These problems are discussed in detail above. See EPA February 2002 Case Study Analysis, p. A11-1, Table F6-3 (omissions, biases and uncertainties in benefits estimates). See also May 23, 2002 Revised Chapter A11, pp. A11-2 to A11-6. While a contingent valuation study would provide another means of assessing the total value of the resources in question, such an approach was beyond the budget and time constraints faced by EPA in developing the BPS permit. (We believe this would typically be the case for most permitting agencies.) Moreover, contingent valuation studies hardly eliminate all controversy. See State of Ohio, 880 F.2d at 474 - 81 (industry challenge to contingent valuation-related provisions of Department of Interior natural resource damages regulations). The HRC method at least allows us to assess restoration costs in a relatively easily and accurate manner. As EPA explains in the May 23, 2002 Revised Chapter A11, p. A11-1:

> [t]he HRC method provides an estimate of the expenditures needed to provide natural habitat to a level that will offset I&E losses of aquatic organisms and the ecosystem services they provide. . . . By focusing on recovering I&E losses through natural production in the environment, the HRC method considers both the species lost and the services they provide.

The HRC Method: In the EPA February 2002 Case Study Analysis, at p. F5-1, EPA generally explained the HRC method as follows:

> [t]o summarize, the HRC method identifies the habitat restoration actions that are most effective at replacing the species that suffer I&E losses at a CWIS. Then, the HRC method determines the amount of each restoration action that is required to offset fully the I&E losses. Finally, the HRC method estimates the cost of implementing the

restoration actions, and uses this cost as a proxy for the value of the I&E losses. Thus, the HRC valuation method is based on the estimated costs to replace the organisms lost because of I&E, where the replacement is achieved through improvement or replacement of the habitat on which the organisms depend.

More specifically, the HRC method involves a multiple step process:

1. Quantify impingement and entrainment losses (as discussed earlier in the document);

2. Identify habitat requirements of species that are impinged and/or entrained;

3. Identify potential habitat restoration actions that could benefit species from Step 1;

4. Consolidate, categorize and prioritize identified habitat restoration alternatives;

5. Quantify the benefits for the prioritized habitat restoration alternatives;

6. Scale the habitat restoration alternatives to offset impingement and entrainment losses;

7. Estimate "unit costs" for the habitat restoration alternatives; and

8. Develop total cost estimates for impingement and entrainment costs.

Id. at Figure A11-1. EPA used published data wherever possible in applying the HRC method to losses at BPS regarding restoration costs and other matters, but where published data was lacking EPA used and documented unpublished data and best professional judgment from knowledgeable resource experts. Id. at p. F5-1.

EPA used various cost-reducing assumptions throughout the analysis but not beyond the range of values the experts deemed reasonable. In other words, the HRC analysis sought to identify what relevant experts believed to be the minimum restoration costs necessary to offset the fish lost to the BPS cooling water intakes. Id. at p. F5-2.[62] Cost-reducing assumptions used in the analysis are discussed in Chapter F5 and at § F6-3 of the EPA February 2002 Case Study Analysis. Two of the more important ones are the following: (1) although data did not exist to specify proposed habitat restoration measures for all species of fish entrained and impinged at BPS, it was assumed that

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[62] It should be noted that EPA looked to habitat restoration measures that would replace the lost fish in an ecologically sound and complete manner, rather than to fish stocking programs which do not address several ecological services and address others inefficiently, and which may raise ecological problems and fail to produce fish equivalent to wild fish. See the May 23, 2002 Revised Chapter A11, at p. A8 (discussion of fish stocking).

measures for the species for which data was available would be sufficient to replace all species, id. at p. F5-2; and (2) entrainment and impingement losses are based on data from 1974 to 1983, but these data may underestimate the losses from a healthy fishery because BPS operations pre-dated 1974 and some data indicates that BPS contributed to a fishery decline commencing prior to that date. Id. at p. F6-6.

EPA believed it was appropriate to adopt these and other cost-reducing assumptions because the purpose of this exercise was to develop an estimate of restoration costs for EPA to consider in applying the wholly disproportionate cost test under § 316(b) rather than actually to require implementation of a specific restoration program to fully offset fishery losses to the power plant. It would, of course, make little sense to implement these measures to restore fish to Mount Hope Bay only to have those fish killed by the BPS cooling water intake structures or otherwise harmed by habitat changes resulting from the plant's thermal discharges. The costing components of the HRC analysis are described in §§ A11-2.7 and A11-2.8 and F5-7 and F5-8 of the EPA February 2002 Case Study Analysis.

Additional discussion of strengths and weaknesses of the HRC method is presented in the May 23, 2002 Revised Chapter A11, pp. A11-15 to A11-16.

HRC Results: The HRC analysis ultimately estimates that the cost of habitat restoration needed to replace the fish lost to impingement is $873,400 per year (Year 2000$) and to entrainment is $27.7 million per year (Year 2000$). Id. at Tables F5-40 and F5-41 and Figure F5-5.

iv. Range of EPA Estimates

Combining the "benefits transfer" analysis with the "per-person" non-use value analysis, one finds a range of estimated values for all the fish lost to the BPS cooling water intake structure from $239,078 *per year* (Year 2000$) (entrainment and impingement combined; mid-point of the range of benefits transfer values) to $ 37.9 million (Year 2002$) (entrainment and impingement combined; mid-point of range, of per-person New England estimate) and $124.5 million (Year 2002$) (entrainment and impingement combined; mid-point of range of per-person national estimates). As stated above, the estimated cost to restore the lost fish through an ecologically sound restoration program is estimated by the HRC analysis to be approximately $28.6 million per year (Year 2000$) (impingement and entrainment effects combined). As stated above, there is some data to suggest, as explained above, that HRC values are unlikely to be greater than the total value of these resources to the public.

In order to relate the above figures to particular technology options, EPA then assumed that the proportion by which a technology would reduce flow would also reduce entrainment and impingement by the same percentage.[63] This percentage was then applied to the monetary values indicated above to

[63] As discussed above, EPA believes this approach would tend to produce a conservative (i.e., low) estimate.

determine the value of the resources saved by a particular option, or the cost of restoration that would be needed to provide the same number of fish that a particular option would save. Thus, since the Closed-Cycle Entire Station option would reduce flows by approximately 96%, the approximate values associated with that option are calculated by multiplying the above figures by 0.96. Likewise, since the Closed-Cycle Units 1 or 2 & 3 option would reduce flows by approximately 59%, the approximate values associated with that option are calculated by multiplying the above figures by 0.59. Since the Enhanced Multi-Mode option would reduce flows by approximately 33%, the approximate values associated with that option are calculated by multiplying the above figures by 0.33. The resulting values from these calculations are presented in Table 7.6.3.2.d-1 below.

Table 7.6-2: Natural Resource Value and Restoration Cost Estimates Associated with Different Technology Options (all values in Year 2002$)

Technology	% Flow Reduction	Benefits Transfer (Use and Non-Use Values)	Per-Person Non-Use Values (New England)	Per-Person Non-Use Values (National)	HRC*
Closed-Cycle Entire Station:	96%	$240,853/yr.	$36.4 million/yr.	$119.5 million/yr.	$28.9 million/yr.
Closed-Cycle Units 1 or 2 & 3:	59%	$148,025/yr.	$22.4 million/yr.	$73.5 million/yr.	$17.7 million/yr.
Enhanced Multi-Mode:	33%	$82,793/yr.	$12.5 million/yr.	$41.1 million/yr.	$9.9 million/yr.

* HRC values represent the cost of restoring the same number of fish that would be saved by the particular technology option.

v. Assessment of Reasonableness of the High Values

Obviously, the various analyses undertaken have produced a considerable range of figures. We have already discussed above some of the issues related to the various analytical approaches, including reasons why we believe the low figures are likely to represent substantial underestimates. In addition, EPA undertook, with the support of its consultant, Abt Associates, the following effort to review the likely reasonableness of the high estimated values developed from the "per-person, non-use to use benefit" ratio and the HRC methods.

To perform this reasonableness review, EPA compared these benefit estimates to values derived from illustrative calculations of the potential use and non-use benefit that might arise in certain New England regional populations based on very simple and conservative valuation assumptions. In effect, EPA asked the following questions: (1) if regional populations assigned relatively conservative values to the prospective improvement to the aquatic resources and habitat affected by BPS intake system operations, what would the indicated benefit of the improvements be those regional populations? and (2) do the values resulting from this relatively crude approach to benefit assessment suggest that the "per-person, non-use to use benefit" ratio method and the HRC estimates are within a "ballpark" degree of reasonableness?

For this comparison, EPA used three populations of households as representative of the potential "market" for valuing the improvement of aquatic resources that would result from reduced impingement and entrainment at BPS. The first and most narrowly defined market is the estimated number of households in the Narragansett Bay watershed. These households comprise the population group who will most readily value – whether as users or non-users – improvements in the affected aquatic resources. As a somewhat broader population, we also considered the number of households within 120 miles of the affected area. The distance of 120 miles has sometimes been used in natural resource valuation studies as an outer bound for defining the population who might reasonably travel to an affected resource site in the course of a one-day trip and, accordingly, would readily benefit from resource improvements at the affected site.[64] We believe the 120-mile distance is reasonably conservative; some resource valuation studies have used longer distances. Finally, as a third, broader potential market that would benefit from the improvements in question, EPA considered the number of households in the six New England states. This, in effect, is the population of the region covered by the EPA - New England Regional office.

The resulting numbers of households in each defined "market" area are as follows: 800,354 households within the Narragansett Bay watershed; 4,209,126 households within 120 miles; and 5,611,374 households in the New England states. Since EPA limited the definition of potential benefit populations to households within New England for this illustrative "test-of-reasonableness" calculation, any

[64] See U.S. EPA 2002, CWA § 316(b) Phase II Rule: Benefits Case Studies, Part C: The Ohio River Case Study. (U. S. EPA, Office of Water, Washington, D.C. 2002).

additional benefit from households beyond New England is ignored. This represents a point of conservatism in this analysis.

EPA also used the following three values as a range of potential annual benefits per household: $5.00, $10.00 and $37.50. The $5.00 per household value is essentially a nominal, lower bound estimate. The $37.50 per household value is approximately the *average* of per household, annual non-use benefit values found in six studies of non-use value for improvements to water resources, as reported in Brown and referenced by Abt Associates in its estimation of the per-person, non-use benefit values from reduced impingement and entrainment at BPS. The intermediate, $10.00 per household value is approximately the average of the two *lowest* per household values reported in the Brown article. Not using the high values from the studies for this analysis represents another point of conservatism in the analysis.

Combining the estimated numbers of households within the defined "markets" and the range of annual benefit values per household yields estimated potential benefit values ranging from $4.0 million to $210.4 million. Table 7.6.3.2.d-2, below, reports the values calculated from this analysis. As shown in the table, except for the values produced by combining the two lowest per-person values with the most narrowly defined benefit population (i.e., households within the Narragansett Bay Watershed), the indicated potential benefit values are all greater than $20 million per year. Even at the conservative, nominal value of $5.00 per household, the indicated potential values exceed $20 million per year based on the numbers of households within 120 miles of the affected area and in the six New England States. At the intermediate annual benefit value of $10.00 per household, the indicated benefit values increase substantially to approximately $50 million per year for the cases defined by the number of households within 120 miles of the affected area and in the six New England States. Finally, when the average non-use benefit value of $37.50 per household from the six water resource studies cited in Brown is used as the basis of the calculation, the potential benefit values increase to more than $150 million per year for the two higher population cases.

These annual benefit values were developed on the basis of relatively simple and conservative assumptions about the potential population of households that may value improvements to the affected aquatic resources and the potential annual benefit values per household. That the resulting annual values fall in a range extending from a few million to over one hundred million dollars per year provides support for the reasonableness and credibility of the values reported above for the "per-person, non-use to use benefit" ratio and HRC methods. The values from these analyses fall very much within the range of the values developed from the illustrative potential benefit calculations presented in the table below.

On balance, EPA concludes that the estimates from the "per-person, non-use to use benefit" ratio and HRC methods are reasonable and credible and provide realistic, meaningful insight into the potential benefits of reduced intake flow at BPS and accompanying improvement in aquatic resources in Mount Hope Bay.

Table 7.6-3: Potential Range of Annual Benefits Based on Number of Households in Benefit Markets and Potential Annual Household Benefit Values

Benefit Population (Households)	Estimated Number of Households	Potential Annual Benefit ($000,000; 2002$) Based on Average Benefit Value Per Household		
		$5.00	$10.00	$37.50
Narragansett Bay Watershed*	800,354	4.0	8.0	30.0
Population Within 120 Miles**	4,209,126	21.0	42.1	157.8
Six New England States^	5,611,374	28.1	56.1	210.4

* Source: Narragansett Bay Estuary Program, "Atlas of Narragansett Bay - Coastal Habitats" (Report # 01-118; October 2001). Households calculated as estimated population (approximately 2 million divided by 2.5 persons per household; average number of persons per household for New England from 2000 Census).
** Based on 2000 Census, U.S. Bureau of the Census. Population calculated for all census tracts within 120 miles of estimated aquatic resource impact area. Excludes Long Island.
^ Estimated 2001 population values from U.S. Bureau of the Census.

vi. USGenNE Analysis

USGenNE has indicated that it is also undertaking an effort to monetize the benefits that would flow from technological improvements to reduce capacity of the cooling water intake structures at BPS. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, p. 60. The permittee indicated in the December 2001 USGenNE 316(a) and (b) Demonstration, p. 60, n. 88, that it would be submitting this analysis to the regulatory agencies “shortly,” but at least as of July 15, 2002, it has not been submitted. Therefore, it is impossible to fully consider or even describe the permittee’s analysis.

EPA will, however, say a few things about this analysis based only on the brief statements about it in the Executive Summary of the December 2001 USGenNE 316(a) and (b) Demonstration and a few subsequent comments made by the permittee at various meetings. First, the permittee indicates that it has addressed both commercial and recreational fishery benefits of reducing cooling water intake flow. December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Executive Summary, p. 60. This was later reiterated at a January 29, 2002, meeting between EPA, MA DEP and USGenNE. See April 30, 2002, Memorandum from Mark Stein, EPA, to Brayton Point NPDES File, “Some Notes Regarding Meeting with USGenNE on 1/29/02.” Second, it is unclear from the text in the December 2001 USGenNE 316(a) and (b) Demonstration, at Vol. I, Executive Summary, p. 60, whether the permittee attempted to monetize any value for fish that are not exploited in commercial or recreational fishing (though we would *expect* that the permittee’s consultants would do so). Third, it does not appear from the text of the December 2001 USGenNE 316(a) and (b) Demonstration, at Vol. I, Executive Summary, p. 60, or from statements at meetings with EPA, see April 30, 2002, Memorandum from Mark Stein, EPA, to Brayton Point NPDES File, “Some Notes Regarding Meeting with USGenNE on 4/8/02,” that the permittee has included any non-use values in its assessment.

Second, it *seems* that the permittee's analysis may be conceptually similar to EPA's analyses in the sense that we *expect* that the permittee took its estimates of fish mortality from entrainment and impingement under current flows with the once-through cooling system, and then reduced those losses by the percentage of flow reduction provided by the various options. We *expect* that the permittee then took the number of fish "saved" and did certain calculations to derive an estimated value of those fish. In any event, the permittee did provide certain values in the December 2001 USGenNE 316(a) and (b) Demonstration, at Vol. I, Executive Summary, p. 61, Table IV.C.2. Specifically, USGenNE concluded that the total monetized benefit (over 20 years, presented as a present value in 2001 dollars) from various flow reduction technologies are as follows: $0.28 million from the Enhanced Multi-Mode option; $0.32 million from the Unit 3-Closed-Cycle option; $0.38 million from the Units 1 & 2 Closed-Cycle option; and $0.62 million from the Entire Station Closed-Cycle option. The permittee did not provide an equivalent annual values, but it would appear that the permittee's values would be even lower than the above-cited figures developed in EPA's benefits transfer analysis.

vii. **RI DEM Analysis**

The RI DEM's Division of Fish and Wildlife conducted an assessment of the value of the fish lost to the Brayton Point Station *since the 1986 Mount Hope Bay fishery collapse*. The analysis is presented in a paper entitled, "Ex-Vessel Value of Production Foregone in Mt. Hope Bay as a Result of Operations at USGen of New England's Brayton Point Station" (Gibson, 2002C). It is EPA's understanding that RI DEM conducted this analysis in the context of assessing damages to the Mount Hope Bay fishery by the BPS cooling water intake structures since the fishery collapse in the mid-1980's. In the introduction to the paper, RI DEM explains:

> While denied fishing opportunities are the most obvious loss, denied ecological services also need to be considered. Since most natural deaths in the marine environment are caused by predation, power plant losses remove food resources from the benthic and pelagic food webs. Computation of production-foregone accounts for both denied catch opportunities and biomass contributing to higher trophic levels. Attaching monetary value to the production foregone is more difficult. The simplest approach is to assign a value to the production commensurate with the ex-vessel value in a commercial fishery.

Id. at p. 3. Gibson used this "simple" approach, but approached his production foregone analysis by looking at the response of the total stock complex and working down to losses of individual species. (In contrast, both EPA and USGenNE began their analyses from the individual losses.)

RI DEM's analysis concludes that, "[t]he value of foregone fishery production, including unexploited and seasonal species, has fluctuated between 0.5 and 1.4 million dollars per year . . . [and s]ince 1986, the cumulative loss has been 12.7 million dollars." Id. at p. 8. RI DEM further explains that "[t]he loss is understated as recreational value is not considered, a commercial multiplier is not employed [to capture economic ripple effects], and foregone production from plant startup through 1985 is not included." Id.

7.7 CWA § 316(b) Determination and Application of "Wholly Disproportionate Cost" Test

This section of the document discusses the analyses presented above, applies the "wholly disproportionate cost test," and presents EPA's determination regarding the necessary NPDES permit requirements for Brayton Point Station under CWA § 316(b). To the extent that this section reiterates matters that have been discussed and documented in earlier sections of this document, supporting references will not be repeated here.

7.7.1 Introduction

Brayton Point Station (BPS) is the largest fossil fuel burning power plant in New England. With an operating capacity of approximately 1500 MW – approximately 1100 MW from coal-burning units 1, 2 and 3, and 400 MW from oil/natural gas-burning Unit 4 – BPS produces about six percent of the electricity consumed by New England (at 2001 consumption levels). See Abt Associates, Inc., "Impact of Thermal Discharge Management and Air Pollution Control Options for Brayton Point Station on New England Electricity Market and Consumer Rates," p. 3 (May 8, 2002). As such, it is clearly an important contributor to New England's power supply at the present time.

Unfortunately, in addition to producing electricity, BPS also kills fish (eggs, larvae, juveniles and adults) and other organisms, and adversely alters the habitat of the Mount Hope Bay estuary on a massive scale. Situated at the head of Mount Hope Bay, at the confluence of the Taunton and Lee Rivers, BPS withdraws a daily average flow of nearly one billion gallons of water from Mount Hope Bay through its two cooling water intake structures.[65] In the process of withdrawing water from the bay, the plant annually kills literally trillions of organisms. These organisms are not taken for the beneficial uses of food, recreation or ecological services; rather, they are simply wasted as a byproduct of the cooling method presently used to generate electricity at BPS. In addition, by discharging the huge volume of heated water back to the bay, BPS significantly alters the thermal regime of the water body. The extent and significance of the habitat alteration varies seasonally, and with the tides, but at times can cause important effects across much of the bay, throughout the water column, and in important parts of the rivers that flow into the bay.[66]

The Mount Hope Bay estuary is an important part of the larger Narragansett Bay estuary, an estuary of

[65] Increased use of "piggyback" operations under the MOA II, however, has somewhat reduced flows and allowed the use of only one intake for eight months of the year.

[66] We also note that BPS is also the largest New England source of emissions of an array of important air pollutants (e.g., nitrogen oxides, sulfur dioxide).

great local and national environmental significance. Mount Hope Bay once supported a productive fishery and the Mount Hope Bay estuary should provide an important nursery area for fish and other aquatic organisms. At present, the Bay is achieving neither of these ecological services. It is widely accepted that Mount Hope Bay's fishery has collapsed. In an effort to help restore fish stocks to health, Massachusetts and Rhode Island have imposed stringent commercial and recreational fishing restrictions across the bay. These restrictions have been in place for a number of years, drastically limiting public use and enjoyment of these natural resources. Applicable Massachusetts and Rhode Island Water Quality Standards (designated uses and criteria) related to fishery resources and habitat quality are clearly not being attained in the bay.

Current once-through cooling operations at BPS result in the cooling water intake structures killing vast numbers of individual aquatic organisms and substantial percentages of the populations of various fish species. Furthermore, data indicates that the precipitous decline in the bay's fish stocks occurred around 1985, *coincident in time* with BPS's conversion of Unit 4 from closed-cycle to open-cycle cooling, and its attendant large increases in cooling water flow and thermal discharge. In addition, however, other data suggests that the fishery decline began well before 1985. This data indicates that the Mount Hope Bay fishery has been in decline since the early 1970's, and that the changes at Unit 4 in the mid-1980's simply helped to push the fishery "over the edge." On the basis of current information, EPA has concluded that BPS cooling water intake operations have, at a minimum, significantly contributed to the collapse of fish stocks in Mount Hope Bay. EPA concludes that BPS operations – Units 1, 2 and 3 began operation in the 1960's – played a significant role contributing to fishery declines prior to the mid-1984 conversion of Unit 4 to open-cycle cooling. The Unit 4 conversion, in turn, helped to trigger the precipitous fishery decline of the mid-1980's.

EPA understands that this correlative data does not prove "cause and effect" in a strict scientific sense. The only way to achieve that level of certainty would be to conduct a controlled experiment on the Mount Hope Bay estuary, recreating true baseline conditions and then controlling all variables, including the power plant. It is obviously impossible to conduct such an experiment. In addition, it is impossible to be certain about the exact extent of the fishery decline since the commencement of BPS operations because collection of fish abundance data for Mount Hope Bay did not begin until 1972, *after* Units 1, 2 and 3 began operations. EPA cannot, however, simply "throw up its hands" in light of these limits on the scientific certainty that can be achieved. Instead, we have to do the best we can to draw reasonable conclusions from the best, reasonably available information in order to apply the requirements of the Clean Water Act. We believe the above-stated conclusions are reasonable and appropriate in light of current data and understanding.

Despite the current problems in Mount Hope Bay, the "good news" is that by upgrading BPS's cooling systems with modern cooling technologies that cut cooling water volume (and thermal discharge), the power plant can both drastically reduce its harmful effects on the waters of Mount Hope Bay *and* continue generating electricity for New England's energy supply. By taking advantage of these well-established cooling technologies, BPS can generate electricity in a manner that is far less harmful to the marine environment.[67] Moreover, we believe that undertaking such efforts are clearly worthwhile because experience shows that when pressure on depleted fish stocks is reduced or removed, those stocks can rebound. It is clear that strong, difficult and expensive actions have been, or are being, taken to reduce other pressures on Mount Hope Bay's fish stocks. These include fishing restrictions, water pollution reductions. Improvements are also needed at BPS.

7.7.2 Brief Reiteration of Legal Standards

CWA § 316(b) states that:

> [a]ny standard established pursuant to section 301 or section 306 of this Act and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

33 U.S.C. § 1326(b). Assessing the level of "adverse environmental impact" includes, among other things, assessing the number of individual aquatic organisms of various species that are killed, assessing the percentage of various species' populations that are killed, and assessing whether the health of specific species populations or the overall community or assemblage of species in the water body is compromised. Considering all of these elements, EPA can judge the overall magnitude of the adverse environmental impacts from the cooling water intake structure to help determine what measures should be implemented. "Minimize" has been defined by EPA in the past to track the common dictionary definition of "reduce to the smallest possible amount, extent, size, or degree."

The "Best Technology Available" (BTA) refers to the available technology that would do the best job of minimizing (i.e., get the greatest reductions of) the adverse environmental impacts from operation of the cooling water intake structure. The technologies relied upon must be technologically and economically practicable.

EPA may regulate the level of cooling water flow through a cooling water intake structure as part of ensuring that the "capacity" of the intake structure reflects the BTA. This type of flow-based performance standard may indirectly lead a discharger to use a particular type of cooling system, though EPA cannot directly mandate that a particular type of cooling system be used. For example, EPA cannot mandate the use of cooling towers, but EPA can impose a flow limit that might lead a facility to choose to use cooling towers as a means of compliance. EPA can also require improvements to pumping, screening and fish return systems as part of ensuring that the "design" of the intake structure reflects the BTA.

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[67] Similarly, BPS's air pollutant emissions can also be greatly reduced by utilizing updated technologies to comply with new Massachusetts air regulations.

Although the text of CWA § 316(b) makes no mention of economic considerations, EPA has long interpreted the provision to bring economic considerations to bear in two ways. First, remarks by Representative Clausen from the legislative history of CWA § 316(b) indicated that BTA means "best technology available commercially at an economically practicable cost." Therefore, the cost of measures to meet BTA requirements should be economically practicable. 1972 Legislative History, p. 264. Second, EPA has interpreted § 316(b) to contemplate a consideration of economics such that the costs of BTA measures should not be "wholly disproportionate" to their benefits. Neither statute, regulations nor EPA guidance dictate exactly how to apply the wholly disproportionate cost test under § 316(b). The Administrator of EPA explained the Agency's interpretation, later upheld by the courts, in the case of *In re Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2),* 10 ERC 1257, 1261 (NPDES Permit Application No. NH 0020338, Case No. 76-7; June 17, 1977) (Decision of the Administrator), stating as follows:

> . . . the Agency's position, that cost benefit analysis is not required under Section 316(b), is correct. Section 316(b) provides flatly that cooling water intakes shall "reflect the best technology available for minimizing adverse environmental impact." Unlike Sections 301 and 304, Section 316(b) determines what the benefits to be achieved are and directs the Agency to require use of "best technology available" to achieve them. There is nothing in Section 316(b) indicating that a cost benefit analysis should be done . . .. Indeed, but for one bit of legislative history [citation to Representative Clausen's remarks omitted], there would be no indication that Congress intended costs to be considered under Section 316(b) at all. I find, therefore, that insofar as the RA's decision may have implied the requirement of a cost/benefit analysis under Section 316(b), it was incorrect.
>
> However, the RA may have meant only that some consideration ought to be given to costs in determining the degree of minimization to be required. I agree that this is so – otherwise the effect would be to require cooling towers at every plant that could afford to install them, regardless of whether any significant degree of entrainment or entrapment was anticipated. I do not believe that it is reasonable to interpret Section 316(b) as requiring the use of technology whose cost is wholly disproportionate to the environmental benefit to be gained.

Thus, a cost/benefit analysis is not required. Rather, "some consideration" must be given to costs and EPA does so by applying the wholly disproportionate cost test.

For general guidance, EPA looked both to past EPA § 316(b) decisions as well as EPA's past application of the "wholly disproportionate cost" test in the analogous area of developing Best Practicable Treatment (BPT) technology standards for pollutant discharges. Numerous court cases indicate that under the BPT wholly disproportionate cost test, cost is not to be considered a factor of "primary" or "paramount" importance, that EPA's assessment of costs and benefits "is a relatively subsidiary task and need not be precise," that an "overall" cost/benefit comparison is sufficient, and that EPA is not required to prepare an "incremental" cost/benefit analysis or "knee of the curve" analysis. (Citations to court cases for the above quoted language are set forth in the legal discussion presented in an earlier section of this document.)

At present, EPA continues its longstanding practice of applying CWA § 316(b) to existing facilities on a case-by-case, best professional judgment basis. On April 9, 2002, EPA published for public review and comment new proposed regulations for applying § 316(b) to large, existing power plants. However, these proposed regulations are not yet in effect, are subject to change, and specify that they are not to be used as guidance for current permit actions. 67 Fed. Reg. 17121 (April 9, 2002).

7.7.3 BTA for Minimizing Adverse Environmental Impacts

EPA concludes that the magnitude of the adverse environmental impacts from current operations of the Brayton Point Station cooling water intake structures is severe, and that the location, design and capacity of the current intake structures do not reflect the Best Technology Available for minimizing those adverse environmental impacts (BTA). Vast numbers of individual organisms – literally trillions of organisms, including billions of fish eggs, fish larvae, adult and juvenile fish – are being killed and/or injured annually as a result of entrainment and impingement at BPS. The ecological functions that these organisms provide to the food web and ecosystem are lost from the Mount Hope Bay estuary. Even after calculations to convert eggs and larvae to "Age 1 equivalent" fish, millions of these Age 1 fish are lost annually to entrainment and impingement, including species of commercial and recreational importance and forage fish species of significance to the food web and ecosystem health (e.g., 520,716 winter flounder; 1,237,140 bay anchovy). EPA February 2002 Case Study Analysis, p. F5-2.

BPS is also clearly taking substantial percentages of the Mount Hope Bay adult populations of a number of fish species (e.g., winter flounder, tautog, hogchoker). Moreover, the overall assemblage of fish species has collapsed in Mount Hope Bay. The balanced indigenous community of fish that should exist in Mount Hope Bay has been severely compromised. EPA believes that BPS's take of organisms through its cooling water intake structure has contributed to the fishery collapse, and is helping to prevent or inhibit a recovery despite public steps being taken to promote such a recovery, including fishing restrictions and water pollution reductions. In sum, the magnitude of adverse environmental impacts in this case is severe.

EPA has determined that the essential means of reducing the adverse environmental impacts of the cooling water intake structures at BPS in the future is to substantially cut their permitted capacity (i.e., flow reductions). This is the only practicable way to get major reductions in the number of individual organisms and the percentage of species populations that are killed by the power plant as a result of entrainment and impingement. Indeed, EPA has concluded that unless there is a major reduction in the number of organisms that BPS culls from the Mount Hope Bay ecosystem, the bay's balanced indigenous community of organisms is unlikely to recover. Conversely, with major reductions in the cooling water intake structure's take of fish (as well as major reductions in the scope of the thermal discharge plume and other measures, such as careful management of fishing pressure), EPA believes that the fishery of Mount Hope Bay can recover and once again be a productive ecological resource contributing to the public's welfare and quality of life.

Like the permittee, EPA investigated numerous technological options for determining what permit requirements are needed in order for the design, location, capacity and construction of the cooling water intake structures to reflect the BTA for minimizing adverse environmental impacts (BTA). From this work, EPA has concluded that cooling water intake structure capacity limits should be based on flows commensurate with converting Units 1, 2, 3 and 4 to closed-cycle cooling using mechanical draft wet cooling towers (the Closed-Cycle Entire Station option) in order to reflect the BTA for minimizing adverse impact. The flow limits associated with this option are 56 MGD, down from the current flow of approximately 1.0 BGD (a reduction of about 94%).

First, EPA has concluded that retrofitting closed-cycle wet mechanical draft cooling towers for Units 1, 2, 3 and 4 at BPS should be technologically and economically practicable. See May 20, 2002, Memorandum from Michael Fisher and Geoff Bennett, Abt Associates, Inc., to Mark Stein and Dave Webster, US EPA Region 1, "Subject: Financial Impact of Closed Cycle System Installation at Brayton Point Station - WITH CONFIDENTIAL BUSINESS INFORMATION EXCLUDED FROM TEXT AND TABLES." Such retrofits have been completed in the past at other large power plants. This fact along with other site-specific information indicates that such a retrofit should be feasible at Brayton Point Station. It is recognized, however, that there will be logistical challenges at the site and the regulatory agencies will need to work closely with USGenNE to develop an appropriate schedule for implementing the retrofit.[68]

Second, in order to give the Mount Hope Bay fishery a chance to recover, EPA has concluded that the number of organisms, and the percentages of species populations, taken by entrainment and impingement by the BPS cooling water intake structures must be drastically reduced. Such large-scale reductions can be accomplished by the Closed-Cycle Entire Station option. This option can achieve approximately a ninety-six percent reduction in flow. It will achieve comparable reductions in entrainment and impingement. With this option, the losses of organisms of various species can be reduced by nearly two orders of magnitude. This option will also allow the elimination of one of BPS's two cooling water intake structures. Coupled with current fishing restrictions and water pollution controls – including the substantial reductions in BPS's thermal discharges that will accompany the Closed-Cycle Entire Station option – removing the severe stress the BPS intake structures place on the

[68] It will also be important for the regulatory agencies to work with the permittee to negotiate an implementation schedule that minimizes any generating unit construction outages occurring during peak electricity demand periods.

ecosystem and fish populations will give the community of organisms an opportunity to recover.

EPA acknowledges that there will still be some adverse environmental impacts from the Closed-Cycle Entire Station option because organisms will continue to be entrained and impinged due to the approximately 56 MGD of makeup cooling water that the power plant would still need to withdraw from Mount Hope Bay with this technology. As stated above, however, the number of organisms and percentages of species populations lost to the cooling water intake structures will be substantially reduced with this option as compared to the other options. Moreover, EPA believes this level of improvement should be sufficient to facilitate the recovery of Mount Hope Bay's balanced, indigenous community of organisms. In sum, based on current information, we believe the magnitude of the adverse environmental effects from this option will not be substantial.

Finally, although even greater reductions in adverse impacts could theoretically be achieved with the use of dry cooling technology, which essentially eliminates the need for cooling water, EPA has concluded based on current information that this technology is not clearly practicable for use at BPS. As far as we or the permittee could learn, no large existing power plant has been retrofitted to dry cooling. Further, this technology has been estimated to cost roughly three times the cost of mechanical draft wet cooling towers. EPA deemed it inappropriate to impose flow restrictions that would triple the cost in order to increase flow reductions from ninety-six to one hundred percent, given that we believe that flow levels associated with the Closed-Cycle Entire Station option will result in insubstantial adverse impacts.

EPA also considered various other environmental and energy issues raised by a proposed conversion to the Closed-Cycle Entire Station option. Based on this evaluation, EPA has concluded that these issues do not pose serious problems and can be effectively managed. Of greatest importance, because it raises the possibility of a public safety concern, is the issue that the permittee raises concerning the potential for traffic safety problems to result from cooling tower vapor plumes causing fog or ice affecting Route 195 or the Braga Bridge. The permittee indicates it could alleviate any such problem by instituting periodic generating unit shutdowns, but complains that such shutdowns would be very expensive.

EPA's research on the vapor plume fog/ice issue at other plants indicates that it is unlikely that cooling tower plumes would create fog or ice that would pose significant traffic safety problems at Route 195 or the Braga Bridge and require generating unit shutdowns. Indeed, the permittee's analysis –which EPA has many questions and reservations about – suggested only a small marginal potential increase in fog or ice over existing background conditions, and this possible increase was well within the range of natural variability in the background conditions. Nevertheless, EPA also believes there are a number of potential ways to deal with any problem that could emerge. These range from coordinating extra safety measures with the Massachusetts Highway Department (MHD) (e.g., deployment of extra fog warning signs, extra road sanding/salting crews, as EPA and MA DEP have discussed with the MHD), to engineering the cooling towers so that they can be bypassed (i.e., shifted to temporary once-through cooling operations) if necessary to protect traffic safety, to undertaking cooling tower and generating unit shutdowns if absolutely necessary to ensure public safety. However, EPA does not believe the latter situation is likely to occur. The permittee also could install a technology known as “hybrid” (or “wet/dry”) cooling towers to further reduce any threat of vapor plume problems, but the likely extent of the potential problem here does not appear to warrant the increased expense of this technology.

EPA also believes that the other environmental issues raised by the plant are either insignificant or can be managed. As discussed in detail above, neither noise, air emissions, aesthetic concerns, salt drift, nor any other issue raises a problem that renders modernizing the BPS cooling system with wet mechanical draft cooling towers infeasible or inappropriate. Obviously, federal, state and local requirements for noise and air emissions will need to be addressed and complied with.

EPA also evaluated numerous technological options beside the Closed-Cycle Entire Station option. For example, we assessed and rejected dry cooling, as discussed above. Options such as intake design modifications (e.g., screening technologies) and re-locating the intake structures to less sensitive water body segments were also evaluated and rejected for various reasons.

Furthermore, EPA evaluated options that would have provided closed-cycle cooling with wet mechanical draft cooling towers for fewer than all four steam-electric generating units at BPS (e.g., the Closed-Cycle Unit 3 option and the Closed-Cycle Units 1 or 2 & 3 options). EPA believes these options are also practicable. They would obviously be cheaper than the Closed-Cycle Entire Station option as they involve lower capital costs, energy penalties, and maintenance expenses. However, they also would achieve substantially lesser flow reductions. As a result, with these options BPS would continue to take huge numbers of individual organisms and significant percentages of Mount Hope Bay’s populations of various fish species. Furthermore, EPA does not believe the reductions achievable with these options would be sufficient to allow the recovery of the balanced, indigenous population of organisms in Mount Hope Bay (despite fishing restrictions and water pollution improvements). Obviously, the Closed-Cycle Units 1 or 2 & 3 options would reduce flows to a significant degree beyond the Closed-Cycle Unit 3 option, but EPA is not convinced that this incremental improvement would be sufficient to facilitate the fishery’s recovery. In light of the above factors, EPA has determined that capacity limits based on these two options would not reflect the BTA for minimizing adverse environmental impacts.

Finally, EPA also carefully evaluated the Enhanced Multi-Mode option proposed by USGenNE. This option also utilized closed-cycle cooling with wet mechanical draft cooling towers configured in such a way that the cooling towers could be bypassed or could cool water from different units under different circumstances. EPA commends the permittee for developing and proposing this option. We believe it was a constructive proposal that showed ingenuity. Indeed, we believe that the closed-cycle cooling system for the Closed-Cycle Entire Station option should be designed and constructed with the same ability to bypass the cooling towers that the Enhanced Multi-Mode option has. (Cooling tower bypass capability has also been used at other existing power plants.)

Nevertheless, the Enhanced Multi-Mode option would achieve only approximately a one-third reduction in flow from the current condition, far less than the Closed-Cycle Entire Station option. With the Enhanced Multi-Mode option, vast numbers of organisms, and substantial percentages of the Mount Hope Bay populations of various fish species, would continue to be killed by entrainment and impingement by BPS's intake structures. Moreover, EPA does not believe that the reductions achievable with this option would be sufficient to allow the recovery of the overall community of organisms that should exist in Mount Hope Bay, despite restrictions on fishing and improved controls on water pollution. As such, EPA does not believe that intake capacity limits based on flows achievable by the Enhanced Multi-Mode would reflect the BTA for minimizing adverse environmental impacts. (The Enhanced Multi-Mode option also achieves far lower thermal discharge reductions than the Closed-Cycle Entire Station option.)

In summary, EPA determines that a capacity limit reflecting the BTA for minimizing adverse environmental impacts should be based on the performance capability of closed-cycle cooling with mechanical draft cooling towers for Units 1, 2, 3 and 4.[69] Thus, the flow limit in the draft permit is 56 MGD.

7.7.4 Application of the Wholly Disproportionate Cost Test under CWA § 316(b)

As stated above, cost/benefit analysis is not required under CWA § 316(b). Instead, EPA must "consider" costs. EPA does so by determining whether the cost of a selected BTA option for minimizing adverse environmental impacts is practicable, and by determining whether the cost of the option is "wholly disproportionate" to its benefits. There is no statutory, regulatory, or CWA § 316(b) guidance document indicating exactly how this test should be applied. EPA has a substantial range of discretion in applying this test. Looking by way of analogy to case law concerning EPA's application of a "wholly disproportionate cost" test in the development of BPT effluent discharge guidelines, the courts have held, among other things, that cost is not to be considered a factor of "primary" or "paramount" importance, that this assessment "is a relatively subsidiary task and need not be precise," and that an "overall" assessment is sufficient.

In order to inform the best possible decision, and in light of the complexity of the issues involved and the range of discretion left to the Agency under CWA § 316(b), EPA has considered the cost of the BTA options and the significance of their environmental benefits from a number of perspectives.

[69] Since the intake structure for Units 1, 2 and 3 will not be used under the Closed-Cycle Entire Station option – only the Unit 4 intake will be used – there is no need to implement the screening and fish return system upgrades discussed above for the Units 1, 2 and 3 intake (e.g., improved fish buckets, low pressure spray wash). The Unit 4 intake structure already has these components.

7.7.4a Significance of Environmental Improvements from BTA Upgrades at BPS

EPA has determined that cooling water intake structure capacity limitations based on the Closed-Cycle Entire Station option are necessary to reflect the Best Technology Available for minimizing adverse environmental impacts. Among the practicable options that were considered, the Closed-Cycle Entire Station option achieves the greatest reduction in the number of individual organisms entrained and impinged by the BPS intakes. It also achieves the greatest reduction in the percentages of fish species populations lost to entrainment and impingement. Moreover, EPA has concluded that the major flow reductions associated with this option are needed to allow the Mount Hope Bay fishery to recover. EPA believes that the Closed-Cycle Entire Station option would not only greatly reduce adverse environmental impacts but it would remove the BPS cooling water intake structures as a major impediment to the recovery of the Mount Hope Bay fishery. (Other steps are also necessary, such as achieving major reductions in thermal discharges and, for the present time, continued fishing restrictions.) Although this option would not eliminate all adverse impacts, EPA believes that the remaining adverse effects would be insubstantial and that permit requirements based on this option would reflect the BTA for "minimizing" adverse environmental impacts as required by CWA § 316(b).[70]

The Closed-Cycle Entire Station option also has the major "secondary" benefit of achieving large reductions in thermal discharges. These reductions should restore most of Mount Hope Bay to temperatures consistent with suitable habitat for the balanced indigenous community of aquatic life that should reside in the Bay. This will also be an important part of restoring the ecosystem to health.

Based on a qualitative evaluation, the environmental improvements to be obtained from the Closed-Cycle Entire Station option are exceptionally significant and valuable. As discussed in more detail above, restoring the Mount Hope Bay fishery is an extremely important public goal for a number of reasons. It is consistent with the federal Clean Water Act's goal of restoring and maintaining the biological, physical and chemical integrity of the Nation's waters and rendering those waters suitable for the protection and propagation of fish and providing for recreation in and on the water. It is also necessary to achieve the designated uses and satisfy water quality criteria assigned to Mount Hope Bay and its tributaries by both the Commonwealth of Massachusetts and the State of Rhode Island.

In addition, the Mount Hope Bay estuary is an important component of the greater Narragansett Bay estuary. The Narragansett Bay estuary is a federally designated estuary of national environmental

[70] EPA has also concluded that flow reductions from the permittee's Enhanced Multi-Mode proposal would be insufficient to minimize adverse impacts. Continued adverse effects from this option would be severe and would continue to prevent or inhibit a recovery of the Mount Hope Bay fishery.

significance under the National Estuary Program, and the Mount Hope Bay estuary should provide a productive nursery area for fish and other organisms. Moreover, the waters of the bay are designated Essential Fish Habitat for several species managed under the Magnuson-Stevens Act.

Nevertheless, due to depleted fish stocks in Mount Hope Bay, Massachusetts and Rhode Island have had to severely restrict or prohibit both commercial and recreational fishing in Mount Hope Bay. This has impacted people's livelihoods and recreational opportunities and deprived the public of the beneficial use of the bay's natural resources. This has no doubt caused people to have to travel further for fishing opportunities or pursue other forms of recreation. In addition, the City of Fall River has been required to undertake a $150 million dollar combined sewer overflow program, as well as sewage treatment plant improvements, in order to improve water quality and meet applicable requirements. Thus, the ecosystem of the Mount Hope Bay estuary is extremely important and the public has made significant, expensive sacrifices to improve the condition of the bay.

Meanwhile, the BPS cooling water intake structures annually kill trillions of organisms, including billions of fish eggs, fish larvae, and juvenile and adult fish. The intakes remove these organisms from the food web. Operation of the BPS cooling water intake structures has contributed to the collapse of Mount Hope Bay's fishery and helped to prevent or inhibit its recovery. Marine organisms are being killed by the BPS cooling water intakes as a byproduct of making electricity. This is not a beneficial use of these organisms.

These adverse effects from the plant's intake structures are avoidable. Installation of well-established, practicable cooling technologies at BPS can dramatically reduce these impacts, thus meeting the CWA § 316(b) standard of minimizing adverse environmental effects and facilitating the recovery of the Mount Hope Bay ecosystem. From a qualitative standpoint, these improvements are extremely valuable.

While a cost/benefit analysis is not required by CWA § 316(b), EPA also attempted to evaluate the benefits of improvements at BPS from a monetary perspective in order to provide additional information to consider in applying the wholly disproportionate cost test. Any such effort to monetize the value of environmental quality or natural resources will unavoidably suffer from significant weaknesses due to our present inability to fully and accurately quantify all the benefits flowing from ecological services, such as those that would be provided by a healthy ecosystem and fishery in Mount Hope Bay. As discussed above, recognition of this limitation is one of the reasons that Congress has not required application of cost/benefit analysis in determining requirements under a number of environmental statutes, just as it did not for CWA § 316(b).

One of the most difficult challenges is to try to estimate as fully and accurately as possible the non-use value to the public of such environmental resources. One method for determining non-use values for particular environmental resources is to conduct a site-specific "contingent valuation" study. However, designing and completing these studies can be extremely time-consuming and expensive. Despite their cost in time and money, the results of contingent valuation studies can still be controversial. EPA had neither the time nor budget to undertake such an analysis in connection with this NPDES permit. Moreover, such expenditures for a contingent valuation study would be especially hard to justify when a cost/benefit analysis is not actually required.

Due to the above issues, EPA implemented several different approaches to estimating the value of the resources in question and developing relevant information for Agency consideration. Each of these analyses is discussed in detail in prior sections of this document. First, EPA undertook a "benefits transfer" analysis to estimate the use benefits of reduced impingement and entrainment losses at BPS. This somewhat conventional approach had several limitations, including that it was only able to account for the benefits of a small fraction of the fish that would be preserved by the technological improvements in question. Furthermore, this analysis also included only a crude estimate of the non-use value of the fish that could be saved. This estimate was based on the application of a "quick and dirty" "rule of thumb" to estimate aggregate non-use benefits in relation to recreational use benefits. For this analysis, EPA used the rule of thumb because it was preferable to ignoring non-use values entirely. Still, EPA believes that this rule of thumb approach does not reasonably capture the non-use value of the resources in question – at least in cases involving especially significant natural resources such as those within the Mount Hope Bay and Narragansett Bay estuarine ecosystem. As a result of these issues, and others, EPA concludes that use and non-use benefits from the "benefits transfer" analysis are likely to substantially underestimate the value of the resources in question. (See Table 7.7-1 below.)

Second, in order to try to develop a more comprehensive and accurate estimate of the non-use value of the fishery resources at issue, EPA undertook an analysis based on developing a ratio of per-person recreational use value to non-use value. (See Table 7.7-1 below.) Although this analysis is not a site-specific contingent valuation study, EPA undertook a conservative analysis to review the likely reasonableness of the estimated values developed from the "per-person, non-use to recreational use benefit" ratio. This analysis developed annual benefit values on the basis of relatively simple and conservative assumptions about the potential population of households likely to value improvements to the affected aquatic resources and the potential annual benefit values per household. The resulting annual values fell in a range extending from a few million to over one hundred million dollars per year. (See Table 7.6-3, above.) The values reported above for the "per-person, non-use to recreational use benefit" ratio method fall very much within this range. Therefore, these results provide support for the reasonableness and credibility of the per-person results. On balance, EPA concludes that the values estimated from the "per-person, non-use to use benefit" ratio are reasonable and credible and provide realistic, meaningful insight into the potential benefits of reduced intake flow at BPS and accompanying improvement in aquatic resources in Mount Hope Bay.

Third, EPA conducted a Habitat Replacement Cost (HRC) analysis using a method adapted from natural resource damages evaluations. The HRC analysis does not directly estimate the value of the natural resources in question. Rather, it calculates the cost of habitat restoration measures sufficient to replace the fish lost from the Mount Hope Bay estuary to the BPS intake structures. (See Table 7.7-1 below.) For a variety of reasons, the HRC estimates are likely to underestimate the true costs of restoring the fish to Mount Hope Bay. Furthermore, undertaking such restoration efforts would clearly be futile as long as the BPS intakes continue to kill huge numbers of organisms from the bay and the BPS thermal discharge continues to render large areas of habitat unsuitable for various fish species.

Nevertheless, the HRC data is of significant interest for two reasons: (1) it provides an estimate of what it would cost society to try to restore the lost fish that can be compared to estimates of what it would cost the power plant to upgrade cooling system technology in order to avoid taking the fish in the first place;[71] and (2) there is some (albeit limited) information from cases in which both a total value analysis and an HRC analysis was conducted that suggests that the HRC values are likely to be lower than the total value results. The second point suggests that an HRC analysis – if used as a substitute for a total value analysis – would be unlikely to yield a figure greater than a total value estimate. Because the HRC approach may be cheaper and quicker to implement than a total value analysis, this suggests that the HRC method could provide a useful alternative analytical method that would provide "supply-side" numbers that would be unlikely to exceed the results of a "demand-side" total value analysis. In other words, the HRC analysis would be likely to produce conservative figures. This conclusion tends to be supported by a comparison of the above-discussed per-person non-use value estimates and the HRC figures. The latter are, indeed, lower than the former.

The above analyses have produced a wide range of figures.[72] The figures presented in Table 7.7-1 below represent particular estimates of particular components of the value of, or cost of restoring, the fish that would be saved as a result of the approximately 96% flow reductions that would accompany the Closed-Cycle Entire Station option. It is important to remember that none of these estimates include any value for the "secondary" benefit that these cooling water intake improvements would have in terms of greatly reducing thermal discharges, which will also be important for restoring habitat quality in Mount Hope Bay. (This benefit is "secondary" only in the sense that thermal discharges are not the primary focus of CWA § 316(b)).

Table 7.7-1: Natural Resource Value and Restoration Cost Estimates Associated with the Closed-Cycle Entire Station Option (all figures in Year 2002$)

[71] Obviously, from an ecological and public policy perspective, it generally makes more sense to avoid the harm in the first place than to commit the harm and then hope that natural resource restoration projects will be sufficient to offset that harm, given that the success of such restoration projects is always uncertain.

[72] It should also be noted that USGenNE has conducted an analysis that appears to have resulted in figures even lower than the benefits transfer figures. (USGenNE reported the results of its analysis but did not submit the analysis itself.) This analysis appears not to have looked at non-use values.

Technology	% Flow Reduction	Benefits Transfer (Use and Non-Use Value)	Per-Person Non-Use Value (New England)	Per-Person Non-Use Value (National)	HRC
Closed-Cycle Entire Station:	96%	$240,853/yr.	$36.4 million/yr.	$119.5 million/yr.	$28.9 million/yr.

7.7.4b Expense to USGenNE of Improvements

Both EPA and USGenNE prepared detailed estimates of the potential expense to the company associated with implementing various technological options at BPS. Despite the parties' efforts to narrow areas of disagreement, our respective cost estimates vary considerably. Nevertheless, EPA believes our cost estimates are reasonable and appropriate.

EPA's cost estimates are reasonably conservative and based on sound, careful evaluation. Our cost analyses were conducted in conjunction with expert consultants. Capital costs represent the largest source of variation in the estimates by EPA and the permittee. Yet, EPA conducted two different, independent analyses to develop capital cost estimates and both yielded similar and substantially lower figures than those estimated by USGenNE. To be conservative, EPA used the higher of our two independent capital cost estimates in our subsequent analyses. Apart from capital costs, there were also other areas of difference between the cost estimates of EPA and the company. These include areas such as the extent of cooling tower energy efficiency penalties, the extent of generating unit outages for cooling tower construction, and the discount rates used in the calculations. Again, EPA believes its analyses are reasonable and appropriate. These factors are discussed in more detail earlier in this document. In the table below, we have set forth certain relevant figures from EPA's and USGenNE's respective analyses related to the Closed-Cycle Entire Station option. This table is excerpted from Table 7.4-6 above.

Table 7.7-2: Comparison of Selected USGenNE and EPA/Abt Cost Scenarios

Technology Option	USGenNE 15% Discount Rate Figures (with calculation errors corrected by Abt) (over 20 years)[1]	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 20 years)	EPA/Abt Figures (using 11.8 Discount Rate and other independent values) (over 30 years)
Closed-Cycle Entire Station			
0% plume abatement[2]			
Total After-Tax Cash Flow Cost, Present Value:	Not Calculated	$68.385 Million	$67.975 Million
Annual Equivalent Cost:	Not Calculated	$9.041 Million	$8.314 Million
100% plume abatement[3]			
Total After-Tax Cash Flow Cost, Present Value:	$254.485 Million	$83.269 Million	$85.803 Million
Annual Equivalent Cost:	$40.657 Million	$11.009 Million	$10.494 Million

[1] The USGenNE figures for the Closed-Cycle Entire Station option reflect the permittee's capital costs and its assumptions for generating unit outages for water vapor plume abatement.

[2] The Abt/EPA "0% plume abatement" figures reflect no generating unit outages for plume abatement, but do reflect the SAIC-estimated capital costs that were increased to reflect piping and pumping costs to allow the cooling towers to function in multi-mode fashion so that they could be bypassed if necessary to avoid generating unit outages for plume abatement.

[3] The Abt/EPA "100% plume abatement" numbers reflect calculations including 100% of the plume abatement effect predicted by the permittee. However, these figures also reflect SAIC's capital cost estimates without the upward adjustment to equip the cooling towers for potential multi-mode/bypass functioning.

Assuming a twenty-year equipment life, USGenNE estimated the Total After-Tax Cash Flow Cost, Present Value costs for the Closed-Cycle Entire Station option to be approximately $254 million, with an equivalent annual cost of approximately $41 million. However, also assuming a twenty-year equipment life, EPA estimated the Total After-Tax Cash Flow Cost, Present Value costs for the Closed-Cycle Entire Station option, assuming no plume abatement outages and increased capital costs to allow for bypass capability of the cooling towers, to be approximately $68 million, with an annual equivalent cost of approximately $9 million. Assuming a thirty-year equipment life, which EPA believes is more likely, the total costs are still approximately $68 million, but the equivalent annual cost drops to $8 million.

Based on the information available to us to date, EPA concludes that the cost of implementing the Closed-Cycle Entire Station option at BPS is economically practicable for the permittee. We believe this to be the case whether one considers the EPA costs with the zero percent or the 100 percent plume abatement economic effects scenario (and we believe the zero percent scenario is more likely). See May 20, 2002, Memorandum from Michael Fisher and Geoff Bennett, Abt Associates, Inc., to Mark Stein and Dave Webster, US EPA Region 1, "Subject: Financial Impact of Closed Cycle System Installation at Brayton Point Station - WITH CONFIDENTIAL BUSINESS INFORMATION EXCLUDED FROM TEXT AND TABLES." We also believe it to be the case even if one considers the permittee's costs estimates. Indeed, the permittee has not presented a financial impracticability argument to the regulatory agencies.

Nevertheless, EPA understands that the expenditures contemplated are significant and will cut into the permittee's profits. See Id. at pp. 2, 7. These cooling intake improvements are necessary, however, to protect the public's natural resources adequately under applicable law. Moreover, Brayton Point Station has long been a very profitable plant and will remain so after the improvements are installed. Id.[73]

7.7.4c Cost to Society of Undertaking Improvements at BPS

The above cost estimates were developed from the perspective of the power plant's owner, USGenNE. These estimates consider the cost *to the company* in terms of the estimated change in after-tax cash flow that would result from implementing a particular technology. Cash flows were presented in nominal dollars (i.e., without removing the expected effects of inflation) and were discounted to present value on the basis of an estimated weighted-average, after-tax, cost-of-capital for the company.

In applying the wholly disproportionate cost test, however, it is also appropriate to consider costs *from the perspective of society* (i.e., the "social costs"). To recast the costs of the Closed-Cycle Entire Station option within a social cost framework, EPA's consultant, Abt Associates, Inc. (Abt), reviewed the earlier cost analysis to determine how it should be modified to reflect social costs. See May 9, 2002, Memorandum from Michael Fisher, Geoff Bennett, Abt Associates, to Mark Stein, Dave Webster, "Subject: Social Cost Analysis of Closed Cycle System Installation at Brayton Point Station." For some cost elements (e.g., the capital cost of technology installation and annual maintenance costs), Abt concluded that the market prices estimated to be paid by the Company reasonably represent their "opportunity cost" to society. For other elements, however, a number of adjustments were needed to convert the private cost estimates to a social cost concept under which cost is measured in terms of opportunity costs to society. These adjustments included: (1) adjusting the value of Brayton Point

[73] Abt also concluded "on a very preliminary basis" that it would not expect the additional cost of air pollution controls to comply with recent Massachusetts regulations to "materially change the qualitative character of our findings." Id. at p. 2, n. 3.

Station production losses for construction outages, auxiliary energy requirements, and energy efficiency losses to reflect the electricity production cost of replacement generating capacity in the New England market, including provision for use of higher production cost capacity than would otherwise have been needed to meet electricity demand at the time of these production losses; (2) adjusting the cost savings from increased Brayton Point electricity production during high water temperature periods to reflect the electricity production cost of generating capacity that would be displaced by the increased availability of Brayton Point's generating units, including recognition that marginal generating unit production cost may be somewhat less than the market clearing price for electricity at the time of these increased production events; (3) elimination of tax considerations from the cost analysis; (4) use of an estimated real (i.e., with the effect of expected inflation removed) social discount rate of 7 percent instead of the estimated cost-of-capital to USGenNE for calculating present value and equivalent annual costs; and (5) conversion of all cost values to a 2002 constant dollar basis (i.e., estimates of costs that exclude the effect of expected inflation).

On the basis of these adjustments, the estimated present value of the social cost for the Closed-Cycle Entire Station option, considering EPA's cost estimate with no plume hazard abatement impact, is $119 million, assuming an equipment life of 20 years, and $122 million, assuming an equipment life of 30 years. These figures represent the present value of the costs calculated at mid-year 2002, at a discount rate of 7 percent, and in 2002 constant dollars. The corresponding equivalent annual costs for these values are $11.2 million and $9.8 million for the 20-year and 30-year equipment life cases, respectively. Assuming the full plume hazard abatement impact estimated by the permittee, the present value of the total cost increases to $157 million and $168 million for the 20-year and 30-year equipment life cases, respectively. The equivalent annual costs then increase to $14.9 million and $13.6 million, respectively, for the 20-year and 30-year equipment life cases. As noted in earlier discussions, EPA finds it unlikely that the plume-related generating unit outages predicted by USGenNE will be necessary. In addition, EPA also believes that the new equipment is more likely to have a 30-year useful life than the 20-year life proposed by the company. Accordingly, EPA believes the $9.8 million equivalent annual cost value is the more credible estimate of social cost for consideration. This figure is somewhat higher than the costs to the company estimated by EPA and presented in Table 7.7-2.

7.7.5 Additional Factors Considered

EPA has also considered certain other factors in applying the wholly disproportionate cost test. First, EPA investigated what effect the Closed-Cycle Entire Station option would have on consumer electric rates. "Impact of Thermal Discharge Management and Air Pollution Control Options for Brayton Point Station on New England Electricity Market and Consumer Rates" (Abt Associates, Inc., May 8, 2002). As a result of this analysis, EPA concludes that the effects will be relatively insignificant. The long-term rate effect to the typical 500 kWh per month consumer from increased production costs and slightly reduced generation as a result of the cooling system improvements is conservatively estimated to range from $0.03 per month to $0.13 per month. When possible BPS expenditures to comply with recent Massachusetts air pollution regulations are taken into account, the figures only rise to $0.09 to

$0.38 per month.

EPA also conservatively estimates that generating unit construction outages would likely result in a short-term rate effect of $4.70 spread over 36 weeks (i.e., approximately $0.52/month for just 9 months) for the typical 500 kWh per month consumer. This short-term effect is not altered as a result of likely BPS improvements to comply with the new Massachusetts air quality regulations. The analysis also indicates that even these figures are likely an overestimate.

In addition, EPA has considered whether the improvements at BPS would have any significant adverse effect on the Region's energy supply and, as discussed in more detail above, we have concluded that they will not. With these improvements, BPS can continue to generate approximately the same amount of electricity. Indeed, the new cooling technologies offer the benefit of enabling BPS to generate somewhat *more* electricity during hot weather peak demand periods when the Region's energy supply is most stretched. Of course, it is important to note that short-term generating unit outages are likely to be needed for cooling system construction. EPA estimates that these outages could extend approximately three months beyond the regularly scheduled one month annual maintenance outages for each unit. This short-term effect will only occur for one unit at a time, and EPA and the MA DEP expect to work with USGenNE to schedule construction so that any necessary outages avoid peak electricity demand periods. Also, the new cooling technology will have no effect on the Region's fuel diversity as it will not require any changes in BPS's current fuel mix. Thus, neither the Region's long-term nor short-term energy supply should be significantly affected by this permit decision.

Finally, while the cooling system improvements required to meet intake capacity limits reflecting the Closed-Cycle Entire Station option will clearly require significant expenditures by the permittee, it is also worth remembering that the owners of BPS have clearly reaped substantial economic benefit over the years from avoiding upgrading the once-through cooling system until this time. The once-through cooling system for Units 1, 2 and 3 was installed in the 1960's, prior to enactment of the Clean Water Act and the creation of EPA. Unit 4 was originally not permitted to operate in an open-cycle mode by the regulatory agencies due to concerns about the effects it might have on the Mount Hope Bay estuary, but the owners of the plant eventually convinced EPA and Massachusetts to authorize conversion to once-through cooling, which took place in 1984. We recognize that the BPS has not yet been required by the regulatory agencies to install closed-cycle cooling. However, it is worth noting, that EPA has estimated that (1) the benefit to the permittee of "delaying" the installation of the Closed-Cycle Entire Station option by one year from 2002 to 2003 is approximately $5.6 million; and (2) the benefit to the permittee of delaying the installation of the Closed-Cycle Entire Station for the four years from 1998 to 2002 is approximately $27.7 million (present value at mid-year 2002). May 14 2002, Memorandum from Michael Fisher, Abt Associates, Inc., to Mark Stein, EPA (Subject: Financial Benefit of Delayed Technology Implementation). If the analysis were run further back, the financial benefits to the owners of BPS would be even greater. EPA's biological analysis indicates that closed-cycle cooling should have been installed years ago and that BPS's open-cycle operations have significantly contributed to the collapse of the Mount Hope Bay fishery. The above economic analysis indicates that the owners of the power plant have profited significantly from being able to avoid that expenditure for many years.

EPA also observes that the plant's current owner, USGenNE, will almost certainly have prudently taken into account the expectation of capital outlays and additional operating expenses for cooling water system improvements as part of its due diligence for the acquisition of BPS. USGenNE acquired the plant in 1998 around the same time the current thermal discharge permit expired. This was also only shortly after major public controversy had erupted regarding the power plant's contribution to the collapse of the Mount Hope Bay fishery and subsequent negotiation of the MOA II. In addition, there had been a long history of controversy regarding BPS operations, including permits in the 1970's that included thermal discharge limits based on water quality standards and required Unit 4 to operate with closed-cycle cooling. Therefore, it is inconceivable to EPA that the permittee would not have factored an expectation of potentially significant capital outlays and additional operating expenses into the estimated value of the plant at the time of purchase and reduced the offered purchase price accordingly. In effect, USGenNE will likely have established a "reserve liability" against the value of the plant in the anticipation of needing to make cooling water system upgrades. In short, the possible need to upgrade the cooling system at substantial expense was foreseeable and the plant's owner will likely have planned for a substantial financial commitment on these matters.

7.7.6 Conclusions

Cooling water intake system capacity limitations of 56 MGD, with an additional 6,847 million gallons per year allowable for cooling tower by-pass, based on the Closed-Cycle Entire Station option, reflect the Best Technology Available for minimizing adverse environmental effects. In light of the above analysis, EPA concludes that the cost of the Closed-Cycle Entire Station option is not wholly disproportionate to the benefits it would produce. We believe this to be the case whether EPA's cost estimates (including the social cost estimate) or the permittee's cost estimates are considered, though we believe EPA's estimates are more reasonable and should be used.

EPA concludes that there will be great benefits from upgrading BPS's cooling system to utilize the well-established technology of mechanical draft wet cooling towers. Operation of the cooling water intake structure with the current open-cycle system has caused severe adverse environmental effects to the Mount Hope Bay estuary and, as a result, to the greater Narragansett Bay estuary of which it is a part. Severe adverse impacts are likely to remain from the options other than the Closed-Cycle Entire Station option. The Closed-Cycle Entire Station option, on the other hand, will dramatically reduce these adverse effects and give the fishery a chance to recover to a healthy state.

As discussed above in some detail, this will have major benefits in a qualitative sense. In addition, recognizing the uncertainties inherent in all the efforts to estimate the monetary value of the fishery resources that would be saved by the Closed-Cycle Entire Station option, EPA concludes that these estimates also indicate that there will be major benefits from this option. While one estimate (the benefits transfer analysis) produced an annual sum of approximately $240,853/yr. (Year 2002$), we have discussed how this estimate fails to account for a variety of important aspects of the total value of the resources and, therefore, must be regarded to be a significant underestimate. Meanwhile, another estimate of resource value (the "per-person recreational use/non-use analysis") yielded a "New England estimate" of approximately $36.4 million/yr. (Year 2002$) and "a national estimate" of approximately $119.5 million/yr. (Year 2002$). These estimates are likely to be more accurate than the "benefits transfer analysis" results because the per-person analysis yields a more refined estimate of non-use value. EPA also conducted a conservative analysis to test the likely reasonableness of these estimates and found the estimates to be reasonable.

The per-person results are also supported by the HRC results, which were approximately $28.9 million/yr. (Year 2002$). (As discussed above, there is some information suggesting that HRC numbers will tend to be lower than a total value analysis and this tends to be confirmed by the "reasonableness analysis" discussed above.) Moreover, the HRC results indicate it would cost society more than $28 million per year to implement ecologically sound restoration projects to restore the number of fish lost to BPS's cooling water intake structures, whereas the loss of these organisms could be prevented in the first place by implementing the Closed-Cycle Entire Station option at a lower or similar cost. And all of these estimates are likely to be underestimates because they are based on fishery data from 1974 - 1983, which does not reflect a healthy fishery unaffected by the plant, and because none of these estimates take into account any of the adverse effects of the BPS thermal discharge on the fishery. EPA also notes that making the proposed improvements at BPS would result in only a relatively small long-term increase in electric rates for the average household, with our conservative estimate placing the increase at between from $0.03 per month to $0.13 per month.

Finally, retrofitting BPS with the Closed-Cycle Entire Station option should not harm the Region's overall energy supply and offers some potential benefits during the peak hot weather demand periods. The option is affordable for the permittee and, although it will reduce the value of the plant, the facility should continue to make substantial profits for the owners.

In conclusion, cooling water intake capacity limits of 56 MGD based on the Closed-Cycle Entire Station option reflect the Best Technology Available for minimizing adverse environmental impacts. The option is technologically and economically practicable and its costs are not wholly disproportionate to its benefits. It is also a necessary step, in conjunction with other measures being taken, to allow the recovery of the ecosystem of the Mount Hope Bay estuary and its fishery. We are bolstered in our conclusion by the knowledge that both the Commonwealth of Massachusetts and the State of Rhode Island share our view.

8.0 Final Permit Requirements for Thermal Discharge and Cooling Water Intake

Each time the permit is reissued, EPA must revisit its latest determinations under Sections 316(a) and (b) of the Clean Water Act. CWA Section 316(a) allows for variance-based limitations for thermal discharges if certain conditions are met, while CWA Section 316(b) governs cooling water intake requirements.

EPA's determinations and supporting evaluations for setting thermal discharge and cooling water intake structure limits under CWA Sections 301, 316(a) and (b) for the Brayton Point Station NPDES permit are contained in this document. This document includes the biological, engineering, economic, legal and policy analyses upon which EPA's final determinations are based. A brief summary of the conclusions and the resulting permit limitations are presented below.

It should be noted here that the existing permit contained narrative thermal conditions (see Part I.A.1.g of existing permit) that have been deleted from the draft permit. EPA believes that the removal of these narrative conditions is warranted because the proposed numerical draft permit conditions for heat and flow are sufficiently stringent to ensure that the previously contained narrative statements will not be violated. These narrative conditions were included in the prior permit due to unavoidable uncertainty regarding whether the numeric permit conditions would prove sufficient to satisfy the biological standards set forth in the narrative conditions. In other words, the narrative standards provided "backstop" permit conditions to ensure that the biological goals would be met. For the current permit, EPA is more confident that the new numeric permit conditions will meet the appropriate biological goals and, therefore, the narrative, backstop conditions are no longer needed.

8.1 Thermal Discharge Effluent Limitations: Technology-Based, Water Quality-Based, and Section 316(a) Variance-Based Limitations

In developing effluent limitations, EPA is to determine technology-based and water quality-based requirements, and whichever is more stringent governs the permit requirements. For thermal discharges, however, EPA may also consider granting a variance under Section 316(a) from either or both the technology-based and water quality-based effluent limitations if less stringent variance-based limitations will nevertheless be sufficient to "assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife" (BIP) in and on the water body receiving the discharge. As a practical matter, EPA has with some permits simply jumped to developing permit limitations under a Section 316(a) variance if a set of limitations were determined to be sufficient assure protection and propagation of the BIP. In such cases, determining the technology-based and water quality-based limitations would serve no practical purpose. Similarly, in some cases, EPA has determined water quality-based conditions without determining the technology-based requirements, when we had reason to believe that it was clear that the water quality-based requirements would be more stringent than the technology-based standards.

In this case, however, it was not clear to EPA which CWA requirements would drive the thermal discharge standards. Therefore, we have endeavored to determine technology-based limits and water quality-based limits, as well as to determine whether alternative limitations based on a CWA Section 316(a) variance would be warranted. The permittee has requested a variance pursuant to Section 316(a) and has proposed specific thermal discharge limitations that would apply under such a variance.

8.1.1 Technology-Based Limits

EPA has developed Best Available Technology Economically Achievable (BAT) thermal discharge limitations for BPS on a case-by-case basis using Best Professional Judgment (BPJ) pursuant to CWA § 402(a)(1), 33 U.S.C. 1342(a)(1), and 40 C.F.R. 125.3. This is because BAT requirements apply to thermal discharges and there is presently no applicable National Effluent Guideline for thermal discharges from steam electric facilities. For BPS, EPA has determined that thermal discharges consistent with closed-cycle cooling using mechanical draft cooling towers for Units 1, 2, 3 and 4 at BPS are required to satisfy the BAT requirements of the CWA. Some thermal discharge is still necessary to accommodate blowdown requirements. Therefore, EPA has set the following performance standard limitation based on this technology (including blowdown requirements):

Yearly Heat Load Discharged to Mount Hope Bay: 0.8 Trillion British Thermal Units

Daily Maximum Temperature: 85 °F

8.1.2 Water-Quality Based Limits

The Commonwealth of Massachusetts has developed water-quality based limits based on a mixing zone designed to protect the designated uses of the Massachusetts portions of Mount Hope Bay and satisfy other aspects of the Commonwealth's water quality standards (including its mixing zone requirements). The resulting thermal limits from this mixing zone are:

Maximum Allowable Average Temperature(s) at Benthic Monitoring Locations within the Bay: 5 °C from February 12 - April 23, and 24 °C at all other times

Maintain Zone of Passage in the Lee River during Fish Migration Periods

No Discharge as needed to Allow for the Normal Migration of Striped Bass

At times, depending on background conditions, the mixing zone would allow only minimal or no discharge; at other times, however, the mixing zone would allow a discharge and for those times the mixing zone provides the following thermal discharge maximum limits to "cap" the allowed *discharges:*

Monthly Maximum Heat Load to Mount Hope Bay: 1.2 Trillion BTUs per year

The submission of a nuisance species monitoring and prevention plan within 90 days of a final permit.

8.1.3 Thermal Discharge Limits Under Section 316(a) of the CWA

BPS has submitted a variance request which included legal, biological, financial, and technical information. EPA has reviewed this information, as well as other available information, and has determined that thermal discharge limits sufficient to allow for the protection and propagation of the BIP are as follows:

Yearly Heat Load to Mount Hope Bay: 1.7 Trillion British Thermal Units

Maximum Discharge Temperature: 95º F

The above variance-based thermal discharge limitation being proposed for the new BPS permit is somewhat less stringent than the technology-based limits and it is likely to be less stringent than the water quality-based thermal discharge limits as well. EPA has determined that the technology-based and, most likely, the water-quality based thermal limits are both more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on Mount Hope Bay. At the same time, however, EPA has also determined that the specific variance-based limits proposed by the permittee are not sufficient to assure the protection and propagation of the BIP. Therefore, although EPA is denying the specific variance-based limits proposed by the permittee, EPA is, nevertheless, granting a variance pursuant to Section 316(a) of the CWA from both the technology-based and water quality-based limits and is imposing alternative thermal effluent limits on BPS that will be sufficient to assure the protection and propagation of the balanced indigenous community of shellfish, fish, and wildlife in and on Mount Hope Bay. These variance-based limits are significantly more stringent than the limitations proposed by the permittee in its variance application.

Specifically, as indicated above, the permittee shall be required to meet a yearly heat load not to exceed 1.7 Trillion British Thermal Units. This heat load is somewhat higher than the above referenced technology-based limit of 0.8 TBTU/year. This 0.9 TBTU increase over entire station closed-cycle may allow some switching to once-through cooling, should conditions such as potential icing and/or fogging warrant it. EPA has calculated, based on a maximum station heat load of 7360 MBTU/hr (combined condenser duty of all 4 units operating), that the facility may operate approximately 122 hours per year in the once-through mode while meeting the proposed thermal limits. See below:

$$(0.16 \text{ x } 10^{12} \text{ BTU/yr})/(7.36 \text{ X } 10^{9} \text{ BTU/hr}) = 122 \text{ hr/yr}$$

8.2 316(b), Cooling Water Intake Structures

CWA § 316(b) governs requirements related to cooling water intake structures (CWISs) and requires "that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." EPA recently promulgated new, final § 316(b) regulations providing specific technology standard requirements for *new* power plants and other types of *new* facilities with CWISs. 66 Fed. Reg. 65255 (Dec. 18, 2001) (effective date of the regulations is January 17, 2002). These regulations do not, however, apply to *existing* facilities such as BPS. EPA has also issued proposed §316(b) regulations for existing power plants with flows of 50 million gallons per day or more (so-called "Phase II" facilities), such as BPS, but these regulations are not yet final. These proposed regulations are currently undergoing public review and comment, are subject to change, and are not to be applied to permits currently under development for existing plants. 67 Fed. Reg. 17122 (April 9, 2002). As a result, EPA continues the longstanding practice of applying § 316(b) on a case-by-case basis to existing facilities.

EPA has considered the nature and magnitude of the adverse environmental impacts from Brayton Point Station's CWIS (namely, the entrainment and impingement of marine organisms) and has evaluated the technological options available for minimizing these impacts. EPA has also considered the costs of implementing these technological options.

While EPA is not authorized to *directly* order the installation of cooling towers, CWA § 316(b) does authorize EPA to impose a intake capacity (or flow) limit based on the permittee's ability to meet that limit using the best technologies available, such as, for example, cooling towers. Such a technology-based limit imposes a performance standard for CWIS capacity (or flow) which the permittee should be capable of meeting using a particular technology but is permitted to meet in any manner it chooses.

EPA has determined that operation of BPS's cooling water intake structures is causing severe adverse environmental impacts and that minimizing these impacts requires cooling water intake flow or capacity to be greatly reduced. EPA investigated a wide range of technology options and has determined that there is a practicable method of reducing cooling water flows by approximately ninety-five percent without substantially reducing the amount of electricity that BPS can generate. Specifically, this method is to retrofit mechanical draft closed-cycle cooling towers for the four major generating units at the power plant to replace the current open-cycle cooling system. EPA has concluded that without a change of this magnitude the fishery of Mount Hope Bay is unlikely to recover to a healthy state, but that with this change it has a good chance of doing so. While this technology will clearly be expensive for the permittee to implement, EPA has also determined that the costs of this option are not wholly disproportionate to its benefits. Therefore, EPA is imposing a capacity (flow) requirement consistent with this technology. The draft permit limits the withdrawal of water from Mount Hope Bay to 56 Million Gallons per Day (for cooling tower makeup water). The resulting discharge from outfall 001 is 39 Million Gallons per Day (cooling tower blowdown plus wastewater treatment plant flow, with the balance lost to evaporation).

As with the thermal limit above, EPA has determined that allowing approximately 122 hours per year of operation in the once-through mode will not increase the facilities entrainment and impingement losses to a significant degree. Therefore, the draft permit allows an additional 6,847 million gallons of water withdrawal per year to allow the station to operate in the once-through mode. See below:

Once-through flow = 1347 million gallons/day x 1 day/24 hours = 56.125 million gallons per hour
122 hours/year of once-through flow allowed to meet thermal limit, so
Annual increase = 56.125 million gallons/hr x 122 hr/yr = 6847 million gallons per year

This translates into approximately 5 days of operation in the once-through cooling mode, although EPA does not expect that the facility will actually need to switch to once-through cooling.

It should be clear that it will take a significant amount of time to implement this technology option. EPA and Massachusetts will work with the permittee to agree upon an enforceable, expeditious schedule for putting the technology in place taking into account site constraints, regional energy needs, and other factors.