6.0 CWA § 316(a) - Determination In Response to USGenNE's Variance Application

6.1 Introduction

This section of the NPDES permit development package for BPS presents EPA's determination in response to USGenNE's application for alternative thermal discharge limitations under CWA § 316(a) (commonly referred to as "a § 316(a) variance application").

As discussed in the Permitting History section of this document, the thermal discharge limits included in the original October 1973 NPDES permit for BPS were based on Massachusetts Water Quality Standards rather than a § 316(a) variance. This permit included a maximum temperature limitation of 90° F and a Δ-T limitation of 20° F. The permittee subsequently sought relaxation of those limitations under a § 316(a) variance. The record shows this request to have been extremely controversial. The permit's maximum temperature and Δ-T limits were alternately raised and then returned to the original limits in a series of permit modifications and agreements over the years from 1976 to 1979.[1]

In 1979, a new permit was issued by EPA and MA DEP on the basis of a CWA § 316(a) variance. This permit raised the maximum temperature and Δ-T limits to 95° F and 22° F, respectively. These limits remain in place in the current permit with certain conditions. See EPA Fact Sheet for BPS Draft NPDES Permit No. MA003654 (June 11, 1993), p. 11. In 1982, although the maximum temperature and Δ-T limits of 95° F and 22° F remained constant, BPS was nevertheless effectively authorized to discharge more heat (in BTUs) to Mount Hope Bay when another permit change allowed the plant to discharge an increased volume of cooling water flow due to the conversion of Unit 4 from closed-cycle to open-cycle cooling.

As required by applicable regulations, the permittee applied for permit reissuance on January 15, 1998, at least 6 months prior to the existing permit's expiration date of July 16, 1998. The permittee did not, however, indicate in its application that it was requesting a renewal of its CWA § 316(a) variance and did not submit a § 316(a) variance demonstration. Instead, the permittee indicated to the regulatory agencies that it was seeking a permit based on water quality standards, including limits based on approval of a mixing zone. See June 19, 2001, Letter from David Webster (EPA) to Meredith Simas (USGenNE); January 15, 1998, Letter from Andrew H.

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[1] See, e.g., October 30, 1996, Fax from NEPCO to EPA ("Chronology of Brayton Point Station Operations" and "Circulating Water (S/N 001) - Permit Limitations"); NPDES Permit No. MA0003654, Modification No. 3, Issued to NEPCO for BPS (July 21, 1976); July 26, 1977, Letter from Charles Corkin II, Massachusetts Office of the Attorney General, to John Scanlon, Save the Bay (attaching "Agreement for Judgment" to be entered in Suffolk County Superior Court between NEPCO, the Commonwealth, EPA, Save the Bay, and Ecology Action for Rhode Island).

Aitken, Vice President, NEPCO, to Jane Downing, EPA, and David Johnston, MA DEP, p. 3. The regulatory agencies and the permittee proceeded on that basis in their efforts to develop appropriate permit limitations for BPS.

Early in 2001, however, USGenNE indicated to the regulatory agencies that it intended to seek a CWA § 316(a) variance after all. See June 19, 2001, Letter from David Webster (EPA) to Meredith Simas (USGenNE). The permittee then submitted its "Variance Request Application and Partial Demonstration Under the Clean Water Act, Section 316(a) and (b)" dated May 24, 2001 (emphasis added) (hereinafter, the "May 24 2001, USGenNE Partial 316(a) and (b) Demonstration"). See also June 19, 2001, Letter from David Webster (EPA) to Meredith Simas (USGenNE). Then on December 7, 2001, USGenNE finally submitted its full variance application 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.

EPA has also considered material submitted by the permittee subsequent to the December 2001 submission, but we note that on July 3, 2002, the permittee submitted three new papers presenting biological analyses by its hired contractors.[2] As a result of the very late date of this 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.

6.2 Legal Requirements and Context

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[2] The papers submitted by the permittee on July 3, 2002, are as follows: Hilborn, Ray and Andre Punt, "Analysis of Brayton Point Station's Impact on the Mt. Hope Bay Population of Winter Flounder" (June 29, 2002); DeAlteris, Joseph, "Trends in the Abundance of Five Fish Species in Mount Hope Bay: A Response to M. Gibson's Assessment of the Effect of Brayton Point Station on Fish Stocks in Mount Hope Bay" (July 1, 2002); and Hilborn, Ray and Andre Punt, "Calculation of Power Plant Impact on the Winter Flounder Population in Mt. Hope Bay Using Survey Data" (July 2, 2002).

6.2.1 CWA § 316(a)

NPDES permits generally must include the more stringent of any effluent limitations derived from technology-based and/or water quality-based requirements. CWA § 316(a) provides, however, that the regulatory agencies may put alternative, less stringent thermal discharge limitations in an NPDES permit if certain criteria are met. Specifically, CWA § 316(a) provides, in pertinent part, as follows:

> [w]ith respect to any point source otherwise subject to the provisions of section . . . [301 or section 306 of the CWA], whenever the owner or operator of any such source, after opportunity for public hearing, can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State) that any effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the pro[t]ection and propagation of a balanced indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made, the Administrator (or, if appropriate, the State) may impose an effluent limitation under such sections for such plant, with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water.

33 U.S.C. § 1326(a). See also 40 C.F.R. § 125.70. A determination to approve alternative limitations under this statutory provision is commonly referred to as a "CWA § 316(a) variance." See 40 C.F.R. § 125.71(a) and 125.72 (heading).

6.2.2 Criteria for Assessing § 316(a) Variance Applications

CWA § 316(a) authorizes alternative thermal discharge limits when it is demonstrated to EPA that the limits "will assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on that body of water" (sometimes referred to herein as the "BIP"). This criterion is reiterated in EPA regulations promulgated at 40 C.F.R. § 125.73(a).

The terms "protection" and "propagation" are not defined in the statute or regulations. However, the American Heritage Dictionary (2d College Ed. 1982) defines "protection," in pertinent part, as "[t]he act of protecting . . . [or t]he condition of being protected," while it defines "protect" as "[t]o keep from harm, attack, or injury; guard." In addition, it defines "propagation" as the "[i]ncrease or spread, as by natural reproduction." Thus, thermal discharge limits based on a CWA § 316(a) variance must "assure" that the receiving water's BIP will be safe from harm or injury from the thermal discharge, and that the thermal discharge will not interfere with the BIP's ability to increase or spread naturally within the receiving water.

The CWA also does not define the term "balanced indigenous population." Some clarification of Congress' intent is provided, however, in the CWA's legislative history. The Report of the Conference Committee on S. 2770, the bill that was enacted as the Clean Water Act of 1972 and originated the current § 316(a), stated the following:

> THERMAL DISCHARGES [Section 316]
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> * * *
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> It is not the intent of this provision to permit modification of effluent limits required pursuant to Section 301 or Section 306 where existing or past pollution has eliminated or altered what would otherwise be an indigenous fish, shellfish and wildlife population. The owner or operator must show, to the satisfaction of the Administrator, that a "balanced indigenous population of fish, shellfish and wildlife" could exist even with a modified 301 or 306 effluent limit. Additionally, such owner or operator would have to show that elements of the aquatic ecosystems which are essential to support a "balanced indigenous population of fish, shellfish and wildlife" would be protected.

Congressional Research Service, "*A Legislative History of the Water Pollution Control Act Amendments of 1972, Vol. 1,*" 93d Cong., 1st Session, p. 175 (cited hereinafter as the "1972 Legislative History") (Senate Consideration of the Report of the Conference Committee (October 4, 1972)). See also December 27, 1977, Letter from EPA Region 1 Regional Administrator William R. Adams, Jr., to Edward A. Plumley, Vice President, NEPCO, p. 2 ("the indigenous community is . . . the community that would exist absent man-induced environmental changes."). This indicates that Congress did not intend that a thermal discharger would be able to "take advantage" of prior pollution-induced harm that eliminated the BIP to justify alternative thermal discharge limitations under § 316(a) that would themselves be insufficient to protect the BIP. It also makes clear that Congress intended that elements of the aquatic ecosystem necessary to support the protection and propagation of the BIP would also be protected under § 316(a).[3]

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[3] In the legislative history of the 1977 CWA Amendments, Senator Muskie also discussed the meaning of the phrase "balanced indigenous population of fish, shellfish and wildlife" as used in the "interim [national] water quality standard." He explained that:

Consistent with Congressional intent, EPA regulations define “balanced indigenous population” in the following manner:

> The term *balanced indigenous community* is synonymous with the term *balanced, indigenous population* in the Act and means a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence or abundance is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the Act [i.e., technology standards]; and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a).

40 C.F.R.§ 125.71(c) (emphasis in original). It is clear under this definition that a satisfactory BIP

> As in 1972, it was intended that the interim water quality standard be that condition of aquatic life which existed in the absence of pollution. There is no question that man’s activities have radically altered receiving water ecosystems in this country and that alteration is continuing at an accelerated pace in many areas. Restoration of aquatic ecosystems which existed prior to the introduction of pollution from man’s activities is an important element of the restoration and maintenance of the biological, physical, and chemical integrity of receiving waters. It is an essential aspect of assuring that future generations will have an adequate supply of basic life support resources.
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> The concept of indigenous does not anticipate the removal of structures from waterways. It does not anticipate the existence of ecosystems which existed in the absence of those structures. But it does fully anticipate the analysis of aquatic populations in terms of man’s activities prior to, and subsequent to, pollution.

L. History 1977, p. 448.

under § 316(a) need not in all circumstances match some sort of estimated aboriginal assemblage of organisms. At the same time, however, the BIP must satisfy the listed indicia of an ecologically healthy community of organisms, including that it cannot be dominated by pollution tolerant species, or species whose presence or abundance is attributable to § 316(a)-variance based permit limitations, or include pollutant discharges that will be eliminated pursuant to technology-based effluent limitations under § 301(b)(2). See 44 Fed. Reg. 32894 (June 7, 1979) (Preamble to Revised 40 C.F.R. Part 125 Subpart H); see also 39 Fed. Reg. 36178 (October 8, 1974) (preamble to earlier version of EPA regulation containing substantially similar definition).

EPA provided further clarification regarding the meaning of BIP under § 316(a) in the case of In the Matter of: Public Service Company of Indiana, Inc., Wabash River Generating Station, 1979 EPA App. LEXIS 4, 1 E.A.D. 590 (November 29, 1979). In Wabash, EPA made clear that in assessing the BIP, EPA must look not only at the community as a whole but also at the effects on individual species of fish that should be part of that community. 1970 EPA App. LEXIS at 21 ("it is clear that both individual [species] and community considerations are relevant"). EPA explained that:

> . . . in attempting to judge whether the effects of a particular thermal discharge are causing the system to become imbalanced, it is necessary to focus on the magnitude of the changes in the community as a whole and in individual species; i.e., whether the changes are "appreciable."

Id. at 22. Finally, EPA also made clear that it is not acceptable that a particular discharge will allow the propagation of *some* community of fish with a certain degree of diversity and abundance; the thermal discharge limits must be sufficient to protect *the* BIP that ought to be present in the particular receiving water consistent with the regulations. As EPA explained:

> Section 316(a) must, like any other provision of the Act, be read in a manner which is consistent with the Act's general purposes. Consequently, § 316(a) cannot be read to mean that a balanced indigenous population is maintained where the species composition, for example, shifts from a riverine to a lake community or, as in this case, from thermally sensitive to thermally tolerant species. Such shifts are at war with the notion of "restoring" and "maintaining" the biological integrity of the Nations' waters. Thus, even though it may be difficult or even impossible to define what the precise balanced indigenous population would be in the absence of heat, it is generally sufficient, as the regulations provide, that it "will not include species whose presence or abundance is attributable to the

> introduction of pollutants," such as heat, and that it should be characterized by "non-domination of pollution tolerant species."

Wabash, id. at 28-29 (citation omitted).

Another step in applying CWA § 316(a) is to define "the body of water into which the discharge is to be made" and whose BIP is to be protected. Obviously, many water bodies connect to other water bodies –e.g., a river or bay flowing into the ocean– and a point of reference must be selected for analysis. Neither the statute nor regulations dictate how this should be done. EPA has made this determination on a case-by-case basis appropriately shaping the approach to the facts of each case. In different cases EPA has focused on discrete water bodies, water body segments, or even sub-areas within a water body segment, that may be influenced by the thermal discharge in question. In Appalachian Power Company v. Train, the court described (and upheld) EPA's reasoning as follows:

> EPA points out that state water quality standards typically apply to an entire waterway or a relatively large segment of it. By way of contrast, EPA views § 316(a) as providing for consideration of specific site conditions in the setting of thermal limitations for individual power plants. Thus, while a greater level of thermal effluent by a generating unit might well fall within the general requirements of an approved state standard, EPA takes the position that such discharges might nevertheless cause serious harm to a particular spawning ground, for example, located just below the plant's discharge point. It is such specific site conditions to which EPA contends § 316(a) is directed.

545 F.2d 1351, 1372 (4th Cir. 1976).[4] See also 39 Fed. Reg. 36177 (October 8, 1974). Accord In re Public Service Company of New Hampshire, 10 ERC 1257, 1265 (June 10, 1977) (Permit Appeal Decision by Administrator of EPA) (for a discharge into the North Atlantic Ocean, EPA stated that ". . . in order to give effect to Section 316 it is necessary to look at smaller portions of the coastal waters where human use or enjoyment of the marine resource may be affected"). This approach makes ecological sense and is consistent with the CWA's overall purpose of restoring and maintaining the chemical, physical and biological integrity of the Nation's waters.

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[4] It should be noted that in the situation described in the quotation a proposed discharge might satisfy numeric thermal water quality criteria but fail to satisfy § 316(a). In such a case, thermal discharge standards would need to be based on either technology standards or perhaps more stringent water quality-based limits necessary to protect designated uses.

The statute and regulations are also clear that in applying CWA § 316(a), the permitting agency must take account of the cumulative effects of other stresses to the BIP. First, CWA § 316(a) states that the permitting authority may impose variance-based thermal discharge limitations, "(taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population . . .." Second, EPA regulations promulgated at 40 C.F.R. § 125.73(a) (emphasis added) state that a discharger's request for a § 316(a) variance "must show that the alternative effluent limitations desired by the discharger, *considering the cumulative impact of its thermal discharge together with all other significant impacts on the species affected*, will assure the protection and propagation of" the BIP. See also 40 C.F.R. § 125.73(c)(1)(i). In the preamble to 40 C.F.R. Part 125 Subpart H, EPA stated:

> Several commenters argued that applicants should not be required to analyze cumulative effects of thermal discharges together with other sources of impact upon the affected species as required by proposed § 125.47 (now 125.72(a)). This issue was addressed in the Administrator's first *Seabrook* decision which concluded that analysis of cumulative effects is required.

44 Fed. Reg. 32894 (June 7, 1979).

In the *Seabrook* permit appeal decision referenced above, EPA's Administrator stated the following:

> The RA [(i.e., the Regional Administrator)] 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 be 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.

In re Public Service Company of New Hampshire, 10 ERC at 1261-62. Thus, discharge limits imposed under CWA § 316(a) must be sufficient to ensure the protection and propagation of the BIP, taking into account other environmental stresses on that population.

Another point worth mentioning here is that "mixing zones" may be used "as a mechanism for dealing with thermal discharges pursuant to section 316(a) of the Act." EPA Decision of the General Counsel, In re Sierra Pacific Power Company, EPA GCO 31 (October 13, 1975). Although a "mixing zone" is a permitting concept or tool generally used in applying State water quality standards, the legislative history of CWA § 316(a) indicates that Congress felt mixing zones could also be used in designing permit limitations based on a CWA § 316(a) variance from applicable technology standards. Id. This also makes common sense. Cf. January 15, 1998, Letter from Andrew H. Aitken, Vice President, NEPCO, to Jane Downing, EPA, and David Johnston, MA DEP, p. 3. Of course, to satisfy § 316(a), a mixing zone would need to be designed to ensure the protection and propagation of the BIP. See 39 Fed. Reg. 36178 (October 8, 1974) (Preamble to EPA's earlier § 316(a)-related regulations).

In applying CWA § 316(a), cost or economic issues are not a consideration. The plain language of § 316(a) makes clear that variance decisions are to be based on a determination of the limits needed to ensure the protection and propagation of the BIP. No mention is made of cost considerations being brought to bear. The legislative history also indicates that Congress did not intend costs to be considered in applying § 316(a). 1972 Legislative History, p. 175. Similarly, EPA's regulations clearly do not provide for costs to be a consideration in making a CWA § 316(a) variance determination. See 40 C.F.R. § 125.73. EPA has also interpreted CWA § 316(a) in this manner in practice. See In the Matter of: Public Service Company of Indiana, Inc., Wabash River Generating Station, 1979 EPA App. LEXIS 4,[*41] - [*43], 1 E.A.D. 590 (November 29, 1979). Thus, while costs are to be considered in developing technology-based standards for thermal discharges, which must be based on the Best Available Technology economically achievable (BAT) standard under CWA §§ 301(b)(2) and 304(b)(2), costs are not to be considered in determining whether to grant a variance from such limits under § 316(a).

6.2.3 "Burden of Proof," Level of Evidence Required, and Different Types of § 316(a) Demonstrations

The statute plainly places the "burden of proof" in justifying alternative thermal discharge limitations under a CWA § 316(a) variance on the permit applicant. The statute provides that the permitting authority may impose such alternative thermal discharge limits, "*whenever the owner or operator of any such source . . . can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State)* that any effluent limitation proposed [under CWA §§ 301 or 306] for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the pro[t]ection and propagation of" the BIP. 33 U.S.C. § 1326(a) (emphasis added). The legislative history underlying § 316(a) confirms the plain meaning of the statutory language. The Report of the Conference Committee on the Clean Water Act of 1972 stated the following, in pertinent part, with regard to § 316(a), "[u]nder the conference agreement thermal pollutants will be regulated as any other pollutant *unless an owner or operator can prove* that a modified thermal limit can be applied which will assure 'protection and propagation' of . . . [the BIP]." 1972 Legislative History, p. 175 (emphasis added).

EPA's regulations further confirm that the burden is on the permit applicant to persuade the permitting authority that the non-variance limits are more stringent than is needed and that an alternative set of limitations will be sufficient to protect the BIP. 40 C.F.R. § 125.73(a). Moreover, in the *Seabrook* permit appeal decision quoted above, EPA's Administrator also clearly stated that the burden of proof under § 316(a) lay with the permit applicant. In re Public Service Co. of New Hampshire, 10 ERC at 1261, 1263.

Moreover, it is also clear that "the burden of proof in a 316(a) case is a stringent one." Id. at 1264. CWA § 316(a) states that the applicant must demonstrate *to the permitting authority's satisfaction* that the applicable non-variance-based permit limitations are more stringent than necessary to *assure* the protection and propagation of the BIP. In the legislative history of the Clean Water Act Amendments of 1977, Senator Muskie[5] stated the following with respect to § 316(a):

> [t]he Congress intended that there be a very limited waiver for those major sources of thermal effluents which could establish beyond any question the lack of relationship between federally established effluent limitations and that water quality which assures the protection of public water supplies and the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife, and allows recreational activities, in and on the water.

L. History 1977, p. 642; see also p. 457.

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[5] Senator Muskie's comments from the legislative history have been given great weight by the courts in interpreting the CWA because he was the "principal Senate sponsor of the Act ...." Environmental Protection Agency v. National Crushed Stone Association, 449 U.S. 64, 71 n. 10 (1980). Accord, e.g., Natural Resources Defense Council v. Costle, 568 F.2d 1369, 1374 (D.C. Cir. 1977); American Iron and Steel Association v. Environmental Protection Agency, 526 F. 2d 1027, 1041 (3d Cir. 1975); American Meat Institute v. Environmental Protection Agency, 526 F.2d 442, 451 (7th Cir. 1975).

Although the § 316(a) standard is extremely rigorous, EPA has not interpreted § 316(a) to require absolute certainty before a variance could be granted. In re Public Service Company of New Hampshire, 10 ERC at 1265. In reality, achieving absolute certainty about a § 316(a) determination is likely to be impossible. See Id. EPA has stated, however, that "[t]he greater the risk, the greater the degree of certainty that should be required." Id. at 1265. See also 44 Fed. Reg. 32894 (June 7, 1979).

The above material suggests that EPA should take a rigorous and conservative approach to granting and reissuing variances in order to meet the CWA's standard of assuring the protection and propagation of the BIP. Such an approach is appropriate in light of the fact that the applicant for a § 316(a) variance is seeking to be excused from otherwise applicable limitations, and in light of the CWA's overarching goals of restoring and maintaining the "biological integrity of the Nation's waters, [and attaining] "water quality which provides for the protection and propagation of fish, shellfish and wildlife." 33 U.S.C. § 1251(a) and (a)(2). EPA's NPDES permit decisions are, of course, subject to the "arbitrary and capricious" standard of review under the Administrative Procedures Act. 5 U.S.C. §§ 701 -706. In other words, EPA's decisions regarding whether the permit applicant has carried its burden in seeking a § 316(a) variance, and in setting the thermal discharge limitations that are ultimately included in the permit, must have a rational basis and be consistent with applicable law.

With respect to the question of how much evidence is needed to support a § 316(a) variance, EPA has explained that, "[n]o hard and fast rule can be made as to the amount of data that must be furnished . . . [and m]uch depends on the circumstances of the particular discharge and receiving waters." In re Public Service Company of New Hampshire, 10 ERC at 1264. At the same time, information requirements are likely to increase to the extent that there is greater reason for concern over the protection and propagation of the BIP. As EPA stated in the preamble to its § 316(a)-related regulations in 40 C.F.R. Part 125 Subpart H:

> Section 125.72 accordingly gives the Director the flexibility to require substantially less information in the case of renewal requests. This does not mean, however, that the Director may not require a full demonstration for a renewal in cases where he has reason to believe that circumstances have changed, that the initial variance may have been improperly granted, or that some adjustment in the terms of the initial variance may be warranted.

44 Fed. Reg. 32894 (June 7, 1979). See also 39 C.F.R. 36177 (October 8, 1977). EPA has also stated that it "'must make decisions on the basis of the best information reasonably attainable.'" In re Public Service Company of New Hampshire, 10 ERC at 1265 (quoting 1974 EPA Draft § 316(a) Guidance). At the same time, the Agency has explained that it "may not speculate as to matters for which evidence is lacking," id. at 1264, and that if "'deficiencies in information are so

critical as to preclude reasonable assurance, then alternative effluent limitations should be denied.'" Id. at 1265 (quoting 1974 Draft EPA § 316(a) Guidance). See also In the Matter of: Public Service Company of Indiana, Inc., Wabash River Generating Station, 1979 EPA App. LEXIS 4, [*34] - [*40], 1 E.A.D. 590 (November 29, 1979) (Administrator remanded permit to Regional Administrator where Region had decided to grant variance-based thermal discharge limitations despite lack of data regarding thermal effects under worst case, low flow conditions). The question is what "an informed scientific judgment," In re Public Service Company of New Hampshire, 10 ERC at 1265, would be in light of the data in the record and absent from the record.

The regulations and guidance provide for several different types of § 316(a) demonstrations. These demonstrations may be structured to utilize existing information and minimize the amount of new information that must be collected. The required demonstrations will likely vary to some extent depending, in part, on whether the variance is sought by a new facility or an existing facility. See 40 C.F.R. § 125.73(c)(1) (two types of demonstrations for existing dischargers); U.S. EPA, "Draft - Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements" (May 1, 1977), p.11 (referred to hereinafter as, "Draft 1977 316(a) Technical Guidance"). See also 39 C.F.R. 36177 (October 8, 1974); In the Matter of: Public Service Company of Indiana, Inc., Wabash River Generating Station, 1979 EPA App. LEXIS 4, [*15], 1 E.A.D. 590 (November 29, 1979).

An existing discharger may base its demonstration on a showing that there has been no "appreciable harm" to the BIP from the thermal discharge "taking into account the interaction of such thermal component [of the discharge] with other pollutants and the additive effect of other thermal sources." 40 C.F.R. § 125.73(c)(1)(i). Alternatively, an existing discharger can attempt to show that "despite the occurrence of such previous harm, the desired alternative effluent limitations (or appropriate modifications thereof) will nevertheless assure the protection and propagation of . . . [the BIP]." 40 C.F.R. § 125.73(c)(1)(ii). With respect to the appreciable harm test, EPA has explained that proposed thermal discharge limitations fail the § 316(a) variance test if those limitations would, taking into account other stresses upon the BIP, cause appreciable harm to the BIP in the future. Wabash, 1979 EPA App. LEXIS 4, [*16] - [*17], 1 E.A.D. 590 (November 29, 1979). In addition, thermal discharge limitations which caused appreciable harm to the BIP in the past are not to be renewed under a § 316(a) variance unless those limits are modified to prevent future harm or other circumstances are demonstrated to have changed so that appreciable harm will not occur in the future. Id.

6.2.4 Permit Procedures

NPDES permits are limited to a term of no more than five years. 33 U.S.C. § 1342(b)(1)(B). Thus, NPDES permits expire and require reissuance at least every five years. (Expired permits remain in effect until a new permit is issued as long as the permittee has filed a timely application for permit reissuance. 40 C.F.R. § 122.6(a) .) Accordingly, EPA regulations provide that previous § 316(a) variance determinations must be revisited at the time of permit reissuance. See 40 C.F.R. § 125.72(c) and (NOTE); 39 Fed. Reg. 36176 (October 8, 1974) (Preamble to EPA's earlier § 316(a)-related regulations) ("Continuing monitoring by existing sources will provide opportunity to review their impacts from time to time and to impose more stringent effluent limitations, if necessary, in subsequent permits.").

With respect to the timing of an application for a CWA § 316(a) variance, 40 C.F.R. § 122.21(m)(6) provides that a request for a § 316(a) variance:

> . . . must be filed with a timely application for a permit under this section, except that if thermal effluent limitations are established under CWA section 402(a)(1) or are based on water quality standards the request for a variance may be filed by the close of the comment period under § 124.10.

Thus, if a discharger did not request a variance with its initial permit application and EPA then proposed permit limits based on applicable technology and water quality standards, the discharger could still request a variance as long as it did so by the close of the comment period on the draft NPDES permit. As discussed above, in this case, the permittee did not request a variance at the time of its application for permit reissuance, filed on January 15, 1998. See January 15, 1998, Letter from Andrew H. Aitken, Vice President, NEPCO, to Jane Downing, EPA, and David Johnston, MA DEP, p. 3. Initially, the permittee sought a permit with limits based on water quality standards, including a mixing zone. However, in May 2001, the permittee submitted its first request for a variance. USGenNE National Energy Group, "Variance Request Application and Partial Demonstration Under the Clean Water Act, Section 316(a) and (b)" (May 24, 2001). As discussed above, this variance application was later supplemented with the December 2001 USGenNE § 316(a) and (b) Demonstration.

EPA does not see any strict procedural bar to the company's filing of its variance application at that time. Indeed, had EPA proposed permit limitations based on technology or water quality standards, the regulations clearly state that the permittee could have requested a variance any time before the close of the comment period on the draft permit. It should also be noted that this is a practical and reasonable approach for EPA to take in light of the fact that the scientific and technical information that the permittee and the regulatory agencies were developing when the company was seeking a permit based on water quality standards and a mixing zone is also pertinent to the § 316(a) variance issues.

6.3 Biological Analysis of Thermal Discharge

6.3.1 USGenNE's Variance Request

USGenNE has requested permit conditions based on a § 316(a) variance. Their preferred technological alternative is the Enhanced Multi-Mode (EMM) option which is described in detail in the permittee's permit application materials and in EPA's CWA § 316(b) determination document. Derived from the operating needs and capabilities of the Enhanced Multi-Mode System, USGenNE is requesting a CWA § 316(a) variance-based permit with the following discharge conditions:

	EMM	Existing (MOA II)
Discharge Temperature:	95° F	95° F
Delta Temperature:	22° F	22°/30° F(under piggyback)
Winter Month Heat Load:	3.5 TBTU	4.1 TBTU
Winter Season (Oct.-May):	19 TBTU	29 TBTU
Summer Month Heat Load:	2.5 TBTU	3.4 TBTU
Summer Season (Jun.-Sept.):	9 TBTU	13 TBTU
Daily Maximum Flow	1298.5 MGD	1298.5 MGD
Winter Seasonal Flow	600 MGD	925 MGD
Summer Seasonal Flow	750 MGD	1080 MGD
Annual Heat Load	28 TBTU	42 TBTU
Annual Flow	650 MGD	no annual limit

The limits requested by USGenNE are more stringent than the current permit limits or MOA II, but less stringent than what would be required by technology-based or water quality-based discharge limits.

6.3.2 Outline of § 316(a) Decision Criteria

Under Section 316(a), the effects of the discharge of heat from Brayton Point Station to the "balanced indigenous population" (BIP) of marine organisms in Mount Hope Bay are analyzed. EPA's 316(a) Technical Guidance Manual (May 1, 1977) uses the term "balanced indigenous community", which it states is consistent with the term balanced indigenous population in Section 316(a) of the Federal Water Pollution Control Act. EPA regulations at 40 CFR §125.71(c) define the balanced indigenous community in the following way:

> "The term *balanced indigenous community* is synonymous with the term *balanced indigenous population* in the Act and means a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection

> with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence or abundance is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the act; and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed to section 316(a)."

The 316(a) Technical Guidance Manual suggests that an assessment of thermal impacts be done on a community-by-community (i.e., phytoplankton, zooplankton, habitat formers, finfish) basis. EPA followed the framework of the guidance document in the construction of our thermal assessment, because it provides a useful analytical structure. The 316(a) Technical Guidance Manual describes areas of low potential impact from the thermal discharge for each community type based on specific criteria. Communities showing little or no impact from current operation were deemed by EPA to have low potential impact for thermal effects from future operation assuming other stressors stay constant. The 316(a) Technical Guidance Manual details specific criteria or endpoints that are indicative of thermal degradation for each community type. EPA considered these endpoints in its thermal assessment. These decision criteria are detailed below.

6.3.2a Phytoplankton

Phytoplankton are unicellular microscopic plants that are one of the most important sources of primary production for coastal and marine food webs. They are important food items for zooplankton, which include larval fish, filter feeding invertebrates and some species of fish. In addition, nuisance blooms of phytoplankton can cause aesthetic and ecological problems.

i. Low Potential Impact Areas for Phytoplankton (Open Ocean and Most Riverine Ecosystems)

Areas of low potential impact for phytoplankton are defined in the 1977 EPA 316(a) Technical Guidance manual as open ocean areas or systems in which phytoplankton is not the food chain base. Ecosystems in which the food web is based on detrital material; (e.g. embayments bordered by mangrove swamps, salt marshes, freshwater swamps and most rivers and streams) are in this category.

The area will not be considered one of low potential impact if preliminary literature review and/or abbreviated "pilot" field studies reveal that:

1. Phytoplankton contribute a substantial amount of the primary synthetic activity supporting the community;

2. A shift towards nuisance species may be encouraged by the thermal discharge; or

3. Operation of the discharge may alter the community from a detrital to a phytoplankton based system.

If a receiving water is determined to be an area of potential impact for phytoplankton, the 1977 EPA 316(a) Technical Guidance Manual directs that the following decision criteria are to be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met:

1. A shift towards nuisance species of phytoplankton is not likely;

2. There is little likelihood that the discharge will alter the indigenous community from a detrital to a phytoplankton based system; or

3. Appreciable harm to the balanced indigenous population is not likely to occur as a result of phytoplankton community changes caused by the heated discharge.

6.3.2b Zooplankton

Zooplankton are microscopic animals that live in the water column. Zooplankton are comprised of two different categories of organisms, holoplankton and meroplankton. Holoplankton spend their entire life cycles as planktonic creatures. Meroplankton, such as fish and crustacean eggs and larvae, only spend a portion of their life cycle as plankton. The zooplankton community is a primary food source for larval fish, shellfish and some species of adult fish.

i. Low Potential Impact Areas for Zooplankton

Areas of low potential impact for zooplankton are defined in the 1977 EPA 316(a) Technical Guidance Manual as those characterized by naturally low concentrations of commercially important species, rare and endangered species, and/or those forms that are important components of the food web or where the thermal discharge will affect a relatively small proportion of the receiving water.

Most estuarine areas will not be considered areas of low potential impact for zooplankton. However, where a logarithmic gradient of zooplankton abundance exists, those areas at the lowest level of abundance may be recognized as low potential impact areas at the discretion of the Regional Administrator.

If the receiving water is deemed a potential impact area for zooplankton, the 1977 EPA 316(a) Technical Guidance Manual directs that the following decision criteria should be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met:

1. Changes in the zooplankton and meroplankton community in the primary study area that may be caused by the heated discharge will not result in appreciable harm to the balanced indigenous fish and shellfish population;
2. The heated discharge is not likely to alter the standing crop or relative abundance, with respect to natural population fluctuations in the far field study area, from those values typical of the receiving water body segment prior to plant operation; or
3. The thermal plume does not constitute a lethal barrier to the free movement (drift) of zooplankton and meroplankton.

6.3.2c Habitat Formers

Habitat formers are species whose presence provide cover, foraging, spawning or nursery habitat for other species. In the marine environment, these would typically include coral reefs, seagrass meadows, kelp beds and macroalgal stands. These environments tend to be limited resources and many other species utilize these habitats for spawning, nursery areas, foraging and refuge from predation.

i. Low Potential Impact Areas for Habitat Formers

In some situations, the aquatic environment at a site will be devoid of habitat formers. This condition may be caused by low levels of nutrients, inadequate light penetration, sedimentation, scouring stream velocities, substrate character, or toxic materials. Under such conditions the site may be considered a low potential impact area. However, if there is some possibility the limiting factors (especially man-caused limiting factors) may be relieved and habitat formers may be established within the area, the applicant will be required to demonstrate that the heated discharge would not restrict re-establishment. Those sites where there is a possibility that a thermal discharge will impact a threatened or endangered species through adverse impacts on habitat formers will not be considered low potential impact areas.

If the receiving water is deemed a potential impact area for habitat formers, the 1977 EPA 316(a) Technical Guidance Manual directs that the following decision criteria should be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met.

1. The heated discharge will not result in any deterioration of the habitat formers community or no appreciable harm to the balanced indigenous population will result from such deteriorations; or

2. The heated discharge will not have an adverse impact on threatened or endangered species as a result of impact upon habitat formers.

6.3.2d Shellfish and Macroinvertebrates

Macroinvertebrate fauna, including shellfish, are important components of aquatic food webs and are directly important to man as a source of food and as bait for sport and commercial fishermen. Their burrowing and feeding activities promote oxygenation of sediments and recycling of important nutrients from the sediments.

ii. Low Potential Impact Areas for Shellfish/Macroinvertebrates

A low potential impact area for shellfish/macroinvertebrates fauna is defined by the 1977 EPA 316(a) Technical Guidance Manual as an area which, within the primary and far field study areas, can meet the following requirements:

1. Shellfish/macroinvertebrate species of existing or potential commercial value do not occur at the site. This requirement can be met if the applicant can show that the occurrence of such species is marginal;

2. Shellfish/macroinvertebrates do not serve as important components of the aquatic community at the site;

3. Threatened or endangered species of shellfish/macroinvertebrates do not occur at the site;

4. The standing crop of shellfish/macroinvertebrates at the time of maximum abundance is less than one gram ash-free dry weight per square meter; and

5. The site does not serve as a spawning or nursery area for the species in 1, 2, or

3 above.

If the receiving water is deemed a potential impact area for shellfish and macroinvertebrates, then the 1977 EPA 316(a) Technical Guidance Manual directs that the following decision criteria should be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met:

1. Reductions in the standing crop of shellfish and macroinvertebrates may be cause for denial of a 316(a) waiver unless the applicant can show that such reductions caused no appreciable harm to balanced indigenous populations within the water body segment;

2. Reductions in the components of diversity may be cause for the denial of a 316(a) waiver unless the applicant can show that the critical functions of the macroinvertebrate fauna are being maintained in the water body segment as they existed prior to the introduction of heat; or

3. Areas which serve as spawning and nursery sites for important shellfish and/or macroinvertebrate fauna are considered as zero allowable impact areas and will be excluded from consideration for the discharge of waste heat. Plants sited in locations which would impact these critical functions will not be eligible for a 316(a) waiver. Most estuarine sites will fall into this category.

6.3.2e Fish

Fish are important components of marine ecosystems and are important sources of food for man.

i. Low Potential Impact Area for Fish

According to the 1977 EPA 316(a) Technical Guidance Manual, a discharge may be determined to be in a low potential impact area for fishes within the primary and far field study areas if the following conditions are satisfied:

1. The occurrence of sport and commercial species of fish is marginal;

2. The discharge site is not a spawning or nursery area;

3. The thermal plume will not occupy a large portion of the zone of passage which would block or hinder fish migration under the most conservative environmental conditions (based on 7-day, 10-year low flow or water level and maximum water temperature); and

4. The plume configuration will not cause fish to become vulnerable to cold shock or have an adverse impact on threatened or endangered species.

If the receiving water is deemed an area of potential impact for fish, then the 1977 316(a) Technical Guidance Manual directs that the following decision criteria should be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met.

The discharge should not result in:

1. Direct or indirect mortality from cold shocks;
2. Direct or indirect mortality from excess heat;
3. Reduced reproductive success or growth as a result of plant discharges;
4. Exclusion from unacceptably large areas; or
5. Blockage of migration.

6.3.2f Other Vertebrate Wildlife

These include marine mammals, sea turtles and birds that may rely on estuarine and coastal waters for foraging, reproduction and other life functions.

i. Low potential Impact Areas for Other Vertebrate Wildlife

According to the 1977 316(a) Technical Guidance Document, most sites in the United States will be considered ones of low potential impact for other vertebrate wildlife simply because thermal plumes should not generally impact large or unique populations of wildlife. The main exceptions will be sites in cold areas (such as North Central United States) which would be predicted to attract geese and ducks and encourage them to stay through the winter. These would not be considered low potential impact areas unless they could demonstrate that the wildlife would be protected through a wildlife management plan or other methods from the potential sources of harm mentioned in the next section.

Other exceptions to sites classified as low potential impact would be those few sites where the discharge might affect important (or threatened and endangered) wildlife such as manatees or sea turtles.

For most other sites, brief site inspections and literature reviews would supply enough information to enable the applicant to write a brief rationale about why the site should be considered one of low potential impact for other vertebrates.

If the receiving water is deemed an area of potential impact for vertebrate wildlife, then the 1977 EPA 316(a) Technical Guidance Manual directs that the following decision criteria should be used.

ii. Decision Criteria

Depending on the severity of the effect, denial of a 316(a) variance may be warranted if the following decision criteria are not met.

The discharge should not cause:

1. Excess heat or cold shock;
2. Increased disease and parasitism;
3. Reduced growth or reproductive success;
4. Exclusion from unique or large habitat areas; or
5. Interference with migratory pathways.

6.3.3 § 316(a) Community Impact Analysis

6.3.3a Phytoplankton Community

EPA does not consider Mount Hope Bay a low potential impact area for phytoplankton, because:

1. Phytoplankton are the dominant primary producers in Mount Hope Bay, as seagrass and salt marshes have declined over time; and

2. The presence of nuisance algal species has been documented in Mount Hope Bay.

i. Nuisance Algal Blooms

To assess potential for nuisance algal blooms in the future, it is useful to review past events. In August 2001, a nuisance blue-green algae, primarily *Anacystis auruginosa*, was documented in Mount Hope Bay (Scherer, 2002A). It has been well established that blue-green algal blooms are stimulated by high nutrients and warm water temperatures (US EPA, 1985). The bloom was identified from material taken off the intake screens (Scherer, 2002A). The exact geographic extent of this bloom was unknown, but no records of similar blooms were recorded for Narragansett Bay (Deacutis, 2002). Due to the proximity of this bloom to the plant and blue-green algae's affinity for higher temperatures, it is likely that the thermal plume from Brayton Point Station contributed to this bloom. The Enhanced Multi-Mode option will significantly reduce the flux of heat to Mount Hope Bay, however a substantial quantity of heat will still be discharged and the discharge temperature and ΔT limits will not be changed. Therefore, even with the Enhanced Multi-Mode option, there is a reasonable probability based on current information, that blue-green algal blooms will continue to appear in Mount Hope Bay.

ii. Phytoplankton Community Changes

The normal seasonal phytoplankton cycle observed in New England coastal waters is a dramatic increase in phytoplankton abundance in late winter to early spring (Valiela, 1995). Keller et al. (1999) state that in many temperate waters, the winter-spring phytoplankton bloom may deliver up to half of the total annual input of organic carbon to the benthic layer. Carbon entering the benthic layer supports a diverse group of benthic infaunal organisms, many of which serve as prey for winter flounder and other benthic predators.

Very little detailed field collected data is available on phytoplankton communities for Mount Hope Bay. The limited chlorophyll (a surrogate measure for phytoplankton density) data collected by Dr. Mark Berman of NMFS for the last 4 years shows that, in general, chlorophyll concentrations in Mount Hope Bay are slightly higher than most areas of Narragansett Bay, except for the Providence River. During the duration of his sampling, Dr. Berman (2001) has not detected what would be considered the typical winter-spring phytoplankton bloom in Mount Hope Bay.

In predicting impacts of elevated temperature to the phytoplankton community of Narragansett Bay, Keller et al. (1999) conducted a mesocosm experiment examining the response of zooplankton, phytoplankton and blue mussels to an elevated winter water temperature. The warm tanks were held at 0.8° C greater than the controls. Cool tanks were held at 2° C less than the controls. The controls were based on the long term monthly average water temperature in Narrangansett Bay from 1977 through 1989. These temperatures declined from 7° C at the beginning of the experiment in December to 3° C at the completion in February. Phytoplankton abundance and biomass were reduced in warm tanks compared to controls. A winter-spring phytoplankton bloom did not occur in the warm tanks, but did occur in the controls and the cool tanks. Zooplankton grazing and filtration rates of blue mussels increased in the warm tanks compared to controls. It was thought to have exerted "top-down" control on the phytoplankton population, eliminating the normal winter-spring bloom cycle. The implication of a reduced or totally absent winter-spring bloom is that carbon will enter the food chain through a different mechanism. In a typical year, with a normal winter-spring phytoplankton bloom, the vast majority of carbon resulting from phytoplankton growth enters the benthic food chain via sedimentation. In this mesocosm experiment, as much as 80% of the phytoplankton carbon in the cool tanks was lost via sedimentation. In the warm tanks, sedimentation accounted for only 29-43% of the losses, grazing by zooplankton and blue mussels accounting for an equivalent or greater percentage 29-55%. This represents a change from carbon entering the food web via the benthic layer to entering via the pelagic layer. The implication of reduced carbon available in the benthic layer is that a reduced quantity of prey organisms would be available for winter flounder and other benthic predators.

NASA satellite images analyzed by Mustard et al. (2001) compared water temperature in Mount Hope Bay to surrounding water bodies. They found that Mount Hope Bay surface waters are on average 0.8° C warmer during the summer and fall than comparable shallow areas of Narragansett Bay. The authors attribute this elevated temperature to the effluent from the plant and states that 35 km^2 (essentially 100% of the bay) are impacted. The plume is less well defined in the winter and spring, because the water column is not stratified and the plume tends to sink. Thus, the plume is less discernible from satellite images at those times of year.

Hydrothermal modeling done by USGenNE's consultant for the warm summertime condition has shown that under existing operating conditions, over 80% of the bay by volume will experience $\Delta 0.8^{\circ}$ C or more (USGenNE 10/1/01, Section 308 Information Request Response, p.38). USGenNE's proposed permit conditions would result in over 50% of the bay by volume experiencing a summertime $\Delta 0.8^{\circ}$ C or more (USGenNE 10/1/01, Section 308 Information Request Response, p.38).

Based on the limited field data documenting the lack of a winter-spring bloom, the mesocosm study by Keller et al. (1999) and the satellite images comparing temperatures in Mount Hope Bay with those of surrounding waters, it is likely that elevated water temperatures, due to Brayton Point Station's discharge, have a reasonable potential to alter normal phytoplankton population dynamics. This change in phytoplankton population dynamics could very likely lead to significant impacts within the trophic dynamics of the food web. Elevated water temperatures in Mount Hope Bay lead to increased grazing by zooplankton and increased filtration rates by shellfish. This increased predation may be responsible for the observed lack of a winter-spring phytoplankton bloom in Mount Hope Bay. Changes in phytoplankton population dynamics can ripple throughout the food web as phytoplankton are the dominant primary producers in Mount Hope Bay. Redirecting carbon away from the benthos and into the pelagic realm, would represent a reduction in prey species for benthic predators such as winter flounder, tautog, hogchoker and windowpane. Therefore, based on the satellite images collected by Mustard, and further supported by computer models run by consultants to USGenNE, the influence of the plume extends over large areas of Mount Hope Bay.

Under USGenNE's proposed Enhanced Multi-Mode alternative, over half of the bay by volume would still experience a change in temperature significant enough, based on the mesocosm studies, to alter normal phytoplankton population dynamics. This represents a substantial areal change in phytoplankton population dynamics, that could lead to significant changes in food web dynamics for a large part of the bay. Based on this analysis, the phytoplankton Decision Criteria no. 1 and 3, from the 1977 EPA 316(a) Technical Guidance Manual would not be satisfied.

6.3.3b Zooplankton Community

EPA does not consider Mount Hope Bay a low impact area for zooplankton, because it is an estuary that serves as a spawning site for numerous fish and invertebrate species.

i. Zooplankton Community Changes That May Harm Balanced Indigenous Population of Fish and Shellfish

There is not an extensive database available for zooplankton abundance and species composition in Mount Hope Bay. USGenNE compared data that was collected by their consultant Marine Research, Inc. (MRI) from 1972-1985 with data collected in 1997/1998. The timing of zooplankton peaks of high abundance and species assemblage was similar to the historical dataset.

The ctenophore, *Mneimiopsis leidyi*, historically bloomed in Narragansett Bay in late summer and early fall. Narragansett Bay is the northern extreme of the latitudinal distribution for this species. In recent years, *M. leidyi* has been appearing in Narragansett Bay and Mount Hope Bay earlier in the calendar year (Sullivan et al., 2001). In 2002, comb jellies, most likely *M. leidyi,* overwintered in Mount Hope Bay (Scherer, 2002B; Colarusso, 2002). Ctenophores are voracious plankton eaters and have been implicated in fish declines in the Black Sea (Sullivan et al., 2001). *M. leidyi* can feed on pelagic fish eggs and zooplankton (Sullivan et al., 2001). For species with demersal eggs, such as winter flounder, there is likely little direct predation by *M. leidyi*, but the ctenophore will compete with fish larvae for zooplankton prey (Sullivan et al., 2001). Jellies are thought to be a good group of organisms to use to track the quality of coastal ecosystems, dramatic increases in their abundance are usually indicative of stressed systems (Pohl, 2002). Increases in water temperatures, increases in nutrients and depletion of fish stocks are thought to be the most important stresses (Pohl, 2002).

Sullivan et al. (2001) suggest increases in water temperature are responsible for the expansion of the range and time of year that *M. leidyi* is found. The authors suggest that long term temperature rise may be responsible for the changes they are observing. In Mount Hope Bay, the incremental quantity of heat being added to the bay as a result of long term temperature rise (assuming that the rise continues at the historical rate of change) is minor compared to the quantity discharged by Brayton Point Station even under the Enhanced Multi-Mode option (Houlihan, 2002). Thus, Brayton Point Station is significantly contributing to the thermal conditions in Mount Hope Bay and potentially facilitating the expansion of the range and time of year distribution of the ctenophore *M. leidyi*. The expansion of time of abundance of this ctenophore would increase natural mortality rates for species with pelagic eggs and create competition for food resources with species, such as winter flounder, that have pelagic larvae. This increased competition for food resources could result in reduced growth rates and survival for larval winter flounder and other species with pelagic larvae.

Based on this analysis, zooplankton Decision Criteria no.1 and 2 from the 1977 EPA 316(a) Technical Guidance Manual are not satisfied.

6.3.3c Habitat Formers

EPA does not consider Mount Hope Bay a low impact area for habitat formers, because past presence of eelgrass in the bay shows that Mount Hope Bay is a capable of supporting this type of habitat. Extensive improvements made to and planned for the Fall River treatment plant and Combined Sewer Overflow (CSO) collection system, continued incremental improvements from other point source dischargers, such as the Brockton sewage treatment plant, as a result of EPA and MA DEP ongoing permitting efforts, combined with EPA's and MA DEP's continued nonpoint source control work should improve water quality in Mount Hope Bay through time. In addition, numerous eelgrass restorations efforts are being or have been attempted around Narragansett Bay. EPA does not deem Mount Hope Bay, a low impact area for Habitat Formers (despite the current lack of eelgrass in Mount Hope Bay), because of the potential for recovery of this habitat in this system.

i. Exclusion of Habitat Formers

Mount Hope Bay at one time, supported extensive eelgrass meadows. In the 1930s, an extensive dieoff of eelgrass occurred along the entire eastern seaboard of the United States (Short et al., 1988). Numerous theories exist as to the cause of this dramatic decline including an episodic disease outbreak, poor water quality and a temperature mediated decline (Short et al., 1988). Although some eelgrass did persist in areas of Mount Hope Bay into the 1940s (http://www.edc.uri.edu/eelgrass), currently, eelgrass is only present in the southern third of Narragansett Bay (http://www.edc.uri.edu/eelgrass). Eelgrass is a coldwater plant that ranges from North Carolina to Canada and grows on predominantly soft bottom substrates (Thayer et al., 1985). A protected (low wave energy) shallow, soft bottom embayment, such as Mount

Hope Bay, is the ideal physical habitat for eelgrass growth (Thayer et al, 1985). However, the combination of warm water temperatures and low water clarity may prevent its re-establishment.

Marsh et al. (1986) measured the changes in eelgrass photosynthesis and respiration rates at 8 temperatures between 0 to 35° C. These experiments were carried out at the point of light saturation. In other words, increasing the intensity of light would result in no change in the rate of photosynthesis. Photosynthetic rates increased with temperature as did respiration rates. The temperature with the greatest ratio of photosynthetic rate to respiration rate was 5° C, thus representing the point of maximum growth. At temperatures above 30° C, the respiration rate exceeds the rate of photosynthesis, which would lead to negative plant growth and mortality. Thus, in clear waters, where the penetration of light is good, 30° C may be a reasonable temperature threshold for eelgrass.

However, Mount Hope Bay is a turbid water body, with reduced light penetration (C. Krahforst, 2002). Bulthuis (1987) examined the effect of temperature on seagrass photosynthesis rates at low light levels. He showed that optimum temperature for photosynthesis in *Heterozostera tasmanica* decreased from 35° C at light saturation to 5° C at reduced light levels. Balthuis did not measure respiration rates, but it has been well established that respiration rates in seagrass increase with temperature (Marsh et al., 1986). Thus, in turbid water bodies, where light penetration is reduced, seagrass growth decreases with increased temperature, because photosynthetic rates decrease, and respiration rates increase.

It is quite likely therefore, that the combination of poor water clarity and high water temperature in Mount Hope Bay represent an exclusion zone for eelgrass growth. The Brayton Point Station discharge, which elevates the temperature over significant portions of the bay, contributes to this exclusion zone.

6.6.3d Shellfish and Macroinvertebrates

EPA has determined that Mount Hope Bay is not a low potential impact area for shellfish and macroinvertebrates, because:

1. Shellfish of commercially important species do exist in Mount Hope Bay and they do exist in substantial densities;

2. Shellfish and macroinvertebrates do serve as important components of this ecosystem; and

3. Mount Hope Bay does serve as a spawning and nursery area for shellfish and macroinvertebrates.

i. Balanced Indigenous Population of Shellfish and Macroinvertebrates

There is not a large quantity of data on shellfish and macroinvertebrates in Mount Hope Bay. Historically, data on benthic macroinvertebrates was collected by Marine Research, Inc. (MRI) from 1975 to 1992. At the request of the permittee, EPA, with agreement from the Technical Advisory Committee (TAC), ended this permit requirement during the reissuance of the 1993 permit. Another survey was done by MRI in 1997/1998 and found no significant differences in the benthic community compared to the 1975 to 1992.

EPA conducted benthic sampling in 2000 at 10 stations in the Taunton River and 10 stations in the Kickamuit River. They compared those results with samples taken by Diaz and Daughters from 11 stations around Spar Island and a Scientific Applications International Corporation (SAIC) study with 1988 data along a transect in Mount Hope Bay (Cicchetti, 2001). All the studies showed similar results, the surveys did not detect extensive areas that showed indication of sustained hypoxia or anoxia (Cicchetti, 2001). EPA found beds of *Ampelisca* amphipod tubes, which is not considered to indicative of an enriched or physically disturbed habitat (Cicchetti, 2001). *Ampelisca* amphipods have been shown to be a substantial percentage of the diet of juvenile winter flounder (Franz and Tanacredi, 1992). EPA has not found substantial evidence of harm to shellfish and macroinvertebrates from the current thermal discharge, thus it is reasonable to expect that any reduction of thermal loading in the future would be acceptable as well.

6.3.3e Fish

EPA has determined that Mount Hope Bay is not a low potential impact area for fish because:

1. Numerous species of recreational and commercially important fish occur in the bay;
2. Mount Hope Bay is a finfish spawning and nursery area; and
3. There is the potential for blockage of normal fish migration.

i. Balanced Indigenous Population of Fish

The analysis of finfish was done in two steps to determine the appropriate thermal discharge limits for Brayton Point station in order to protect finfish populations in Mount Hope Bay. Step 1 was a retrospective examination of total finfish abundance trends in relation to plant operations. This analysis was performed to try to determine the appropriate annual flux of heat into the bay that would be still protective of finfish populations. Step 2 examined specific temperature thresholds for individual species. These thresholds included both acute and chronic mortality and a host of sublethal effects, such as avoidance, cessation of feeding, and impaired swimming or reproduction.

(A) Annual Flux of Heat

USGenNE's 316(a) Variance Request (December, 2001) asks for an annual mass flux of heat totaling 28 trillion British thermal units (TBTU). To derive a protective quantity of heat that can be discharged to Mount Hope Bay as an annual flux number, EPA looked at past plant annual thermal discharge totals and finfish abundance. It is tempting to focus solely on the dramatic decline in total finfish abundance in 1984-1985, when Unit 4 was converted to once-through cooling, and conclude that the appropriate operating condition would be one that mimicked plant operations prior to that time. Several analyses suggest that this would not be sufficient to protect the BIP.

First, total finfish abundance prior to 1984-85 was certainly significantly greater than it is today, but it was not indicative of a stable balanced community. Dramatic swings in total finfish abundance occurred several times from 1972 to 1984. This boom/bust cycle is indicative of an unstable population that may be prone to collapse. It should be noted that Units 1, 2 and 3 were all operational prior to 1972, thus there is no true baseline (pre-impact) data. One of the experts EPA solicited to review the 1996 Gibson report suggested that based on these population swings, it was likely that finfish populations in Mount Hope Bay were going to collapse even if Unit 4 had not been converted to once through cooling (Hicks, 1996).

Second, recent analysis done by Mark Gibson (2002A) suggests that winter flounder abundance in Mount Hope Bay has been declining since the initiation of data collection in 1972. Gibson did a relatively straightforward analysis of regional factors on winter flounder abundance. He divided the results from each MRI annual otter trawl survey by its counterpart from otter trawl surveys away from the plant. He used the University of Rhode Island Graduate School of Oceanography (URIGSO) survey conducted in the lower west passage of Narragansett Bay and the National Marine Fisheries Service (NMFS) survey conducted in Block Island Sound. Theoretically, all these surveys should integrate the large scale regional factors such as overfishing, water temperature rise and increased predation that may be affecting winter flounder abundance. Thus, by standardizing these datasets, the influence of local stressors can be determined. The results of this analysis (Figure 6.3-1) show a steady downward trend in this standard index, beginning in 1972 and culminating in a collapse in the mid 1980s. The plant had been operational for 9 years (Units 1,2 and 3 came on line in 1963, 1965 and 1969 respectively) before fish abundance data began to be collected in 1972, so it is not possible to estimate what the finfish community was like prior to plant impact.

Third, in an analysis provided by Marine Research, Inc., and New England Power Company (former owners of Brayton point Station) entitled Brayton Point Generating Station, Mount Hope Bay, Somerset, Massachusetts, Supporting Document for Cooling Water Discharge Temperature up to 95° , the authors referring to the period of study from 1972-1978, state that "winter flounder (P. americanus), windowpane flounder (S. aquosus) and silversides (Menidia spp.), have noticeably declined in abundance in upper Mount Hope Bay during this period of study...".

The historic annual heat (in TBTUs) outputs for Brayton Point Station are listed in Table 6.3-1 and finfish abundance is shown in Figure 2.6-1. The average annual heat output for Brayton Point Station for the time period (1970-1983) prior to the collapse of the fishery was 28.26 TBTU. Currently, Brayton Point Station discharges in the high 30 to low 40 TBTUs per year range (Table 6.3-1). The USGenNE Variance Request asks for operating conditions that would essentially return station output to the 1970-1983 level. Fish abundance data exists from 1972 onward and for the reasons detailed above, EPA believes that fish populations were experiencing a steady decline during that period. Thus, historical finfish abundance trends do not support an annual heat flux equaling 28 TBTU as being able to stop or reverse a decline in fish populations. A lower annual value would be more appropriate.

Table 6.3-1: Annual Flux of Heat From Brayton Point Station to Mount Hope Bay in TBTUs[1]

Year	Annual Heat Flux	Year	Annual Heat Flux
1970	28	1985	35.2
1971	30.5	1986	33.8
1972	30.9	1987	41.1
1973	30.2	1988	48.8
1974	23	1989	49.5
1975	22	1990	47.7
1976	25.9	1991	41.8
1977	28.2	1992	37.5
1978	29.4	1993	38.9
1979	26.7	1994	38.3
1980	30.2	1995	38.6
1981	25.5	1996	38
1982	32.3	1997	41
1983	32.9	1998	38.4
1984	34	1999	39.1
		2000	37.4

[1] USGenNE 10/01/01 Section 308 Information Response

(B) Temperature Threshold Analysis

This analysis compares predicted water temperatures in the thermal discharge plume from a variety of different operating scenarios compared with critical temperature thresholds for marine organisms as detailed in the scientific literature. A major piece of USGenNE’s 316(a) variance request is a species by species review of critical temperature thresholds.

An essential component of the critical temperature analysis is the ability to accurately predict thermal plume dynamics. Thus, the TAC requested the company to develop a predictive hydrothermal model for Mount Hope Bay. USGenNE hired Applied Science Associates (ASA) to conduct the modeling. ASA used 2 models to characterize the thermal plume, the Cornell Mixing Zone Expert System (CORMIX) for the near field (within 1,640 ft of discharge canal) and WQMAP, developed by ASA and the University of Rhode Island, for far-field effects. Mount Hope Bay was divided into 11 vertical layers and 3300 cells. The models predicted salinity, velocity and water temperature and were calibrated to field data. Model optimization was done with thermistor data acquired in the bay for summer and winter conditions. After model calibration and optimization, the TAC, and EPA accepted the model as an adequate predictive tool of water temperature dynamics in Mount Hope Bay.

Two temporal periods were considered to be the most biologically sensitive by EPA and the TAC and were the focus of modeling efforts. These were labeled as “winter” (which encompassed March 1 to March 31) and “summer” (which encompassed July 15 to August 15). The March time period was selected as it corresponds with some winter flounder spawning activity and with large numbers of larval planktonic winter flounder being present in the water column. The second time period was selected to assess thermal effects during the warmest time of the year.

Historical environmental data was used to define baseline water temperature conditions for the model. Based on review of the environmental data, a range of baseline conditions were defined as “cool”, “average” and “warm” years. The “average” year was not based an arithmetic mean, but represented conditions that approximate the midpoint between the “cool” and “warm” years. The model predicted ΔT (increase over ambient) as well as absolute temperature.

USGenNE analyzed two operating scenarios (MOAII and EMM) in their 316 Partial Demonstration Document (May, 2001). The TAC requested that two additional operating scenarios (Hypothetical A and B) and a “No Plant” alternative be analyzed. The flow and heat load of each scenario is detailed below:

	Flow (MGD)		Heat Load (TBTU/mo)		
Scenario	Summer	Winter	Summer	Winter	Annual
MOAII	1,043	925	3.7	4.1	42
EMM	750	600	2.25	2.375	28
Hypothetical A	750	600	1.2	1.2	14.4
Hypothetical B	750	600	1.8	1.8	21.6
No Plant	0	0	0	0	0

Predicted absolute water temperatures and ΔT values were used to assess the potential impact of the plant’s thermal discharge on the biota of Mount Hope Bay. The initial approach taken by USGenNE, with agreement from the TAC and EPA, was to review the scientific literature on thermal tolerance of important species present in Mount Hope Bay. A list of Representative

Important Species (RIS) had been derived years ago by the TAC. This list was reviewed and approved by the current TAC and includes the following species:

alewife (*Alosa pseudoharengus*)
Atlantic menhaden (*Brevoortia tyrannus*)
Atlantic silverside (*Menidia menidia*)
bay anchovy (*Anchoa mitchilli*)
hogchoker (*Trinectes maculatus*)
rainbow smelt (*Osmerus mordax*)
sand lance (*Ammodyte americanus*)
seaboard goby (*Gobiosoma ginsburgi*)
silver hake (*Merluccius bilinearis*)
tautog (*Tautoga onitis*)
threespine stickleback (*Gasterosteus aculeatus*)
weakfish (*Cynoscion regalis*)
white perch (*Morone americana*)
winter flounder (*Pleuronectes americanus*)
quahog (*Mercenaria mercenaria*)
blue mussel (*Mytilus edulis*)
eelgrass (*Zostera marina*).

For winter flounder, an additional population level analysis was conducted. Critical temperatures from the literature were taken and used to assess acres of suitable habitat that would be left by different thermal discharge scenarios. This data was then fed into the RAMAS model to predict winter flounder population trajectories. The TAC's concerns with the RAMAS model are detailed later in this document. The TAC's major concern with the RAMAS model was its inability to replicate past changes in winter flounder population numbers, thus its ability to accurately predict future changes was questionable. Consequently, EPA has not relied on the RAMAS model results in either the 316(a) or (b) analysis.

In the absence of a proven predictive population model, the potential future effects of the thermal plume on various aquatic organisms were assessed by comparing the hydrothermal model results predicting water temperatures with temperature tolerance numbers taken from the peer-reviewed scientific literature. USGenNE, members of the TAC and consultants hired by EPA did a literature review for thermal tolerances for the RIS. The TAC and USGenNE did not agree on what the appropriate critical temperature values were for many of the species. Examples of these difference of opinions are detailed in a later section below.

As stated above, the hydrothermal model is an 11 layer model, capable of predicting water temperature at 11 different depths in the water column. To assess thermal impacts, results from the hydrothermal model were split into "pelagic" and "benthic" portions. Pelagic was defined as the top 10 layers of the water column as delineated by the hydrothermal model, and benthic was defined as the bottom layer of the water column as delineated by the hydrothermal model. For the RIS, natural history information was reviewed and various life stages were defined as benthic or pelagic. For example, because winter flounder eggs are demersal, this life stage was classified as benthic. Larval winter flounder are planktonic and as a result were classified as pelagic. Juvenile and adult winter flounder live on the bottom and were classified as benthic. Impacts were then assessed based on a comparison of predicted water temperatures from the hydrothermal model with scientific literature values for specific species.

USGenNE's biothermal assessment examined the impact of the thermal plume on growth, spawning, egg survival and/or malformation, potential for habitat avoidance, potential blockage of migratory routes, potential for elevated temperature mortality and potential for cold-shock mortality.

In USGenNE's assessment of thermal impacts on growth rates (May 24, 2001 USGenNE 316(a) and (b) Partial Variance Demonstration), they derived the "optimal" temperatures using a linear relationship incorporating acclimation temperatures. However, USGenNE's definition of "optimal" temperature is not readily apparent. For example, USGenNE discuss their derivation of optimal temperature for tautog growth citing a study by Olla and Studholme (1975) where fish were held in a tank and the water temperature was gradually increased from 21.1 to 30.2^{o} C (64-86.4^{o} F). At 26.9^{o} C (80.4^{o} F), feeding and swimming activity decreased. Feeding and swimming activity further decreased at 28.1^{o} C (82.6^{o}) and sharply fell off at 29.3^{o} C (84.7^{o} F). USGenNE then chose the midpoint between 28.1 and 29.3^{o} or 28.7^{o} C, as the optimal temperature for tautog. Thus, USGenNE did not choose the first temperature, where the researchers first noted thermal effects or the second temperature, where those effects became more pronounced, it chose a temperature that occurred past the pronounced effects, yet before feeding and swimming was completely eliminated, as the "optimal" temperature. Typically, optimal temperatures are selected as points of maximum feeding, growth, or reproduction, but the company chose a temperature that did not correspond to any of these. The tautog example is an important one because 1. tautog are commercially valuable, 2. Mount Hope Bay has been identified as an important spawning area for them (Meng and Powell, 1999), and 3. they are one of the 4 species that RI DEM showed had a statistically significantly different population trajectory in Mount Hope Bay compared to Narragansett Bay (Gibson, 1996).

For a second example, USGenNE selected 35^{o} C as the "optimal temperature" for hogchoker based on a study by Peters and Boyd (1972). This laboratory study represents what may be a physiologically optimal temperature for hogchoker. However, observations in nature indicate that hogchoker avoid water temperatures above 25^{o} C, though this may be physiologically less favorable. Thus, as the authors of the study question, the ecological relevance of 35^{o} C is questionable.

USGenNE in their final Clean Water Act Section 316(a) and (b) Demonstration (December, 2001) conducted an "expanded" biothermal assessment. The "expanded" biothermal assessment allowed for a more “refined” (USGenNE’s description) analysis. The major differences between the permittee’s “expanded” analysis and the biothermal analysis in the partial demonstration document (May, 2001) are that:

1. In the “expanded” analysis, USGenNE looked at predicted temperatures from the hydrothermal model in every cell of the model grid in order to predict biological effects. The prior analysis, attempted to predict biological effects from baywide volumes of water exceeding target temperatures;

2. The “expanded” analysis defined specific habitat areas for different life stages of target species. Prior analysis assumed an equal distribution of organisms throughout the bay;

3. The permittee’s “expanded” analysis uses model predictions for the entire year, while the prior analysis focused in on two biologically critical months of the year;

4. The permittee’s “expanded” analysis relies on abundance of fish, eggs and larvae from the MRI monitoring program. The prior analysis relied on the peer-reviewed scientific literature to determine the time of year when a specific life stage of a target species was present; and

5. The permittee’s “expanded” analysis represents a slightly more involved examination of temperature thresholds for target species than the prior analysis. USGenNE derived graphs that overlay various temperature thresholds and refers to these graphs as “Temperature Polygons”. Acute and chronic toxicity, avoidance temperatures and growth zones are depicted on these graphs.

EPA and other agencies on the TAC reviewed this most recent modeling approach. Several reviewers, Mark Gibson of RI DEM, Todd Callaghan of MA CZM and Gerry Szal, MA DEP, sent EPA their comments on USGenNE’s “expanded” analysis for the 316(a) variance request (See Appendix A). Their major points of disagreement with USGenNE’s analysis are outlined below:

1. USGenNE relies heavily on the concept of “temperature acclimation” to assess biothermal thresholds in fish. USGenNE constructs temperature polygons based on an acclimation of 7 days at a lower temperature, so as, theoretically to allow a greater tolerance of higher temperatures. Physiological acclimation does occur in the laboratory, but the extent to which it occurs in nature is uncertain and debatable. Rhode Island DEM submitted data comparing winter flounder abundance with temperature (Reitsma, 2002). The data suggests that flounder response to water temperature is fairly dramatic. Figure 6.3-2 and Figure 6.3-3

show that adult flounder abundance drops to nearly zero above 15° C and juvenile abundance declines in a similar fashion above 24 or 25° C. The response of these fish are dramatic and indicative of a temperature threshold effect. This field data agrees with reported temperature thresholds found in the scientific literature. Duffy and Luders (1978) and Casterlin and Reynolds (1982), both found that juvenile winter flounder showed avoidance at 24° C. In a publication submitted to EPA by USGenNE, Olla et al.(1969) conducted a study involving field observations of winter flounder behavior at different temperatures in Great South Bay on Long Island. Responses by these fish were not a result of artificial conditions in a laboratory, and therefore represent a reasonable predictor of their behavior in the environment. Olla et al.(1969) found that winter flounder burrow into the bottom sediments, at temperatures higher than 22.2° C. This burrowing phenomenon is a form of temperature avoidance, because temperatures measured in the sediments were several degrees cooler than temperatures in the water column. During the burrowing, winter flounder ceased to feed, representing a stressful situation for the fish. Thus, field studies document that behavioral responses in winter flounder begin at 22.2° C. The above cited laboratory studies, the Rhode Island DEM field data and the field study submitted by USGenNE all support the concept that sublethal temperature effects begin occurring in the low 20s° C and result in complete avoidance of the area by 24 or 25° C. By using the concept of "acclimation temperatures", USGenNE predicted "optimal" temperatures above these avoidance values and dramatically reduce the predicted area of impact of the thermal discharge. EPA and the other agency reviewers regard USGenNE's approach as inappropriate.

2. In addition, USGenNE's acclimation argument assumes that a fish will stay within the same immediate area of the bay for 7 days to allow for temperature acclimation to occur. Fish are mobile creatures and even the demersal species, which may not move much on an hourly scale, will move significantly within Mount Hope Bay on a weekly scale. Several members of the TAC viewed this as a highly unrealistic assumption and EPA agrees. Therefore, the effect of this assumption is that it in appropriately increases the "growth zone" of the USGenNE's temperature polygon and as a result underestimates the effect of the thermal discharge.

3. Using the MRI field surveys from 1972 to the present to delineate areas used by fish in the bay should be recognized as an underestimate of actual habitat utilization, due to the fact that fish population numbers have been declining since 1972. As fish abundance declines, the extent of their habitat usage declines as well.

4. Temperature sensitivity varies dramatically from juvenile life stage to adults.

USGenNE in their temperature polygons derive their regression lines using data from both adults and juveniles together. Under USGenNE's approach, these two life stages should have been separated and regression lines done for each one individually. Temperature polygons for both life stages should have been developed by the permittee, because for most species they would have provided very different results. Generally, juvenile life stages tend to be less sensitive than adults. Therefore lumping the stages tends to overestimate habitat for adults.

5. USGenNE did not consider recent research in the construction of the reproduction portion of the winter flounder polygon. Keller and Klein-MacPhee (2000) showed through a mesocosm study that winter flounder egg hatching success was significantly affected by water temperature. Due to activity of predators, which is controlled by water temperature, egg mortality was greatly reduced in mesocosm tanks with water temperature of 5° C. The permittee has cited this study to support the notion of increased predator activity as helping to cause the collapse of Mount Hope Bay winter flounder, but ignored the study for the purpose of construction of its polygons. Consideration of this study would reduce the habitat area available for reproduction in the winter flounder polygon. The net result is that impacts to winter flounder reproduction due to thermal discharge are underestimated.

6. USGenNE's variance application presents a biothermal assessment for winter flounder eggs, juveniles and adults, but does not consider impacts to larval stages. Buckley et al. (1990) showed that cold water produced larger larvae in good condition as evidenced by high RNA content. Keller and Klein-MacPhee (2000) found using a mesocosm experiment that colder temperatures reduced predation on larvae and led to higher larval survival though metamorphosis to the young-of-the-year stage. By not considering larvae, USGenNE has done an incomplete thermal analysis of the impacts to winter flounder.

7. Figure 6.3-4 shows USGenNE's assessment of the chronic mortality to juvenile winter flounder from the thermal discharge. EPA believes that chronic mortality has been underestimated, because of USGenNE's acclimation assumptions and the use of a 7 day acclimation period.

The greatest point of disagreement with USGenNE on the biothermal assessments has been over the specific temperature thresholds. As a result, EPA contracted with Dr. Charles Coutant and Dr. Mark Bevelhimer of the Oak Ridge National Laboratory to conduct a literature review of temperature thresholds for the RIS and some additional species covered by the Magnuson-Stevens Act. Based on this review report, and the TAC's own review of the scientific literature, the most sensitive species for the pelagic and benthic layers for winter and summer were chosen by the TAC and EPA. In our literature review, EPA identified reasonable, yet protective, temperature values for the most sensitive life stage of the most sensitive species.

In selecting specific temperature thresholds, EPA took a reasonably conservative approach for several important reasons. These reasons are detailed below.

1. **Dire condition of the fish stocks in Mount Hope Bay:** The magnitude, scope and rapidity of this decline is virtually unprecedented. The restoration of fish stocks, in locations such as Georges Bank, has required dramatic reductions in fish mortality and extended recovery periods.

2. **Long term water temperature rise:** Keller et al. (1999), Sullivan et al.(2001) and Scherer (2002C) all document a long term rise in water temperatures in Narragansett Bay and Mount Hope Bay (although the absolute temperature of Mount Hope Bay is warmer) at almost identical rates of change. Keller et al. (1999) cite a rate of change of close to 2° C over the last 40 years in Narragansett Bay. It is likely that any engineering solution that is devised and implemented for Brayton Point Station will be expected to have an operational life of at least 20 years. At the current rate of temperature increase, this would allow for background water temperatures to increase by 1.0° C or more. If background water temperatures continue to increase, the analysis done here becomes less and less conservative.

3. **Inability to predict trophic dynamic effects:** Small changes in water temperature can have disproportionately large impacts due to changes in competitive balance between species. Keller et al. (1999) looked at the processes controlling phytoplankton blooms in a series of mesocosms. In mesocosm tanks held at 1° C above the long term water temperature average, grazing rates of zooplankton and filtration rates of mussels were elevated to the point of eliminating the normal late winter/early spring phytoplankton bloom. In mesocosm tanks held at 1° C below the long term water temperature average, grazing and filtering were reduced and normal phytoplankton blooms occurred.

A second study by Keller and Klein-MacPhee (2000) looked at the impact of elevated winter water temperature on larval winter flounder survival. Mesocosms were held at 1° C above (warm) the long term water temperature average and at 2° C below (cool) the long term water temperature average. Winter flounder egg survival, percent hatch, time to hatch and initial size were statistically significantly greater in cool systems. In addition mortality rates of winter flounder larvae were lower in cooler systems and statistically significantly related to the abundance of active predators. In cool systems, predators of winter flounder larvae tend to be less active allowing the winter flounder a window of time to outgrow their predators. This offset of time is not present in warmer (in this case by just 3° C) systems and predators dramatically reduce winter flounder larval abundance. We are presently unable to predict or even identify all the trophic dynamic effects that may occur from temperature increases. However, the evidence clearly shows, in general, that winter flounder do better in cooler water temperatures.

EPA selected the warmest year (1999) in the dataset (1990-1999) to represent the ambient water temperatures. The TAC reviewed the scientific literature and selected the most sensitive species for the pelagic and benthic zones in both the winter and summer time frames. These critical temperatures were then compared to hydrothermal model outputs run at various operating conditions. The critical temperature values, with their supporting information, are listed below.

> *Benthic Layer, Summer time* ***24° C***: This value was selected based on data from the temperature preferences of juvenile winter flounder. As detailed earlier in this document (See discussion of "temperature acclimation"), several controlled studies document avoidance by winter flounder juveniles at this temperature. Field data collected by RI DEM corroborate these control studies and indicate that the avoidance response is not a gradual one, but a dramatic threshold. Data from Olla et al. (1969) suggest that sublethal effects occur at even lower temperatures around 22° C. Grace Klein-MacPhee, a flounder expert at the University of Rhode Island, stated that sublethal effects begin at 20° C (MA DEP, 2002). EPA selected 24° C, because multiple studies show this is a critical threshold temperature for avoidance. EPA acknowledges that some behavioral changes and sublethal effects may occur at lower temperatures, but the scientific literature is not robust enough to confidently predict the ecological impact of these sublethal effects.
>
> *Benthic Layer, Winter time* ***5 ° C***: This value was selected based on winter flounder egg viability studies. Rogers (1976) found that eggs incubated at 3° C resulted in 100% viability of eggs. At 5° C, egg viability was reduced to 83.5 % and at 10° C, egg viability was only 50%. Rogers (1976) found no viable eggs at 15° C. Keller and Klein-MacPhee (2000) found an over 90% hatching rate at an average incubation temperature of 1.86° C and an approximately 75% hatching rate at an average incubation temperature of 5.11° C. EPA selected 5° C as the winter time benthic layer threshold. Though this temperature is not the optimum for winter flounder egg hatching success, it is not possible to predict the ecological significance of the difference between 100% hatching success and 83.5% hatching success. At the same time, EPA believes that the 50% rate of egg viability at 10° C would be likely to interfere with the recovery of the winter flounder population in Mount Hope Bay. Therefore EPA selected 5° C as the critical temperature.
>
> *Pelagic Layer, Summer time* ***25 ° C***: This value was selected based on avoidance responses by sub-adult and adult striped bass. Coutant and Benson (1990) showed that striped bass avoided waters with temperatures above 25 ° C.
>
> *Pelagic Layer, Winter time* ***8 ° C***: This value was selected based on temperature tolerances of larval winter flounder. Grace Klein-MacPhee recommended 8° C as best

> for larval survival and growth for the 3-4 weeks post-hatch (MA DEP, 2002). She stated that some larvae are capable of tolerating up to 12° C, but their survival and growth is reduced. Given the depleted state of the winter flounder population in Mount Hope Bay, EPA believes the 8° C temperature value should be used.

Using the information from additional hydrothermal model runs produced by USGenNE (October 1, 2001, Section 308 Response to EPA), EPA estimated the volume of the bay that would exceed these critical threshold temperatures and the duration of the exceedance for various thermal discharge scenarios.

Since daily mean temperature was modeled for this analysis, instantaneous temperatures will periodically exceed the specific 24-hour means shown in the analysis. Much thought has been given to the ecological significance of a 24 hour mean. Obviously, some biological responses, such as a fish's decision to avoid an excessively warm area, occur on a much shorter time frame than 24 hours. On the other hand, for egg hatching success, a longer term average (> 24 hours) is probably more appropriate. Computing time and data presentation were also considerations. It is useful for the reader to keep in mind that for biological effects such as avoidance, this analysis may underestimate the effects, while impacts to egg hatching rates may be overestimated.

Benthic Layer, Summer: Table 6.3-2 depicts the results of the hydrothermal model runs done for the benthic layer in the summer. USGenNE's proposal, the Enhanced Multi-Mode, would exceed the juvenile winter flounder avoidance temperature (24° C) for 62% of the bottom water by volume for some time period equal to or greater than 5 days (out of 30 days). An additional 18% of the bottom water would experience avoidance temperatures for varying periods of time less than 5 days, but greater than zero, while only 20% of the bay bottom water would never get to 24° C. Thus, with the Enhanced Multi-Mode, over half the bottom water of the bay would be avoided by juvenile winter flounder for greater than 5 days (out of 30 days) and 80% of the bay would experience some level of impairment. Hypothetical A, which represents the lowest thermal load of any of the model runs, resulted in 36% of the bottom water volume exceeding 24° C for 5 days or more and an additional 22% experiencing some degradation for a duration less than 5 days, but more than zero. Under this alternative 42% of the bottom waters would never reach 24° C. During the warm summer, all of the modeled scenarios represent significant degradation to juvenile winter flounder in Mount Hope Bay as a result of habitat alteration by Brayton Point Station's thermal discharge.

Table 6.3-2: Percent of Bottom Water Volume Less Than, Equal to or Greater Than a Daily Mean Temperature of 24° C in Warm Summer Conditions

Scenario	% Volume < 24° C	% Volume ≥ 24° C 1 to 4 days	% Volume ≥ 24° C ≥ 5 days
MOA II[1]	14	11	75
EMM[2]	20	18	62
Hypo B[3]	32	13	55
Hypo A[4]	42	22	36
No Plant	70	26	4

[1] 1,043 MGD and 3.7 TBTU
[2] 750 MGD and 2.25 TBTU
[3] 750 MGD and 1.8 TBTU
[4] 750 MGD and 1.2 TBTU

<u>Pelagic Layer Summer</u>: Tables 6.3-3 and 6.3-4 present the percentage of surface water volume and middle water volume that exceed the adult striped bass avoidance temperature of 25° C. The Enhanced Multi-Mode option exceeds 25° C in 41% of the surface water volume for 5 days or more. An additional 29% of the surface water volume will experience some level of degradation less than 5 days in duration, but greater than zero. Thirty percent of the surface water volume of the bay would not exceed 25° C. For Hypothetical A, only 5% of the surface water volume exceeded 25° C, with an additional 19% experiencing degradation for a duration of less than 5 days, but for varying periods of time greater than zero. Seventy six percent of the surface water volume never exceeded 25° C. For the middle water volume, the Enhanced Multi-Mode would exceed 25° C for greater than 5 days in 18% of the bay. An additional 17% of the middle water volume would experience some level of degradation less 5 days in duration, but greater than zero. Sixty five percent of the middle water volume would not exceed 25° C . For Hypothetical A, less than 1% of the middle water volume exceeded 25° C for 5 days or greater. Approximately 3% of the middle water volume experienced degradation of a duration less than 5 days and 96% of the middle water volume never exceeded 25° C. Due to the small area of impact in the surface and middle waters, EPA finds Hypothetical A to represent an acceptable area of impact.

Table 6.3-3: Percent of Surface Water Volume Less Than, Equal to or Greater Than Daily Mean Temperature of 25° C

Scenario	% Volume < 25° C	% Volume ≥ 25° C 1 to 4 days	% Volume ≥ 25° C > 5 days
MOA II[1]	7	17	76
EMM[2]	30	29	41
Hypo B[3]	53	16	21
Hypo A[4]	76	19	5
No Plant	98	2	0

[1] 1,043 MGD and 3.7 TBTU
[2] 750 MGD and 2.25 TBTU
[3] 750 MGD and 1.8 TBTU
[4] 750 MGD and 1.2 TBTU

Table 6.3-4: Percent of Middle Water Volume Less Than, Equal to or Greater Than a Daily Mean Temperature of 25° C in Warm Summer Conditions

Scenario	% Volume < 25° C	% Volume ≥ 25° C 1 to 4 days	% Volume ≥ 25° C > 5 days
MOA II[1]	36	24	40
EMM[2]	65	17	18
Hypo B[3]	77	14	9
Hypo A[4]	96	3+	< 1
No Plant	100	0	0

[1] 1,043 MGD and 3.7 TBTU
[2] 750 MGD and 2.25 TBTU
[3] 750 MGD and 1.8 TBTU
[4] 750 MGD and 1.2 TBTU

Benthic Layer Winter: During warm winter conditions, essentially 100% of the volume of the bottom water exceeds the critical temperature of 5° C under all modeling scenarios. Ninety percent of the bay exceeded 5° C for five days or more with the No Plant scenario (Table 6.3-5). Thus, background conditions represent some level of degradation for winter flounder egg hatching rates under warm winter conditions. This is consistent with work done by Jeffries and Johnson (1974) that correlated winter water temperature with winter flounder abundance. They showed that years with cold winters were years of good recruitment to the stock. Additional modeling that could be performed would be to look at the frequency of the 5° C being exceeded in conditions other than the warm winter. There are a range of baseline conditions from the coldest to warmest winter in the last 10 years. The appropriate modeling question is, how many of those winters exceed the 5° C threshold with each different operating scenario. The winter operating conditions (2.375 TBTU) for the Enhanced Multi-Mode option increase the heat load over its summer output (2.25 TBTU). Thus, the Enhanced Multi-Mode option is putting out approximately twice as much heat as Hypothetical A (1.2 TBTU) in the winter, assuming both have a flow of 600 MGD. With its greater heat flux and greater ΔT, one would expect that the Enhanced Multi-Mode option would exceed the 5° C threshold with more regularity than Hypothetical A. None of the operating scenarios exceeded 10° C anywhere in the bay. While the warm winter condition will presumably not occur every year; these conditions are reasonable to use, because they are based on actual data and with long term temperature increase, they can be expected to occur more frequently.

Table 6.3-5: Percent of Bottom Water Less Than, Equal to or Greater Than a Daily Mean Temperature of 5° C in Warm Winter Conditions

Scenario	% of volume < 5° C	% Volume ≥ 5° C 1 to 4 days	% Volume ≥ 5° C > 5 days
MOA II[1]	0	0	100
EMM[2]	0	0	100
Hypo B[3]	0	0	100
Hypo A[4]	0	0	100
No Plant	0	10	90

[1] 925 MGD and 4.1 TBTU
[2] 600 MGD and 2.375 TBTU
[3] 600 MGD and 1.8 TBTU
[4] 600 MGD and 1.2 TBTU

Pelagic Layer Winter: The Enhanced Multi-Mode shows only a small amount of degradation of surface water volume, with less than 10% of the bay exceeding 8° C (Table 6.3-6). For all other scenarios, essentially 100% of the surface water volume does not exceed 8° C. For all operating scenarios, virtually 100% of the middle water volume remains below 8° C (Table 6.3-7). All operating scenarios represent an acceptable amount of thermal degradation.

Table 6.3-6: Percentage of Surface Water Less Than, Equal to or Greater Than a Daily Mean Temperature of 8° C in Warm Winter Conditions

Scenario	% of volume < 8° C	% Volume ≥ 8° C 1 to 4 days	% Volume ≥ 8° C > 5 days
MOA II[1]	81	18	1
EMM[2]	91	9	0
Hypo B[3]	99	1	0
Hypo A[4]	100	0	0
No Plant	100	0	0

[1] 925 MGD and 4.1 TBTU
[2] 600 MGD and 2.375 TBTU
[3] 600 MGD and 1.8 TBTU
[4] 600 MGD and 1.2 TBTU

Table 6.3-7: Percentage of Middle Water Less Than, Equal to or Greater Than a Daily Mean Temperature of 8° C in Warm Winter Conditions

Scenario	% of volume < 8° C	% Volume ≥ 8° C 1 to 4 days	% Volume ≥ 8° C > 5 days
MOA II[1]	91	8	1
EMM[2]	98	2	0
Hypo B[3]	100	0	0
Hypo A[4]	100	0	0
No Plant	100	0	0

[1] 925 MGD and 4.1 TBTU
[2] 600 MGD and 2.375 TBTU
[3] 600 MGD and 1.8 TBTU
[4] 600 MGD and 1.2 TBTU

(C) Other Heat Effects on Fish

USGenNE's thermal analysis focused solely on the impact of heat as a deterrent, but did not speak to the impact of heat as an attractant. It has been well established that the thermal plume from Brayton Point Station has served as a thermal attractant for large numbers of striped bass and bluefish in the fall and winter. The normal migration of these species has been disrupted by their attraction to the plume. Thousands of these fish crowd into the thermal plume and discharge canal to overwinter. This represents an unhealthy situation for the fish as they become much more prone to disease. Instead of slowing their metabolism and overwintering in a condition similar to hibernation, these fish, due to the water temperature, maintain a high metabolic rate. In addition, there is a very limited food supply for these fish overwintering in the thermal discharge. Thus if they persist, they end up in a greatly weakened physical condition. Placing large numbers of fish in a small area with elevated water temperatures and weakened physical condition makes them especially prone to the transmission of disease, such as lymphocystis. Lymphocystis is commonly found in fish residing in thermal plumes, is highly contagious and frequently fatal. This disease has been observed in striped bass taken from the discharge canal in the past, though the relative prevalence of the disease was not measured, but estimated to be present in 30-50% of the fish (DeHart, 1997). USGenNE ignores this issue and lists striped bass as residing in the bay only for half of the year in their biothermal assessment.

A second phenomenon that may fall into the category of attractant is the appearance in Mount Hope Bay of the smallmouth flounder, *Etropus microstomus*. The documented range of smallmouth flounder is from Florida to southern New England (Able and Fahay, 1998). In general, an organism is less common on either end of its latitudinal distribution as it is generally transitioning into environments that may be competitively less favorable to it. When an organism becomes more common on the edges of its latitudinal distribution, this signals some environmental change in the system. Smallmouth flounder have become more common in Narragansett Bay and Mount Hope Bay (Scherer, 2002D). Grace Klein-MacPhee (2002) theorizes that the increase in smallmouth flounder has been due to possibly one of two things:

1. The long-term warming of Narragansett Bay and Mount Hope Bay shifting the competitive balance more in favor of smallmouth flounder; or

2. The smallmouth flounder exploiting an empty ecological niche left after the dramatic collapse of fish stocks in Mount Hope Bay.

If the long-term warming of Narragansett Bay and Mount Hope Bay has resulted in a competitive shift, the operation of Brayton Point Station has only accelerated and/or exacerbated this condition. If the increase in the smallmouth flounder is due to an empty niche left after the collapse of fish stocks in Mount Hope Bay, Brayton Point Station is still complicit as EPA believes that Brayton Point Station’s operations contributed to this collapse and are precluding recovery. Shifts to warmer water species does not satisfy the requirement of a balanced indigenous population.

A third example of potential thermal attraction is the recent large fish impingement events this past February (Ketschke, 2002). In 2 separate events, over 35,000 juvenile Atlantic menhaden were impinged on the intake screens of Units 1, 2 and 3. Atlantic menhaden make seasonal migrations in the spring and fall that reportedly coincide with the position of the 10° C isotherm

(Able and Fahay, 1998). Brayton Point's thermal discharge raises the temperature of Mount Hope Bay in relation to neighboring Narragansett Bay. Thus, the thermal discharge likely contributed to the delay in migration of these fish. In addition, as baywide water temperatures cooled into the winter, these fish became trapped and concentrated in the warmest part of the bay, Brayton Point Station's thermal plume. The presence of the thermal plume affected their relative distribution within the bay during the winter. Fish were pulled closer to the plant by their attraction to the thermal plume, making them more susceptible to impingement. This recent event is not the first large winter impingement event, as another occurred as recently as December of 1999 of 4,000 fish consisting primarily of 6 species (Ketschke, 2000).

Finally, MRI reports that 80% of all winter flounder in the trawl surveys are caught at one station, this is the station in front of the cooling water intake structure. This station is dredged periodically and as a result is one of the deepest points in the bay. Due to its water depth, it also is the coolest water temperature in the bay. Winter flounder are reported to have a wide water depth range (Gray, 1991), thus another factor must be restricting them to a very narrow depth profile in Mount Hope Bay. The deeper water is the only location where the adult winter flounder can find refuge from the warm water temperatures.

6.3.3f Other Vertebrate Wildlife

EPA finds Mount Hope Bay to be an area of low potential impact for vertebrate wildlife. Discussions with National Marine Fisheries Service and Bob Kenny of the University of Rhode Island suggest that Mount Hope Bay is not a significant habitat for marine mammals or sea turtles. Thus, there is no potential for any significant impact to marine mammals or sea turtles from any of the alternatives being considered.

6.3.4 Summary of Thermal Effects

Mount Hope Bay is a system that has experienced and is experiencing numerous thermally related impacts and changes. Some of the more obvious ones, for which there appears to be no disagreement, include:

* Absence of the normal winter-spring phytoplankton bloom;

* Appearance of nuisance algal blooms;

* Overwintering of the ctenophore *Mnemiopsis leidyi*;

* Overwintering of striped bass and bluefish in discharge canal;

* Increased abundance of smallmouth flounder in the bay;

*Multiple large fish kills as a result of large impingement events in the winter; and

*Thermal avoidance of most of the bay by adult winter flounder.

Brayton Point Station's current thermal discharge exerts a massive impact on the thermal conditions in the bay dramatically altering what would be the natural thermal regime. USGenNE's proposed Enhanced Multi-Mode system will not reduce the plant's thermal discharge into the bay sufficiently to relieve any of the above listed thermal impacts or changes. In addition, impacts predicted for the Enhanced Multi-Mode include:

* Large areas of the bay being avoided by juvenile winter flounder and striped bass during warm summer conditions;

* Extensive areas of the bay experiencing water temperatures resulting in chronic toxicity to juvenile winter flounder;

* Reduced winter flounder egg hatching success for the entire bay for the warmest winter conditions. Of the control options considered, the Enhanced Multi-Mode Option would have the greatest extent of impact, although this has not yet been quantified;

* Increased predation on winter flounder eggs and larvae by sand shrimp; and

* Potential exclusion of eelgrass.

6.3.5 Cumulative Impact Assessment

According to CWA §316(a) and 40 CFR §125.73 (a) and (c), to determine whether the protection and propagation of the balanced indigenous community is being achieved, EPA must consider, not only thermal impacts, but impacts from other stressors as well. Each species is subjected to a wide variety of stressors or sources of mortality (Figure 6.3-5). Therefore, the future operation of this facility, in conjunction with the other sources of mortality, must ultimately still allow the existence of a balanced indigenous community.

The cause or causes of the dramatic decline of fish stocks in Mount Hope Bay has been the subject of substantial debate. USGenNE has pointed to a wide variety of stressors on fish populations, winter flounder in particular, as potential explanations for the steep decline in fish abundance since 1985 (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, p. 43). These stressors can be classified as natural (predation by fish, birds, etc.) or anthropogenic (overfishing, entrainment, impingement, etc.). Each population will increase or decline based on the cumulative mortality rate, comprised of both natural and anthropogenic factors. The goal of this permit is to allow the fish populations in Mount Hope Bay the chance to recover. Thus the cumulative mortality rate must result in a positive population trajectory. The greater the natural mortality rates, the smaller the anthropogenic mortality rates must be to allow for a recovery.

USGenNE particularly focuses on overfishing as the dominant stressor. Without denying that overfishing has also been an important stressor, EPA believes that entrainment, impingement and thermal effects resulting from plant operations are additional critical stressors on fish populations in Mount Hope Bay. Extensive efforts have been made by both the State of Rhode Island (Gibson, 2001) and the Commonwealth of Massachusetts (Lawton, 2001) to restrict fishing mortality in Mount Hope Bay and elsewhere. In addition, the federal government has continued to reduce fishing mortality on groundfish stocks (winter flounder included) by implementing closure areas, restricting days at sea, requiring nets with larger mesh and buying back fishing licenses.

In an effort to discern what effect alternative improved control technologies might have on fish population recoveries, a winter flounder population modeling effort was undertaken by USGenNE at the request, and with the assistance, of the Brayton Point TAC. RAMAS GIS/metapopulation software, utilizing a Leslie matrix, was chosen to simulate winter flounder population changes in response to different control technology/plant operating scenarios. This model incorporated direct losses of winter flounder due to fishing, impingement and entrainment. A separate habitat exclusion model was also developed to try to examine habitat suitability and the results of this model were then fed into the Leslie matrix. Despite this integrated approach, limitations of the analysis were acknowledged at the outset. For example, the approach to habitat suitability was fairly crude, with no ability to consider the interactive effects of various water quality parameters, such as dissolved oxygen. From the beginning of this modeling work, the regulatory agencies agreed that before the model could be considered validated it would, at a minimum, need to be able to replicate past winter flounder population changes.

At present, despite extensive efforts by USGenNE and its consultants, EPA's consultants (Stratus Consulting), and members of the TAC, the model has not been validated to the satisfaction of EPA or the TAC. The model has been unable to replicate the past winter flounder population changes adequately and, therefore, EPA and the TAC cannot have confidence in any future projections that the model might produce. Two areas, in particular, are of concern to EPA and the TAC: (a) the period from the mid- to late-1970s; and (b) the period from 1996 to the present. In the 1970s, actual abundance data shows multiple swings, up and down, that are not accurately reflected by the model results. Additionally, the model shows a significant recovery of winter flounder in Mount Hope Bay in the late 1990s, but that has not been indicated by the actual trawl data (Figure 6.3-6). Considering all of the above, EPA has concluded that the model cannot be relied upon to produce fair predictions of future winter flounder population numbers under various control regimes. EPA expects that USGenNE, EPA and members of the TAC will continue with efforts to refine the model in hopes of eventually producing a validated predictive model for winter flounder in Mount Hope Bay. It should be noted that by citing the problems with the RAMAS model, EPA in no way intends to criticize the efforts of USGenNE, in this regard. Modeling complex biological systems is a developing area of scientific work that has a long way to go before it will become an easily available and reliable tool for natural resource managers. The number of interacting variables at work in a large natural ecosystem make the task of modeling population fluctuations, of even one species, which is all that was attempted in this case, especially daunting. Therefore, EPA relied on the scientific literature on temperature sensitivities, field data provided by Rhode Island DEM and information submitted by USGenNE.

Outlined below are brief analyses of other sources of mortality to fish in Mount Hope Bay.

6.3.5a Overfishing

EPA recognizes that fish populations are adversely effected by multiple stressors and that direct harvesting or fishing is an important one. However, EPA does not believe that overfishing is the sole significant stressor that has caused the decline of fish populations in Mount Hope Bay.

There is no question that excessive long-term harvesting of fish stocks has occurred for many species in New England waters. Most coastal populations of commercial fish stocks are currently classified as fully exploited or overexploited by the National Marine Fisheries Service (NMFS, 1999). As a result, however, fishing restrictions have been imposed by NMFS on many commercial fish in New England. In Mount Hope Bay, both Massachusetts and Rhode Island have virtually eliminated all commercial and most recreational fishing through regulation (Gibson, 2001, Lawton, 2001).

The permittee suggests that overfishing is the primary cause for the collapse of fish stocks in Mount Hope Bay: “USGenNE believes it can demonstrate that the Station’s historic impacts on the fish population are negligible in relation to the fishing pressure and it is entitled to a [§ 316(a)] variance for that reason alone.” (USGenNE May 2001 Variance Request Application and Partial Demonstration Document under the Clean Water Act Section 316(a) and (b)). After review of USGenNE’s arguments, EPA is not persuaded. Stated below are several reasons that EPA does not accept the permittee’s argument that overfishing is the sole significant stressor on fish stocks in Mount Hope Bay, or that the operation of the BPS CWISs is not one of the significant stressors on these stocks, contributing to their serious decline.

1. *Length distribution of winter flounder and windowpane*: The classic response of a fish stock to overfishing is a truncating of the size frequency distribution, with the larger adult fish decreasing first, because they are subject to the most intense direct fishing pressure. Small and intermediate size fish decline later after the spawning biomass of the stock and recruitment begins to fail. Figure 6.3-7 and Figure 6.3-8 show the size distribution of winter flounder and windowpane in the mid 1970s prior to the collapse. All size classes are represented. Figure 6.3-9,and Figure 6.3-10 represent the length frequency distribution of winter flounder and windowpane during the fish decline. Figure 6.3-11 and Figure 6.3-12 show the length

frequency of windowpane and winter flounder after the decline. The small and intermediate sized fish are almost completely eliminated, leaving only the adults. This is the opposite of what a stock length distribution curve looks like if it is overfished. Finally, Figure 6.3-13 shows the size distribution of fish in Narragansett Bay during the time of the decline in Mount Hope Bay. Comparatively, the Narragansett Bay population shows a very different size structure distribution than the stock in Mount Hope Bay, with fish of all size ranges present in the Narragansett Bay population. The sudden and near complete loss of small and intermediate sized fish in Mount Hope Bay is completely contrary to a decline facilitated principally by overfishing which would target the larger adult fish in the population. Brayton Point Station's operations have greater effects on the egg, larval and juvenile life stages than the adult stage due to:

1. Greater susceptibility of subadult lifestages to entrainment and impingement than adults; and
2. Longer residence time of subadult lifestages in the bay than adult winter flounder.

Thus, impacts associated with Brayton Point Station operation would likely be reflected initially in the smaller size winter flounder and windowpane.

2. *Rapidity of decline*: Units 1, 2 and 3 began operations in the 1960's, and fishery data suggests declining populations in Mount Hope Bay beginning from 1972 when data collection began. While aggregate fish abundance in Mount Hope Bay was already declining, it dropped dramatically in a 1 year time period between 1985-86. Fish abundance profiles of overexploited areas, such as George's Bank, do not show such rapid declines (Fogarty and Murawski, 1998). There was also no corresponding increase in fishing rates that would explain such a sudden shift in aggregate fish abundance (Reitsma, 2001). Yet, Brayton Point Station's thermal discharge and cooling water intake volume increased significantly in July 1984.

3. *Multiple species affected*: Sixteen of the twenty finfish species in Mount Hope Bay show a similar rate of decline, with a dramatic drop-off in 1985. It is highly unlikely, that sixteen different fish species (which include both pelagic and demersal species) would all decline at the same rate due solely to fishing pressure. For the population trajectories to be identical in all 16 species, the interaction between multiple complicated natural processes (i.e., reproduction, recruitment, predation, etc.) and harvesting rates would need to yield an equivalent result for each species. Impacts from fishing are generally focused on the target species (though there is no question that mortality as a result of bycatch occurs), while the impacts from Brayton Point Station's operations are indiscriminate.

4. *Species replacement*: On George's Bank, overexploitation of target species (groundfish) left their populations at extremely low levels. As a result, other species (primarily skates and dogfish) filled the ecological niche left from the reduction of groundfish (NMFS,

1995; Sherman, 1994). Biomass or aggregate resource abundance did not decline, even under the heaviest exploitation rates. In Mount Hope Bay, however, commercially important species declined, with no apparent subsequent replacement by other species and as a result, a dramatic decline in aggregate resource abundance was experienced (Gibson, 1996). Neighboring Narragansett Bay did experience species replacement, with striped bass, scup, butterfish and sea herring increasing (Gibson, 1996). However, while populations of these four species increased in Narragansett Bay, they continued to decline in Mount Hope Bay (Gibson, 1996).

5. *Regional Impacts*: Overfishing is a regional phenomenon which would not affect just one embayment. Additionally, it is highly unlikely that overfishing of 16 species would reach a critical point at the same time in one embayment resulting in a dramatic decline in resource abundance. Furthermore, similar shallow water embayments like nearby Greenwich Bay and the estuarine portion of the Providence River have significantly greater fish abundance than Mount Hope Bay and the fishing restrictions for Mount Hope Bay are equivalent if not more stringent than restrictions for those two water bodies.

6. *Absence of a recovery*: In other systems where overfishing has been the suspected cause of resource decline, reducing harvesting rates has led to a recovery in the resource. Fishing for winter flounder and other species has been severely restricted in both the Massachusetts and Rhode Island segments of Mount Hope Bay. Moreover, exploitation rates of winter flounder have been significantly reduced in Rhode Island waters and region-wide and modest recoveries have been noted in Narragansett Bay and southeastern New England, but no comparable recovery has occurred in Mount Hope Bay (Lynch, 2000; Gibson, 2001).[6] One could make the analogy that Brayton Point Station is a major harvester of fish, fish eggs and larvae and that while commercial and recreational fishing rates have been cut dramatically in recent years (Gibson 2001, Lawton, 2001), the "harvesting" by Brayton Point has increased over the years due to increased cooling water flow and heat rejection from the plant. Link (2002) suggests that there is strong evidence that predation may be a leading factor in limiting or eliminating fish stock recovery, in populations that are severely depressed. The continued harvesting of large quantities of fish eggs and larvae by Brayton Point could serve to limit strong year class recruitment that could fuel a stock recovery.

7. *Timing of decline*: The only stressor that showed a significant change proximate to

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[6] It should also be noted that the tightened thermal discharge and cooling water intake requirements imposed on BPS in MOA II, <u>see</u> above discussion of permitting history, have not resulted in a recovery of the Mount Hope Bay fishery (MRI, 2001). This is not surprising to the regulatory agencies as the limitations in MOA II were the result of a compromise with NEPCO, the previous plant owner and permittee, and were merely an interim step designed to limit or reduce impacts while further study was undertaken to support the development of long-term requirements for a new permit.

the time of the significant decline in the mid 1980s is the change in operation at Brayton Point Station (Figure 2.6-2). Fishing induced mortality did not increase significantly for at least winter flounder in the mid 1980s (Gibson, 2001).

6.3.5b Predators

USGenNE has suggested that perhaps predators have triggered the collapse of fish stocks in Mount Hope Bay. These possible predators include cormorants, green crabs, ctenophores, sand shrimp and a suite of other organisms. Link (2002), in a paper on ecological considerations in fisheries management, states "there is little evidence that predation causes large, persistent stock declines."

> *Cormorants*: Cormorants are piscivorous birds and have been implicated in finfish declines in other areas (Link, 2002). It is extremely unlikely, however, that cormorants were responsible for the dramatic decline in Mount Hope Bay in the mid 1980s for several reasons:
>
> > 1. At the time of the fish collapse in Mount Hope Bay, the only nesting cormorants present in Rhode Island were on Sakonnet Point (Meredith Simas, USGenNE to Todd Callaghan, MA CZM, 3/21/02). The Sakonnet Point nesting site is approximately 15 miles away from Mount Hope Bay. There is plenty of nearshore shallow water habitat along Sakonnet Point, so it is unlikely that the cormorants would fly 15 miles to feed in Mount Hope Bay, when they can feed in the general vicinity of their nests;
> >
> > 2. At the time of the finfish collapse in Mount Hope Bay, cormorant abundance was at a third of the level it is today. It is unlikely that the 3,000 cormorants (Meredith Simas, USGenNE to Todd Callaghan, MA CZM, 3/21/02) in Rhode Island at the time could have consumed sufficient numbers of fish to trigger the collapse of multiple species in Mount Hope Bay;
> >
> > 3. Other areas of Rhode Island waters have not collapsed to near zero abundance levels despite the continued increase of cormorants to over 11,000 statewide by 1997 (Meredith Simas, USGenNE to Todd Callaghan, MA CZM, 3/21/02);
> >
> > 4. Survival rates of young-of-the-year winter flounder have varied without obvious trend since 1986 (Reitsma, 2002). If cormorants were responsible for the collapse in fish stocks, survival rates of young-of-the-year winter flounder would decline as cormorant abundance increased; and
> >
> > 5. Stomach content analysis, conducted by Rhode Island Division of Fish and Wildlife on 67 cormorants, sampled from Hope Island and Sakonnet Point,

showed that winter flounder comprised only 8.7% of the total contents (Reitsma, 2002).

Green crabs: Green crabs are found predominantly in the intertidal and shallow subtidal zones. They prefer rock and other structure and are rarely found on bare sand substrate where large numbers of juvenile winter flounder reside. There is very limited overlap between green crab's preferred habitat and that of juvenile winter flounder. This suggests that green crabs are relatively insignificant predators on winter flounder.

Ctenophores: A more detailed discussion on ctenophores is found in the Zooplankton section of this document. In brief, the timing of ctenophore blooms has changed over historical norms. This is generally believed to be a result of changes in water temperature (Sullivan et al., 2001). Brayton Point Station has significant impact on water temperatures in Mount Hope Bay, where the ctenophores overwintered. Direct predation on winter flounder eggs or larvae by this ctenophore is unlikely, but they may become an additional competitor with larval fish for zooplankton prey. Therefore, if increased abundance of ctenophores has resulted in increased mortality rates of winter flounder larvae, Brayton Point Station is indirectly responsible, as its thermal discharge has contributed to changing temperature conditions in Mount Hope Bay.

Sand shrimp: Winter flounder spawn in the late winter to early spring, when water temperatures are generally cold. This provides winter flounder an "escape in time" from benthic predators that are more active in warmer water temperatures. Sand shrimp, *Crangon septemspinosa*, are one of these important benthic predators. Keller and MacPhee (2000) conducted a mesocosm study examining winter flounder egg and larval survival as a function of winter water temperatures. Winter flounder egg and larval mortality rates were statistically lower in the cool mesocosm tanks. A change in water temperature of just 2 degrees was enough to affect predator activity, hence egg and larvae survival. David Taylor at the University of Rhode Island has shown that *Crangon* will prey on winter flounder in the field in the winter, so their predation is not simply limited to enclosure studies (Haas, 2002). Similar to ctenophores, increased predation by sand shrimp may be a temperature mediated phenomenon that Brayton Point Station is contributing to significantly.

In addition, it should be noted that USGenNE has suggested these predators as triggering the collapse of the winter flounder population. Tautog, windowpane and hogchoker have different natural history characteristics than winter flounder and thus may have a different suite of predators. USGenNE has not addressed predation on these other species.

6.3.5c Water Quality

USGenNE has suggested that poor water quality (specifically high levels of nutrients) has caused the decline of fish stocks in Mount Hope Bay (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I Appendix C, p. 4). Excess nutrient loading in marine systems, primarily nitrogen, stimulates phytoplankton growth, which results in increased organic loading to the system. The organic material is broken down by respiration, which requires oxygen. Areas of high organic loading frequently have low dissolved oxygen concentrations in the water column as a result. Low dissolved oxygen can certainly trigger avoidance and in extreme cases mortality in marine organisms (EPA, 2000). Historically, Mount Hope Bay has experienced periods of extremely low dissolved oxygen (Isaac, 1997). These tend to occur in the warmest time of the year (summer). The spatial extent of the low dissolved oxygen and the frequency of its occurrence are not very well defined. Long term average dissolved oxygen data collected at a limited number of stations shows that May through October dissolved oxygen concentrations in the bottom waters are lower near the point of the thermal discharge compared to a point mid-bay near Spar Island (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, p. A-190, A-214).

Recent data collected in June and July of 2001 in Mount Hope Bay by Massachusetts Coastal Zone Management (MCZM) show periodic excursions of dissolved oxygen in the bottom water to as low as 2 mg/l for several hours at a time (Rountree et al, 2002).

Temperature affects dissolved oxygen through several mechanisms detailed below:

2. The solubility of oxygen in water decreases as water temperature increases;

2. Photosynthetic rates in phytoplankton are increased with temperature, thus potentially increasing the mass flux of organic material to the benthos; and

3. Respiration rates of organic material is increased with temperature. Respiration is a degradative process of organic material that utilizes oxygen.

Thus, the addition of heat by Brayton Point Station, to a nutrient rich embayment such as Mount Hope Bay, exacerbates any ongoing water quality problems. However, EPA does not believe that low dissolved oxygen was the primary cause of the fish collapse in Mount Hope Bay, for the following reasons:

1. *Time of year*: Adult winter flounder come into Mount Hope Bay in the winter and early spring to spawn. Dissolved oxygen concentrations are typically at their highest at this time of year. Thus, it is unlikely that low dissolved oxygen triggered avoidance or mortality at this time of year. Thus, the collapse of winter flounder in the mid 1980s cannot be explained by the effects of dissolved oxygen directly; and

2. *Health of the benthic community*: The benthic infaunal community is often used as an indicator of water quality and stress from organic loading, due to its limited mobility and it's general exposure to the lowest dissolved oxygen concentrations in the water column. The EPA laboratory in Narragansett, as part of a coastal eutrophication study, examined the benthic community from several coastal locations in New England. They observed numerous sample sites in Mount Hope Bay proper and in the lower Taunton River. They did not detect any evidence of extended anoxia or hypoxia. Large areas of the bottom consisted of tube building amphipods, which are considered high quality habitat for juvenile winter flounder (Franz and Tanacredi, 1992). Thus, based on this data, it seems unlikely that water quality, and dissolved oxygen in particular, is the sole or principal cause of the collapse in fish stocks.

6.3.5d Brown Tides

USGenNE has suggested that "brown tides" may have caused the dramatic finfish decline in the mid 1980s (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. I, Appendix C, p. 5). Brown tides are a kind of nuisance algal bloom that in some areas like Peconic Bay have become persistent events. The great quantity of algal cells that comprise these blooms reduce light penetration and thus displace submerged aquatic vegetation. In addition, the cells can clog gills in fish and filter feeding invertebrates leading to their demise. There was a report of a brown tide in Narragansett Bay in the mid-1980s, but there have not been any significant blooms documented since that time (Deacutis, 2002B). Thus, EPA does not believe that brown tides caused the major decline or continued low abundance of fish in Mount Hope Bay.

6.3.5e Entrainment and Impingement

For the complete analysis, please refer to the Section 316(b) portion of this document. Briefly, Brayton Point Station entrains trillions of fish eggs and larvae and impinges tens of thousands of fish from Mount Hope Bay every year (December 2001 USGenNE 316(a) and (b) Demonstration, Vol. II, p F-26, F-27, F-36). These losses represent a substantial percentage of the total population for winter flounder (and likely tautog, windowpane and hogchoker) in Mount Hope Bay.

In summary, in addition to thermal impacts, EPA has considered overfishing, predation, water quality and entrainment and impingement as other sources of fish mortality in Mount Hope Bay. It is unlikely that any of these other sources of mortality, alone, can explain the collapse and lack of recovery of fish populations in Mount Hope Bay. However, these forces in conjunction with the plant's addition of heat to Mount Hope Bay may be exacerbating fish mortality due to poor water quality and increased predation.

6.4 Decision on USGenNE's Variance Application and Proposed "Alternative Effluent Limitations"

6.4.1 Determination of a Balanced Indigenous Community

USGenNE has suggested that the finfish community has become more balanced through time (December 2001 USGenNE 316(a) and (b) Demonstration, Appendix C, p. 26). USGenNE defines "balanced" as a measure of the distribution of numbers of individuals per each species. Thus, a community that is numerically dominated by 1 or 2 species, would appear more balanced with the decline of the numerical dominants. Several members of the TAC were especially critical of USGenNE's analysis of finfish diversity (See Appendix A). USGenNE's analysis negatively biased the diversity index for the samples from the 1972-1986 time frame. Artificially limiting the sample number to 50 fish, out of a sample total much greater than that, in the samples from 1972-1986 reduces the number of species present. This bias was not present in samples after 1986, when only 50 fish were being caught in all of the trawls combined.

The most troubling trend in Mount Hope Bay is the dramatic loss of total finfish abundance and biomass. A greater than 80% reduction in abundance of the nekton community will have a significant impact on other components of the ecosystem as well. Reduction of the nekton community may partially explain the increase in the temporal abundance of the comb jelly, *Mnemiopsis leidyi* (This may also be partially explained by the increased water temperature in Mount Hope Bay). Even in areas of dramatic overfishing, the aggregate nekton abundance remained constant (Fogarty and Murawski, 1998). It is rare that an entire ecological community is virtually eliminated.

Within the nekton community, 16 of 21 species in Mount Hope Bay have significantly declined with time. Winter flounder, windowpane, tautog and hogchoker continue to persist at extremely low levels in Mount Hope Bay. In Mount Hope Bay, winter flounder and tautog are "commercially extinct" and are likely "ecologically extinct" as well. Thus, their abundances are so low that their populations are no longer filling their ecological niche. It has been theorized that this is one factor that may be contributing to the increase in abundance in the smallmouth flounder (Klein-MacPhee, 2002). EPA does not believe that a balanced indigenous community currently exists in Mount Hope Bay. This is further indicated by the increased prevalence of thermotolerant species, such as ctenophores and fish normally found in warmer waters, such as smallmouth flounder. The increased presence of these species and the absence of the historically dominant species indicates that the balanced indigenous population has not been protected.

6.4.2 EPA's Decision on USGenNE's § 316(a) Variance Application

In order to receive a § 316(a) variance from water quality and technology standards, an applicant must demonstrate that its thermal discharge will not interfere with the protection and propagation of a balanced indigenous community within the receiving water. Applicants can do this in one of two fashions: they can submit a retrospective analysis or a prospective analysis. A retrospective analysis attempts to prove lack of harm from past operation. If the applicant can demonstrate a lack of harm from past operations, then one may be able to infer no future harm if operations and other stressors are continuing into the future at rates similar to or less than the past. A prospective analysis attempts to predict impacts in the future based solely on future plant operating conditions and other factors. USGenNE submitted a prospective analysis suggesting that their future operations would allow for the recovery of a balanced indigenous community.

The Mount Hope Bay finfish community of 2002 is in dire condition. Winter flounder, windowpane, tautog and hogchoker all exist at an average abundance of less than 1 fish caught per otter trawl sample in trawls conducted by the applicant. For winter flounder, this represents a 100 fold reduction over historical levels. In addition, 80% of the winter flounder caught in trawls conducted by the applicant were from one station, the station in front of the intake (Scherer, 2002E). This station happens to have the deepest water in the upper portion of the bay, so it is likely that it represents the coolest water temperatures in the upper portion of the bay. This likely explains the higher winter flounder catch rates at that site. Normal migration patterns of striped bass, bluefish and possibly menhaden have been disrupted by the plant's thermal discharge. Not only have Brayton Point Station operations significantly decreased the quantity of fish in Mount Hope Bay, but the thermal plume has restricted the movement of the fish that are left through thermal avoidance or attraction.

Several substantive actions are occurring or have already occurred, which should improve conditions for fish in Mount Hope Bay. The city of Fall River has embarked on a 150 million dollar treatment plant and combined sewer overflow (CSO) upgrade. The States of Massachusetts and Rhode Island have significantly curtailed commercial and recreational fishing in Mount Hope Bay and elsewhere for numerous species including winter flounder (Gibson, 2001; Lawton, 2001). Federal actions have also been taken to reduce overfishing in federal waters. Reduced fishing mortality has spurred a modest recovery of winter flounder stocks in other areas of Narragansett Bay and southeastern New England (Gibson, 2002A). Unfortunately, this recovery has not been seen in Mount Hope Bay, where stocks continue to persist at levels just above zero. Gibson's (2002A) analysis of regional effects shows that fish stocks are behaving differently in Mount Hope Bay than other comparable areas in Narragansett Bay.

Consistent with EPA's § 316(a) Technical Guidance Manual (May 1, 1977), an analysis of each community type was completed. Under the station's current operating conditions, several ecosystem changes have been noted. For the phytoplankton community, nuisance algal blooms have recently occurred in the bay and normal phytoplankton population dynamics have been altered, likely as the result of elevated water temperature. For the zooplankton community, the expanded presence of ctenophores, which may also be related to elevated water temperature, is likely to have a dramatic impact on normal zooplankton population dynamics. For the fish community, there is a documented blockage of striped bass and bluefish migration due to thermal attraction and an increased abundance of smallmouth flounder (a southern warmwater fish). Moreover, the plant's thermal discharge results in large areas of the bay having water temperatures that cause avoidance by winter flounder juveniles. The thermal discharge is apparently restricting adult winter flounder to predominantly the deepest portions of the bay. Finally, the entrainment of huge quantities of fish eggs and larvae and the impingement of large numbers of juvenile and adult fish may dampen or eliminate fish stock recovery. EPA believes that the balanced indigenous population of fish has not been maintained in Mount Hope Bay and that the plant's thermal discharge is a significant contributor to this problem.

USGenNE's Enhanced Multi-Mode scenario (annual flow of 650 MGD and annual heat load of 28 TBTU) represents an approximately 33% reduction in thermal loading to the bay. EPA's analysis concludes that this level of reduction is not sufficient to eliminate the above listed thermal impacts. In addition EPA's analysis predicts significant areal effects to Mount Hope Bay from the thermal discharge under the Enhanced Multi-Mode scenario. These effects include chronic toxicity to juvenile winter flounder, avoidance of large sections of the bay by juvenile flounder and a reduced winter flounder egg hatching rate. In addition, based on the combination of water temperature and water clarity, Mount Hope Bay represents an exclusion zone for the growth of eelgrass. The plant's thermal discharge serves to directly and indirectly depress dissolved oxygen concentrations in the bay. These impacts in conjunction with the high quantity of impingement and entrainment losses certainly will not allow for the recovery of winter flounder or the wider balanced indigenous community. Thus, EPA denies USGenNE's Enhanced Multi-Mode Variance Request.

To determine the appropriate protective thermal limit, EPA reviewed the benthic modeling runs for both the summer and winter conditions. It was obvious from the model results, that the area of critical temperature exceedance was greatest in the benthic layer. For summer operating conditions, a second order polynomial was fitted to the thermal output data versus water quality degradation (as % of the bay exceeding 24° C for more than 5 days per month) (Figure 6.3-14). Using this relationship, EPA determined the condition that would ensure that no more than 10% of the bay exceeds 24° C for more than 5 days per month. This results in a thermal discharge of 0.14 TBTU per month in the summer. Juvenile winter flounder inhabit shallow sandy subtidal areas that predominate in the northern portion of the bay (December 2001 USGenNE § 316(a) and (b) Demonstration, Vol. I, Appendix B, p. B-98). As a result, a large thermal plume would dramatically effect the amount of juvenile habitat available. Thus, EPA has determined that a greater than 10% areal impact of the bay would not preserve sufficient juvenile habitat in the summer to allow for a recovery. Collie and Delong (2001) in their key factor analysis suggest that for winter flounder in Mount Hope Bay, a recruitment bottleneck occurs from Age-1 spring to Age-1 fall. This relationship is different than every other portion of Narragansett Bay, where the bottleneck occurs at a later life stage. This bottleneck occurs in the summer and effects the juvenile life stage. Collie and Delong (2001) found a positive correlation between juvenile mortality rates and water temperature. Thus, higher water temperature led to higher mortality rates in juveniles. In order to restore at least winter flounder in Mount Hope Bay, it is likely that this recruitment bottleneck needs to be relieved. As a result, EPA concludes that no greater than 10% areal impact of elevated temperature is acceptable for the bay in the summer.

Review of the scientific literature suggests that winter is a thermally sensitive time for many ecological processes in Mount Hope Bay. Rogers (1976) found that optimal egg hatching occurred at salinities lower than truly marine waters (35 parts per thousand). Thus, the lower portion of the rivers that feed into Mount Hope Bay are likely important spawning areas for winter flounder in Mount Hope Bay. These spawning locations tend to be in the northern portion of the bay in close proximity to the discharge canal and are susceptible to large thermal plumes. Currently, the lack of the normal winter-spring phytoplankton bloom, the expansion in ctenophore time of occurrence and retention of striped bass and bluefish in the thermal discharge plume show that thermal impacts are already occurring in the winter. In addition, increased predation on winter flounder eggs and larvae may also be occurring due to increased activity of sand shrimp. To minimize thermally mediated changes in the bay, a significant reduction in heat is required for this portion of the year as well. EPA believes that a discharge of 0.14 TBTU is also warranted for the winter months. Therefore, EPA believes a discharge of 0.14 TBTU per month or discharge limit of 1.7 TBTU per year, as proposed in the draft permit, satisfies the requirements of CWA § 316(a).

EPA is continuing the 95° F discharge limit for Brayton Point Station in the current draft permit. Based on the rapid mixing at the venturi, it is not anticipated that an acute toxicity problem will result from this thermal discharge.

While EPA is rejecting the §316(a) variance-based limits proposed by the permittee because we are not convinced that they are stringent enough for the protection and propagation of the balanced indigenous community in Mount Hope Bay, the thermal limits we propose here are less stringent than what would be required by our case-by-case, Best Professional Judgement (BPJ) determination of a technology-based Best Available Technology (BAT) standard. With regard to the water quality-based thermal limits derived by MA DEP in its mixing zone analysis, EPA concludes that the thermal limit of 1.7 TBTU per year and a maximum discharge temperature of 95 °F will be similarly protective, but potentially somewhat less stringent than the water quality-based limits. Since the state's water quality-based limits are tied to ambient water temperatures and other factors, the relative stringency of these limits as compared to the § 316(a)-based limits could only be assessed with certainty after a period of plant operations under the water quality-based limits. Given the impracticability of undertaking this confirmatory test, for the purpose of issuing this § 316(a) variance, EPA assumes that its proposed annual thermal limit of 1.7 TBTU and maximum discharge temperature of 95 °F are less stringent than the water quality-based thermal limits.

Therefore, EPA is proposing to issue a new permit for Brayton Point Station with § 316(a) variance-based thermal discharge limits, but these limits are substantially more stringent than the limits requested by USGenNE. We believe the limits we propose will be sufficient to assure the protection and propagation of a balanced indigenous population of fish, shellfish and wildlife in and on Mount Hope Bay.