D. Response to Comments Concerning the Proposed Zone of Passage and Habitat

Comment D1: Mirant contends that the definition of the Zone of Passage and Habitat (ZPH) and the compliance system to maintain temperatures in the ZPH are flawed.

Response D1: The necessity of the ZPH was articulated in Section 5.8 of the DD and Section 4.4.3 of the Fact Sheet. The ZPH was also displayed on Attachment D of the Draft Permit. The definition and specific requirements corresponding to the ZPH have clear rationales and are further discussed in the responses below.

Comment D2: The proposal to enforce the proposed in-stream temperature limits at a group of fixed, in-stream monitoring points that collectively comprise an in-stream compliance zone, the Zone of Passage and Habitat ("ZPH"), is overbroad.

It is not a sufficient answer for the Agencies to respond that it is necessary to maintain strict compliance at all points and times in the ZPH because the proposed permit would allow the Zone of Initial Dilution ("ZD") on the Cambridge side of the river to exhibit higher temperatures. There is no physical possibility for the whole Cambridge side of the river to exhibit dramatically different temperatures than the whole Boston side of the River; if most of the temperature recordings in the ZPH are in compliance then most of the ZD also will be in compliance, and certainly some of it will. The problem is that the proposed permit establishes two regulatory zones that bear no relationship to biological reality.

In order to assure that it remains in compliance, Mirant Kendall must seek to anticipate when river flows and ambient temperatures, combined with its own anticipated discharges, may tend to cause an exceedance at any one of the in-stream monitoring points for any 4-hour block of the coming days, and then must anticipate curtailments in order to avoid causing an exceedance. As a result, the overbreadth of the compliance scheme will be substantially magnified by Mirant Kendall's necessary anticipatory behavior. It is not a sufficient response for the Agencies to applaud that anticipatory behavior on the ground that it will induce lower discharge of heat, and help to prevent excessive temperatures, because nothing about the Agencies' establishment of the temperature limits or the proposed compliance scheme takes account of Mirant Kendall's need or ability to anticipate in-stream temperature effects.

Comment related to D2 from Union Boat Club: The proposed locations of the testing equipment may obstruct safe traffic flow of various craft. The Charles River basin as described by the rowing community covers that stretch of river from the BU Bridge to the Longfellow Bridges. The only straight stretch of the river, it contains Boston's only full 2000 meter race course and as such is used daily for practice and races by all programs. Thus, the areas of the Basin where the testing sites are proposed are heavily used by rowing shells. The most challenging sites are those that require the permanent canister buoys on the race course: Stations 1, 2/B and A, as described in Sections 14.e.1, 14.c.1 and 14.e.10. Other testing stations are

located in the middle of other heavily used traffic lanes. It is not clear to the lay reader if these sites are permanent or temporary, but are described as nets suspended below the surface. If permanent, this setup could be hazardous to fins and rudders, as well as motors of accompanying coaching safety launches. Unless these nets were sufficiently deep to avoid impact, these locations would need to be marked with buoys. We hope that once the stations are located, formal GPS locations can be measured to assist in maintaining the agreed on locations.

Comment related to D2 from Laura Donohue: Rowers would like to participate in deciding where monitoring buoys are placed. Stations 1 and 2 basically define the start and finish lines of the race course that is often used. It would be best if stations 1 and 2 were not at the start and finish lines of the race course. I am assuming that the other testing stations that were mentioned are not permanent. If these buoys are anywhere near the shore and the water level drops dramatically (due to the operation of the dam), you need to be aware that that may affect your testing equipment, as well as people's ability to get around them.

Response to D2:

1. The thermal plume from Kendall Station will cause mortality and will be too large to meet the requirements of a formal Mixing Zone, as defined in the State's Water Quality Standards. Therefore, a state mixing zone could not be granted. In establishing a suitable variance that would be protective of the BIP, EPA carefully studied both the scientific literature concerning the temperature tolerance of key indicator species and data about the existing conditions in the lower Basin. In addition, EPA compared its' conclusions about temperatures necessary to protect the BIP with Massachusetts' State Water Quality Standards, where possible, to make the framework for protective temperatures and compliance as consistent with those standards as possible.

Since the permittee failed to submit an acceptable model of the lower Charles River Basin (see Introduction to Section E), it can not be stated with certainty what temperature relationship there will be between the ZD and the ZPH. It is reasonable to anticipate that during times of sufficient river flow, the thermal plume from Kendall Station would stay more toward the Cambridge side of the river and move downstream. The ZPH would be comprised largely of ambient temperature river water. Certainly under these conditions, there will be a stark contrast between the ZD and the ZPH.

EPA does not dispute Mirant's assertion that the regulatory structure of the permit may not always perfectly reflect the conditions one might observe in the lower Basin. But acknowledging this truism does not lead to the conclusion that the permit is structurally flawed or arbitrary. Regulatory compliance regimes nearly always have to draw bright lines to define compliance requirements in clear, enforceable terms. A clearly articulated compliance regime inevitably does not correspond perfectly to the dynamic, ever-changing environment it is designed to protect. It would be extremely impractical, if not impossible to draft or enforce a permit that accurately represented the approach suggested by Mirant's comment, where a violation at one or another compliance point should be

ignored as a legal matter because, on balance, it appears enough other compliance points are at temperatures sufficient to protect the BIP. EPA has exercised its best judgment about how many compliance points must meet required temperatures to protect the BIP. Mirant's comment suggests the permit should provide that this judgment must be continually revisited and revised every time compliance with the permit becomes inconvenient for the facility at a particular point. If during the term of the permit Mirant demonstrates based on actual experience with the permit that a particular compliance requirement or scenario is unnecessarily restrictive, EPA and MassDEP can consider a permit modification supported by a demonstration that the modified permit would continue to protect the BIP.

As pointed out in the DD as well as in this Response to Comments document, if Mirant had submitted an acceptable hydrodynamic model, there would not be the uncertainty related to Kendall Station's thermal plume in the Basin as well as the overall thermal profile of the Basin. This uncertainty compels EPA to require these compliance points as the minimum necessary to demonstrate protection of the BIP.

2. All facilities using once through cooling water and permitted with a maximum discharge temperature must anticipate changes in ambient water conditions (intake water temperature) over the course of a day, especially as the discharge temperature approaches the maximum temperature limit. The procedure Kendall Station must follow is more complicated than monitoring only the discharge temperature, because no suitable model was provided by the permittee to identify discharge temperatures that EPA would establish as protective limits, based on their impact to the lower Basin. EPA agrees that the structure of this permit places a considerable monitoring burden on the permittee. But if Mirant wants the flexibility to discharge as much heat as possible on any given day consistent with protecting the BIP, this more sensitive, and therefore complex, compliance monitoring regime is the trade-off. If Mirant wants a simpler permit, the reasonable worst-case assumptions EPA would have to make to have reasonable assurance that the permit would still protect the BIP would likely result in further restrictions on the facility's thermal discharge. This issue is discussed in Response D5 of this Section and in Response I2 in Section I of this response to comments document.

Response to Comments related to D2 from Union Boat Club and L. Donohue: EPA and MassDEP are aware of the potential hazards that fixed buoys in the Charles River may cause to sailing and rowing activities in the lower Basin. Based in part on discussions that took place during the writing of the Draft Permit (Charles River Rowing Committee, August 2002), the number of fixed monitoring stations proposed by the permittee was reduced from 12 to 9, partly to address navigational issues. Only Monitoring Stations 1 through 6 will remain in the lower Basin year round and be made up of fixed buoys (6 fixed buoys in all). Monitoring Station 7 will be attached to the wall of the Museum of Science Lock, requiring no buoy. Although Monitoring Stations 8 and 9 will each be made up of a buoy, they will only be deployed from April 1 through October 31. The stations proposed in the Draft Permit to measure chlorophyll (Stations A, B and C) are not included in the Final Permit as fixed stations which would require

buoys in the Basin. The only other sampling method that may present an obstacle to navigation would be gillnets or other nets that would be deployed in the river and be left unattended for a number of hours. These nets will be clearly marked. EPA and MassDEP will continue to encourage Mirant to communicate with river users when deploying fixed monitors or sampling equipment that will only be left in the river for a short time.

Comment D3: Mirant asserts that the proposed use of 4-hour block averages for maintenance of the temperatures in the ZPH at all times is unjustified and inappropriate for several reasons.

1. The proposed 4-hour blocks have no biological significance to the two species, alewives and yellow perch, which the Agencies have selected to establish the temperature regime.

2. The Agencies have not provided any plausible or even coherent explanation of why 4-hour block averages are necessary or appropriate. Further, the Agencies provide no biological basis for selecting 4-hour averaging as opposed to any other, and documenting temperatures in 4-hour blocks can be achieved without using those blocks as the compliance measure.

3. None of the scientific studies used by the Agencies to set the proposed temperature limits focused on the effects of short, 4-hour exposures

4. It appears that the use of 4-hour block averaging to enforce in-stream limits is both unprecedented and contrary to other precedent. Specifically, for purposes of determining whether Massachusetts waters are in attainment of the temperature portions of its Water Quality Standards, DEP uses 24-hour averages.

Mirant Kendall suggests that 24-hour averaging, consistent with the Mass. Water Quality Standards, is sufficiently conservative and is the appropriate approach.

Response to D3: In the first section of this comment, Mirant takes issue with the proposed 4-hr temperature limit and uses summertime field information to substantiate its comments. Although the field data presented by Mirant are limited to the summertime, Mirant's comments appear to address the 4-hr limit throughout the year.

First, EPA agrees that alosids exhibit a diurnal pattern in resource use. In the springtime, alosid adults are known to move into freshwater systems primarily in the daytime. As a result, a 24-hr limit does not make sense for use in the spring because, as Mirant mentions above, cooler temperatures are expected at night. Therefore, the daytime target temperature needed for alosid passage into the system may not be met if EPA and MassDEP allow cooler nighttime temperatures to be averaged along with warmer daytime temperatures.

Second, the summertime Draft Permit limits were developed to protect the nighttime use of the waterbody's surface by juvenile river herring. During the summer, when air temperatures are

warm, the use of air conditioning can reach very high levels in the afternoon and evening. Peak hours of summertime electricity demand often extend from 2:00 pm to about 9:00 pm. Because electric rates over the course of the day reflect this use EPA expects that peak BTU input from the facility will be during the period of peak demand. Under this scenario, water temperatures across the basin's surface will be highest over the first part of the night when alosid juveniles need this habitat.

In addition to the above, EPA is concerned that if daytime temperatures across much of the lower Basin are near or above the target temperature for habitat use by juvenile alosids, a substantial portion of the populations of these fish will stay away from those areas at night as well. Juvenile fish do not have an ability to a) sense that temperatures at a remote location are within a usable range; and b) quickly move themselves across to remote areas that suddenly become usable habitat. If they are excluded from certain areas by day, they are more likely to be absent from those areas at night as well because they are unlikely to move great distances to reach available habitat well downstream from their daytime location in the few hours available for them for nighttime feeding.

For example, it is unclear how fish near the B.U. Bridge would know to move 1.5 to 2.0 miles downstream to feed at night near the Museum of Science if daytime temperatures in these areas have excluded them from points downstream of Monitoring Station 2. EPA expects that these fish will be unaware that downstream habitat is available at night if these same habitats are unavailable during the day. In other river systems it might be expected that fish would simply remain below the surface in the day, at cooler depths. However, judging from the hydrographic information for 2005 submitted to EPA and MassDEP by Mirant for July and August, this may not be possible throughout much of the summer. Water temperatures exceeded the target temperature of 81ºF from the surface down to depths of 9 and sometimes 12 ft. for several concurrent weeks (or longer) at certain stations in the lower Basin. Thus, there appears to be little daytime refuge at depth during the daytime for alosid juveniles in some areas.

Third, some of the apparent confusion on the part of the company on issues it has raised can be addressed by drawing a distinction between toxicity and avoidance. All of the literature studies referenced by Mirant (Otto, et al., and others) deal with toxicity and the length of time that was used in these experiments to induce toxicity. Many of the permit limits are based on the concern that either adults or juveniles will avoid certain temperatures and either decline to enter the basin (e.g., alewife adults), refuse to breed (e.g., yellow perch adults) or refuse to use certain areas as habitat (e.g., alewife and American shad juveniles).

As a point of clarification, the permit does not require that a particular maximum temperature be maintained. This would require both warming and chilling. Rather, EPA has set maximum allowable temperatures, as measured by 4-hour averages, and have also set a delta temperature maximum, as measured by 24-hour averages. The intent of the permit is that these maximum limits not be exceeded as a result of additional heat discharged from the Kendall Station.

As an additional point of clarification, MassDEP specifies in the Water Quality Certification of

this permit that for purposes of determining whether Massachusetts waters are in attainment of the temperature portions of its Water Quality Standards, MassDEP uses an instantaneous maximum temperature rather than a 24-hour average. See MassDEP section 401 certification at 1, sec. I, par.1.

Also see Response L2 for a discussion as to why a maximum temperature limit calculated from a 24 hour average in the vicinity of a facility with a pronounced thermal discharge would not be protective.

Comment D4: Alternative Approach to Setting In-Stream Temperature Targets – Expect 50% of the Cross-Sectional Area of the River to Remain Within the Range of Ambient Temperature. Mirant Kendall's discharge raises river temperatures somewhat over what they otherwise would be. The extent of the increase varies enormously depending on the quantity of river flow, the level of the discharge, wind and weather conditions, and other factors. As long as those increases do not cause more than 50% of the Charles River affected by the plant to exceed the normal range of ambient temperatures, however, the discharge will be consistent with the goals of the Massachusetts Mixing Zone Policy and with the absence of appreciable harm. Accordingly, Mirant Kendall suggests that the final permit should establish a set of in-stream temperature targets based on that standard.

Specifically, Mirant Kendall suggests that the final permit should seek to assure that 24-hour average temperatures in at least 50% of the cross-sectional area of the Charles River affected by the plant do not exceed the 90% confidence upper bound of the ambient 24-hour average temperatures in the intake at the Broad Canal, with the proviso that on 10% of the days (i.e., three days per month) the allowable temperature would be set at the 95% confidence upper limit.

The reasoning behind this statistically based approach is that the permit limits should be flexible enough to allow temperatures to reach the higher levels within the normal range of ambient temperatures, given that allowing temperatures to reach such levels, in fact, is not tantamount to causing those higher temperatures to occur continuously due to the plant's operations. As described in other comments, the actual operations of the plant combined with the actual conditions of river flows and weather mean that those upper limits will very rarely be reached.

Also, this suggested approach is only addressing the temperature targets for the river. Additional comments address the consequences for the plant's operations as these target temperatures would be approached or exceeded. The utility of these temperature targets should not be judged apart from a consideration of those other suggestions.

Comment related to D4 from CRC: We believe it is unacceptable for one half of the river in the lower Basin to be allowed to reach temperatures that are lethal to native fish and other biota throughout the summer months.

Response to D4 and related comment: The plan Mirant proposes would allow for much higher

temperatures to be reached than the 5 ^{O}F Delta temperature (a 24-hr limit) allowed in the Draft Permit. There are two reasons for this. First, due to limited dilution in the summertime, the Delta T limit in the summer is more quickly reached than during other seasons when river flows are higher. Thus, the summertime Delta T is primarily at issue. Although not specifically stated in this comment, Mirant has commented elsewhere (in Mirant's Comment C5, for example) that intake data has been used to evaluate the profile of the river temperatures. In the summertime, as described in the DD, temperatures at the intake (within the Broad Canal) may be more than 5 ^{O}F higher than river temperatures at the ambient station. Thus, temperatures in the Broad Canal at the Station Intake are not good indicators of ambient river temperatures and are best not used to set allowable Delta temperatures.

Second, it is unclear what Mirant is asking with regard to the "90% confidence upper bound of the ambient 24-hour temperatures." If the permittee is suggesting that the historical record be used for the day in question, this approach is problematic. For example, the facility may be unnecessarily restricted when ambient temperatures are exceptionally high on a particular day. This approach could be harmful for the biota in those cases when the historical record as recorded at the Station's intake shows high temperatures, but the true ambient temperature of the river is much lower. In any case, the 90th percentile figure should not be used for two reasons: a) the lower Basin has water temperatures that are among the highest in the state already, and using the 90th percentile figure would push temperature even higher; and b) there are no biological data to support using temperatures that are far above the 50th percentile. See also Response C5 regarding the manner in which Mirant proposed to use statistics to set upper water temperature limits.

EPA has based the temperature limits on biological data, rather than a physical/statistical relationship, in order to support the goals of the Federal Clean Water Act and to satisfy 316(a) requirements. Suggestions for deriving permit limits must take into account the biological effects of the proposed changes. Mirant's proposal in this comment has not addressed the biological effects of using the Broad Canal as the ambient station; it has not addressed the biological effects of using the 24-hr average temperature data (see Responses C3); and it has not addressed the biological effects of using the 90th percentile data as targets.

Mirant recommends that a combination approach be used to assure compliance with in-stream temperature limits which would include statistically based temperature limits and a revised BTU loading approach. See Comments C5 and D5. The original BTU loading approach was recommended by Mirant in its December 23, 2002 letter to the Permitting Agencies. For the Draft Permit, it was determined that Mirant's BTU proposal would not be protective of the BIP as it would allow for extended periods of temperature violations before the Station would be required to curtail operations to pre-determined levels of maximum heat load discharge. The Draft Permit offered a revised BTU loading approach in the Determination Document for comment and only the permittee commented on this revised approach.

The recommendation for setting in-stream temperature limits based on a statistical approach is a new proposal. Mirant states that using the continuous temperature monitoring at the intakes

would allow for a calculation of 1 and 2 standard deviations above these temperatures that would result in temperatures that would be consistent with the biology of the river. Mirant cites a portion of a MassDEP record that Mirant submitted as an exhibit to comment C5 that states that EPA's Dave McDonald suggests the use of up to 2 standard deviations from the mean as an upper maximum limit for the protection of a population, which is equivalent to a 95% percentile figure. This exhibit is only a portion of a document and text preceding this statement was not included in the permittee's comments. Taken out of context, a reader might conclude that the statement was made in the context of setting temperature limits for this permit. This is not the case. Please see Response C5 to understand Mr. McDonald's recommendation, which was misunderstood by Mirant.

Mirant also uses the 90% and 95% confidence levels and compares these to the Draft Permit temperature limits. This analysis by Mirant was conducted for 24 hour average and 4 hour average temperatures. The results show that the statistically based temperatures were always within a few degrees of the proposed temperature limits. For April, they were 2-4 degrees below the proposed temperatures and for May through August, they were 2-4 degrees above the proposed limits. As mentioned above, EPA and MassDEP do not believe that this statistical approach has direct significance to the biology of fish in the river and should not be used to set temperature limits.

But EPA does not completely reject all consideration of this analysis. This statistical analysis may be useful in characterizing the range of temperatures one would expect to find in the area of the intake structures (absent the influence of the thermal plume). The resulting temperatures could be used to estimate how many days on average during certain times of the year that intake temperatures could exceed any established instream temperature limits. This information in turn could be used to evaluate whether this permit's allowance of six (6) days in the spring during which instream temperature limits may be exceeded is reasonable and consistent with the temperature variations experienced at the intakes. The biological consequences of increasing the number of exceedances would have to be considered by the Permitting Agencies.

Further, EPA has fundamental concerns with applying the permittee's statistical approach to setting temperature limits for this permit. At the core of the permittee's proposal is the assumption that ambient temperatures in the Charles River are inherently protective. Since the evidence indicates that increased thermal loading in 2003, 2004 and 2005 were not protective of the BIP, limits based on a statistical conformance to historical temperatures would not be protective. See also Response C3. The biologically based temperature limits are preferable to the statistical based limits, which do not have direct biological significance. The permittee has not offered any specific evidence that this statistical approach considers the biology of fish species that the permitted limits must be designed to protect. The literature information on toxicity in combination with the appreciable harm information and the finding that alewives in the lower Charles in most years generally avoided temperatures greater than about 81ºF (see Response C3) show clearly that the statistical approach to setting permit limits proposed by Mirant is not protective of the biological community and would result in large-scale habitat alterations, especially in years with low river flows.

Contrary to the permittee's proposal, the proposed temperature limits in the permit have clear, biological rationales. These limits have also taken into consideration ambient conditions by allowing certain days of exceedances during the spring, based on an analysis of past ambient temperatures. The permittee has shown that its statistical numbers are similar to those proposed temperature limits and likely within the margin of error. However, they are based on a standard deviation from recorded intake temperatures which might, at best, predict what instream temperatures would be, but which have no biological basis relative to the species that EPA must protect.

Comment D5: BTU Loading Approach – Mirant Kendall's December 2002 Proposal. By a letter dated December 23, 2002, Mirant Kendall proposed a temperature compliance program that it termed the BTU Loading Approach. The key idea behind the BTU Loading Approach, as summarized on p. 2 of the referenced letter, was to recognize that day–to–day operation of a power generating station cannot be stop-started, stop-started on short notice. Rather, both for physical operating reasons and due to its role in the competitive market place for power in New England, Kendall Station must have some advance reliable understanding of how it will be able to operate the facility over the immediate planning horizon of 24-48 hours.

Accordingly, Mirant Kendall's BTU Loading Approach would include temperature thresholds which, if surpassed, would require the Plant to cut back its operations by pre-established amounts over the next operating day. Also, Mirant Kendall proposed that, if it made those cut-backs according to the terms of the permit, it would not be held responsible for temperature exceedances in the river that might occur notwithstanding the cut-backs.

The Agencies appear to have given little detailed consideration to Mirant Kendall's BTU Loading Approach, and certainly the approach in the draft permit entirely disregards Kendall Station's operating need for advance certainty. Were the compliance scheme in the draft permit to become final, Kendall Station would be forced to curtail its operations severely for several reasons, including the need to curtail its operations in anticipation of rising temperatures irrespective of whether the plant's discharge would have caused an exceedance. That approach is overbroad, arbitrary and capricious and should not be included in the final permit.

Rather, Mirant Kendall urges the Agencies to give full consideration to the December, 2002 BTU Loading Approach and work with Mirant Kendall to develop a compliance system based on those principles. Mirant Kendall recognizes that the Agencies have sought public comment on a version of the BTU Loading Approach, Determination Document, Section 5.11, and looks forward to working with the Agencies to elaborate on that or a similar approach to find a workable compromise.

Response to D5: EPA has suggested an alternative BTU loading approach to that which was recommended by the permittee in its December 23, 2002 letter to the Permitting Agencies. This alternative approach may be found in Section 5.11.3 of the Determination Document. In its Comment D5, the permittee does not endorse the alternative BTU approach that EPA put forth

and argues that it is not workable for this facility. EPA has given careful consideration to the permittee's proposal. EPA modified the permittee's proposal as reflected in the DD because the permittee's proposal allowed for excessive periods of time during which temperature limits would be exceeded before the facility would have to curtail production to pre-specified BTU loading levels. EPA cannot endorse the permittee's BTU loading approach or the statistically based temperature limits approach with which it was proposed to be coupled. Other facilities that use once through cooling water and must comply with a permitted instantaneous maximum discharge temperature limit accept the very real prospect of modifying their operation in anticipation of rising temperatures, irrespective of whether a given facility's discharge would have caused an in-stream exceedance of a temperature criterion. These facilities do not have some advance reliable understanding of how they will be able to operate the facility over the immediate planning horizon of 24-48 hours. They must plan their generating capacity based in part on their best prediction of how hot the background temperature of the cooling water will be as it comes to the plant. This challenge of predicting the impact of ambient conditions on generating capacity is faced by all generating facilities that use once through cooling water, especially during dry, hot summertime conditions, and in this manner, Kendall Station's situation is not unique.

In Comment D6, Mirant proposes an "enhanced BTU loading approach." As explained in the Response to D6, that proposal shares most of the flaws as its original 2002 proposal. Therefore, EPA does not endorse and does not intend to incorporate any aspect of the permittee's BTU heat load approaches or statistically based temperature approach into this permit.

Although EPA and MassDEP are not prepared to adopt Mirant's proposed BTU Loading Approach for the reasons given above, the permitting agencies are sensitive to the company's expressed concern that it would "be held responsible for temperature exceedances in the river that might occur notwithstanding the cut-backs." Mirant's proposal is not acceptable because it improperly insulates the company from responsibility for maintaining the protective in-stream temperatures necessary to protect the BIP, while granting the company the opportunity to take advantage of the lower Basin's actual assimilative capacity. But EPA and MassDEP agree that Mirant should not be liable under the permit for in-stream temperature exceedances which the Kendall Station did not cause or contribute to. Temperature in the lower Basin can be influenced by a variety of factors. It is conceivable, though not likely, that despite appropriate curtailments or cessation of the Station's operations, temperatures in the lower Basin might exceed the in-stream limits. In that case, it would not be appropriate to hold the permittee strictly liable for those exceedances beyond its control. Therefore, the permit has been modified in footnote 7 on Page 4, to state that the permittee shall not cause or contribute to conditions that cause exceedances of the temperature limits provided for in the seasonal profile of protective temperatures.

Comment D6: This comment suggests an enhanced variation to the BTU Loading Approach using some principles from Mirant Kendall's December 2002 BTU Loading Approach and some from the Agencies' alternative BTU loading approach in section 5.11 of the Determination Document. It also builds on the alternative approaches to in-stream limits described in Comment

C5.

Specifically, the Agencies should consider a combination of a refined BTU Loading Approach and the statistical analysis of ambient temperatures at the Broad Canal intake described in Comment C5. Under this suggestion, at 8:00 a.m. of each operating day Mirant Kendall would evaluate the average temperature for the prior 24 hours at the intake. If a specified trigger temperature had been reached, the plant would be required to reduce its BTU loadings in the current 24-hour period or adequately document why it did not. For example, if the 24-hour average trigger temperature had been reached as a carry-over from too warm temperatures during the prior afternoon and evening, but the river was cooling rapidly due to a change in weather, Mirant Kendall could proceed without being subject to thermal caps on the current day.

The suggested reduction protocol is to reduce to no more than 50% of the maximum daily allowable loading of 13,344 mmBTU/day, averaged over the 24 hours from 8:00 a.m. that day to 8:00 a.m. of the following day. These thermal discharge limits would continue for as long as the daily 8:00 a.m. evaluation showed expected same-day exceedances of the trigger temperature. Should Mirant Kendall determine to discharge at levels above the thermal discharge limit, it would do so at its own risk of failure to correctly predict that temperatures would not exceed the in-stream temperature limits.

Under this enhanced approach, the trigger temperatures would derive from the statistical analysis of ambient temperatures at the Broad Canal intake in the fall, winter and spring, and from the Massachusetts Water Quality Standard of 83 ^{o}F in the summer. Specifically, maximum daily allowable BTU loadings would be reduced to prevent the 24-hour temperature at the intake from exceeding the 90% confidence upper limit during the fall, winter and spring, except for up to 3 days per month when the 95% confidence upper limit would apply. During the summer this approach might be varied to account for the fact that the 90% confidence upper limit exceeds the Massachusetts Water Quality Criterion of 83 ^{o}F, so that the WQS might be used as the trigger temperature instead. Up to three days per month in June, July and August could be allowed within the still protective 90% to 95% confidence upper bound range, consistent with the Region 1 Ecological Risk Assessment suggestion.

There are two improvements in this refined approach as compared to Mirant Kendall's December, 2002 BTU Loading Approach. Both of these changes reflect the feedback Mirant Kendall received from the Agencies about that approach. First, action upon a triggering event would be taken the same business day, whereas it was taken the following day in the earlier proposal. Second, the action decision would be made at temperatures lower than the in-stream temperature limits. In the earlier proposal, action was taken only upon reaching the limits.

A key feature of this approach, as with the December 2003 proposal, is that it allows Mirant Kendall to anticipate the expected temperatures in the river and adjust its conduct accordingly, but does not lock Mirant Kendall into unnecessary curtailments. By contrast, under the alternative BTU Loading Approach described by the Agencies in Section 5.11 of the Determination

Document, Mirant Kendall would still anticipate the expected temperatures in the river and adjust its operations, but would be forced to overcompensate (by reducing to 3^{O} F below the limits) in order to be sure of avoiding in-stream exceedances.

Response to D6: The permittee has proposed a system where BTU heat load reductions would occur consistent with whether or not the statistically based temperature limits are exceeded. For the summer, the facility would not use these figures but would revert to the State temperature standard of 83 ºF. For the other seasons, the facility would curtail operations if the 90% percentile temperatures (between 1 and 2 standard deviations) were exceeded, but would be allowed up to 3 days per month to reach the 95% percentile temperatures, or 2 standard deviations from ambient. Even if EPA agreed with this BTU loading approach, this approach would not protect the BIP. The approach would require an analysis of the previous 24 hours of intake temperatures at 8 AM every day. If a specified trigger temperature is reached, the permittee proposes that the facility would be required to reduce its BTU loadings in the current 24 hour period to 50% of the maximum heat load, averaged over the 24 hour period of 8AM to 8 AM, or document why it did not. Thus, the permittee would be out of compliance for temperature for some portion of the previous 24 hours, and it could operate from 8 AM to 8 PM at 90% heat load (likely with continued temperature violations) and then cut down to the rate of 10% heat load (the minimum necessary for steam production) from 8 PM to 8 AM and be in compliance once the BTU loadings were averaged over 24 hours. As with Mirant's previous proposal, EPA believes this would allow for extended periods of in-stream temperatures which would not be protective of the BIP. EPA's Draft Permit is flexible in allowing for 4 hour block averages, but having exceedances of these temperatures for potentially a good portion of 2 consecutive days would not be in keeping with the requirement to protect the BIP.

EPA has concluded that the statistical approach endorsed by the permittee does not adequately take into account the biology of the aquatic life in the lower Charles basin. This approach would allow the permittee to continue operating for an extended period after threshold temperatures had been reached. See Response to D4.

In addition, as discussed in Response L2 and Response D3, temperature limits based on a 24 hour average are not protective when a large thermal discharge is involved.

Also, EPA and MassDEP do not agree that the 90% confidence upper limit exceeds the Massachusetts Water Quality Criterion of 83 ºF in the summer. Based on the summertime ambient temperature data that is available for the Charles River near the BU Bridge (see Section 5.9.2 of the DD), the use of a 24 hour average temperature of 83 ºF as the trigger temperature is not an accurate representation of ambient temperatures in the lower Basin from June 15 through October 31.

One further problem with Mirant's proposal is that it applies the risk of managing the Kendall Station's heat load in the lower Basin in an asymmetrical manner. The asymmetry appears to lift the risk off Mirant and place it on the environment. If the statistical temperature trigger in

Mirant's proposal is reached, and it appears the lower Basin will remain hot, Mirant is only required to curtail its operation by a pre-agreed amount that may bear no relation to the full level of curtailment actually needed to protect the BIP. On the other hand, if the trigger is reached, but Mirant concludes the lower Basin is cooling, Mirant is able to increase its thermal discharge, at its own risk, to whatever level the company concludes will stay below the in-stream temperature limits. As a result, Mirant is able to take full advantage of warming up the lower Basin to the in-stream temperature limits, but the company does not bear the corresponding risk of having to curtail its thermal discharge to levels consistent with protecting those temperature limits.

Comment D7: The ZPH is more properly considered a "ZP" (Zone of Passage). The Agencies have been overly broad in characterizing the area downstream of the Longfellow Bridge as a "Zone of Passage and Habitat," or ZPH. For the reasons discussed below, the area is not habitat for spawning or for the early egg and larval stages of the target fish species (alewives and yellow perch).

The area is only visited a minority of the time by the older life stages of these species. Specifically, adult alewives pass through the area on their spring spawning run in April and May and again when they leave the river in May and June. In the summer, the upper water column is used only occasionally. For the most part, this use consists of visits by feeding and out-migrating juvenile alewives in the evening and at night. The same takes place throughout the rest of the lower river, with numbers of fish everywhere below the Harvard Bridge comparable to those in the ZPH. Mirant Kendall's monitoring data indicates that the upper water column of the area is essentially never used by yellow perch. MK Comment Ex. No. D7. Yellow perch were found in the lower water column in the ZPH in small numbers, and only about 30% of the time.

These findings lead to the conclusion that full-time compliance with four-hour block in-stream limits at two-foot depth anywhere in the ZPH, and specifically at proposed Monitoring Station 3 is inappropriate, because it is not significant habitat most of the time. The BIP is dependent on other, deeper habitat, further upstream, which can be protected appropriately by limits and measurements at their respective locations. As discussed elsewhere in these comments, Mirant Kendall believes the data demonstrate that the appropriate compliance locations are the upstream edge of the ZD just above the Longfellow Bridge, and 50% of the cross-sectional area of the river throughout the ZPH.

Response to D7: See Responses D9 through D12. EPA disagrees that the ZPH is "more properly considered a 'ZP' (Zone of Passage)." Mirant correctly notes that the zone supports passage for adults in the spring and passage for juveniles in the late summer and fall. However EPA disagrees with Mirant's habitat characterization. Both the pushnet and the beach seine sampling have shown that much of the area downstream of the B.U. bridge is used as habitat for juvenile alosids. The series of graphics included in Response C3 strongly supports the position that habitat use by both blueback and alewife juveniles is influenced by Mirant's discharge and the temperature increases that it causes. Arguably, were it not for Kendall's discharge, habitat use by alosids in the area of the Basin downstream of the B.U. Bridge would likely be increased. This area was "impaired" as habitat for juvenile alosids in the summers of 2004 and 2005. In addition to

anadromous species, resident species expected to be present in the lower Basin will have their habitat protected by the thermal limits established for the ZPH. Juvenile and adult yellow perch, identified as the resident species most sensitive to temperature, were collected by the permittee in the lower Basin and would be part of the BIP found in the ZPH.

Comment D8: A Compliance point at two foot depth in the ZPH is inappropriate. Section 5.8.1c of the DD presents the Agencies' rationale for applying the limits in 50% of the cross-sectional area of the ZPH and at the 2-foot depth at Station 3 near the Boston Shore to prevent high temperatures near the surface "for long periods of time."

Mirant Kendall agrees that a ZP defined as 50% of the cross sectional area of the river is appropriate, but disagrees concerning the validity of a 4-hour block average 2-foot depth compliance point at proposed Monitoring Station 3. Four hours is not "a long period of time." This compliance point is offered by the Agencies as a proxy to protect uses that are negligible or non-existent at the location. As described in the rest of this section of the comments, the important shallow habitat for resident species is negligible to non-existent at proposed Monitoring Station 3, but is abundant between the Longfellow and Harvard Bridges, upstream of Station 2.

Response to D8: EPA and MassDEP addressed the issue of the 2 foot monitoring depth in the Response to D11. The 4-hour block average issue is addressed in Responses to D3 and L2.

Comment D9: ZPH is Unsuitable Spawning Habitat. There are two reasons for the lack of suitability of the ZPH for spawning and early development for both yellow perch and alewife:

First, the area is too far downstream for eggs and young larvae in the upper water column to remain in the basin. The residence time of water in the upper water column in the ZPH, before entering Boston Harbor, is less than 3 days at normal springtime flows of 500 cfs. Even at extreme low flows for the spawning period (i.e., 100 cfs for May), the residence time is only about 8 days. See table of residence times in Volume II of the February 2001 Supplemental Application (A.R. No. 454). Moreover, the values for the upper water column would be about half the values shown in the table, which are for the overall water column. For early life stages to reach the size where they can swim well enough to remain in the river, a residence time after spawning of at least 3 weeks (21 days), and more likely 4 weeks (28 days), would be needed.

Second, for those eggs and larvae which sink into the lower water column, there is too little dissolved oxygen for survival. As shown by the vertical profile measurements made at the various stations in the ZPH since 1999, the area has become more frequently and more severely stratified, with DO generally below 2 mg/l and salinity generally above 14 ppt. See MK Comment Ex. No. D9.

Response to D9: According to data provided to EPA and MassDEP in a February 2001 submission by Mirant, in both 1999 and in 2000 the geometric mean densities of river herring larvae collected within the intake canal reached 1-10 larvae per cubic meter in mid-May to the

end of June. This is consistent with the juvenile information as juveniles began to appear in the seine nets in late June to early July. The 10 larvae per cubic meter value is a high concentration of larval fish. The location and density of these fish may provide information as to where the fish were spawned. A lower concentration would be expected if they had been spawned well upstream. Because these herring larvae were not keyed to species, it is not known whether they were alewives or bluebacks. Bluebacks are expected to spawn in faster water than alewives and should be more inclined to utilize habitat upstream of the wide, slow section of the Charles. Alewives are more likely to spawn in the slow, shallow areas along the banks. In addition, MA DMF personnel have observed river herring spawning downstream of the B.U. bridge along the Cambridge shoreline. Because bluebacks are not expected to spawn in this type of habitat, these fish were probably alewives.

The residence time information is not a good indicator of retention time of larval fish within the wide section of the lower Basin if those fish are primarily located along the shoreline. Rugosity, or roughness coefficient, greatly alters water velocities, and water velocities along the banks of the Charles are well below velocities in the mid-channel where there is essentially laminar flow. Thus, larvae spawned along the shoreline would be expected to have a much longer residence time than the general residence time calculated by average river flows. The data on larval presence in the basin are at odds with Mirant's implied statement regarding the period of larval presence. Mirant states that the residence time at normal springtime flows in May is only about 8 days, intimating that this should be the most important period regarding larval presence in the lower Basin. However, as mentioned above, peak densities of larvae were not found in May, but in early June of 1999 and 2000. Thus, the residence time of larvae during the period of highest densities should be longer than that in May because June river flows are typically lower than those in May. The median flow figure for June 1999 was 83.5 cfs. This was the second lowest June flow for the 9-years period from 1994-2002. This is below the 100 cfs figure given by Mirant that yielded the 8-day residence time.

Mirant has also stated in other comments that the years of highest juvenile river herring densities appear to be correlated with years of low springtime flows and that this is because the "washout" rate of larvae during years of high flow is controlling juvenile densities, i.e., that water temperature during the summer is playing only a secondary role. As indicated in Response C23, if, during years of low river flows, the washout rate is much reduced and during these years a higher percentage of larvae is retained within the Basin, these low-flow years become extremely important to the river herring population. This is because it is during these years that the population has the greatest opportunity to rebuild stocks. Stocks of river herring are currently at very low levels along the coast of Massachusetts (MA DMF Advisory, November 14, 2005). The agencies responsible for attending to these resources should do all they can during these low-flow years to allow these larval fish to grow to the juvenile stage and exit the system in the late summer and fall. Unfortunately, low-flow years are those with the highest potential for negative impacts due to thermal releases from the Mirant facility. This is due to the fact that there is less river water moving past the facility to assist in diluting Kendall's thermal discharge. See also Response C23 regarding Mirant's "washout" hypothesis.

EPA does not agree that there is too little oxygen in the lower water column for the sinking eggs and larvae to survive. Fish eggs and larvae occur in the lower Basin in the spring and early summer. Water quality data does not identify this time as a period when a large layer of water is absent of dissolved oxygen in the lower Basin. For example, in mid-May of 2004, when river herring egg and larval density was at a peak at the Charles River Station, DO levels at this Station were greater than 5.0 mg/l from the surface to the bottom (approximately 15 feet). Even at the Deep Diffuser Station, the bottom depth of 36 feet recorded a DO of 5.4 mg/l (Mirant Kendall Exhibit C3, October 14, 2004: May 18, 2004 Field Data). See Response H22. Vertical profile data does not show bottom depths that have become more frequently and more severely stratified since 1999. The initial onset, duration, and severity of the deep water anoxic layer is influenced by many factors, including river flow, storm events and the timing and degree of use of the New Charles River Dam Locks. Because of the variability of these factors, the characteristics of the deep waters of the lower Basin change from year to year, but have not exhibited a discernable trend since 1999.

Comment D10: Upper Water Column of ZPH is not Viable Habitat for any Life Stages of Yellow Perch. In Section 5.6.3b of the DD, the Agencies indicated that the Boston side of the river in the vicinity of Kendall Station is "more suitable habitat for the presence of yellow perch eggs."

The habitat in the ZPH is, however, a predominantly deep channel without sufficient contiguous shallow vegetated habitat for yellow perch. As shown in MK Comment Ex. No. D10-1, the area between the Longfellow Bridge and Museum of Science, especially on the Boston side, has negligible contiguous shallow habitat (i.e., less than 6 feet deep). Further, the narrow strip along the Boston shore that is less than 6 feet deep is not well vegetated. In combination, the lack of suitable depth and the lack of suitable vegetation make the shallow portions of the Boston portion of the ZPH of negligible habitat value for yellow perch.

Mirant Kendall's gillnet sampling and pushnet sampling captured no yellow perch in the upper water column on the Boston side of the ZPH. See MK Comment Nos. C3-1, C3-2.1 (2004 Data). On a minority of occasions, yellow perch were present in the lower water column. Three of the gillnet stations were in the ZPH: "Below Museum", "Boston" (near proposed monitoring station 3), and "Below Broad Canal,(on the Cambridge side between the existing discharge and the Longfellow Bridge). Yellow perch were only present in 25% (3 of 12) of the gillnet collections at the "Below Museum" Station, all of which were spring collections. Yellow perch were only present in 32% overall (44% through July) of the collections at the "Boston" station near proposed compliance Station 3, and only at depths below 12 feet.

By contrast, yellow perch were present more frequently on the Cambridge side at the "Below Broad Canal" station near the plant and the Longfellow Bridge. This area is proximate to more extensive shallow habitat than is present on the Boston side. When near-bottom salinity remained generally below 12 ppt in 2004 (through July), yellow perch were present in almost 70% of the collections (17 out of 25) at the Below Broad Kendall Canal station. As shown in MK Comment Ex. No. D10-2. Mirant Kendall's 2004 gillnet collections, despite nets deployed

at higher salinity, captured no yellow perch at salinities above 14 ppt. Most fish were caught at salinities below 10 ppt, and a few were caught between 10 and 14ppt.

Comment related to D10 from Mark Jaquith: I am also concerned about the ZPH as discussed in the fact sheet and as depicted in Attachment D of the Draft Permit. The zone is along the south bank of the river, the Boston shore. The reason that this troubles me is that there are so very many more fish near the north bank. I base this assertion on the following personal observations. When walking the banks during the herring run, you will see many times more fish along the sea wall in Cambridge than along the Esplanade. When walking the banks or boating you will see more fish breaking the surface near or from the Cambridge side. I do not fish the Charles, but those who do gravitate to the wall in Cambridge despite the relative difficulty of retrieving any fish caught. I have seen herring, eel and striped bass taken along the (Cambridge) wall.

Comment related to D10 from MA DFW: The proponent is proposing a maximum temperature of 28.3 °C in the mixing zone and certain other maximum temperatures during critical life stages of yellow perch. The optimal habitat for yellow perch is the Boston side of the river. This is the farthest point away from the station and is expected to experience temperatures on average 1.1 °C less than the proposed maximum. Therefore, this should not significantly impact the yellow perch population in this reach of the Charles River.

Response to D10 and related comments: Mirant is suggesting that the area along the Cambridge side is more important habitat for fish in general, and yellow perch specifically, than the area along the Boston shore. This is unfortunate because much of this area is within the "Zone of Dilution" (or is not monitored by a nearby monitoring station) where the facility is allowed to discharge temperatures that are toxic to many species of fish.

It must be pointed out that no qualitative and quantitative habitat assessment has been submitted by the permittee to properly characterize the two banks of the Charles River and their suitability for yellow perch habitat. While it is open to debate whether shoreline habitat on the Cambridge side would be of more value to the yellow perch population than the habitat on the Boston side, this does not mean that EPA should sacrifice habitat on both sides of the river.

Mirant's comments that perch were not found in pushnets and gillnets in the upper water column along the Boston side of the Basin, near Monitoring Station 3, exclude the information from the shoreline seines which only sample the upper water column. The shoreline seining program in 2004 did not have any stations downstream of the Longfellow Bridge; however, seining just upstream at the "Lagoon" station produced yellow perch in July, August and September that year. Thus, shoreline habitat slightly upstream of Longfellow must be at least somewhat appropriate for yellow perch. Shoreline seining in 2005 produced yellow perch at the "Boston" station, which is located directly across from the discharge, on the Boston shoreline, downstream of the Longfellow Bridge. Thus, yellow perch habitat there must also be at least somewhat

appropriate for this species. This station is near Monitoring Station 3.

Mirant's comments regarding the quality of habitat are pertinent, however. They may lead EPA and MassDEP to ultimately consider the relocation of Monitoring Station 2 in the future. The present location of Monitoring Station 2, in the middle of the river, will not provide a real time mechanism to evaluate the temperature profile of the shoreline habitat on the Cambridge side of the river upstream of the Longfellow Bridge. Placement of this station closer to the Cambridge shoreline would provide real time protection of the Cambridge shoreline from the facility's thermal plume. Early modeling by Mirant predicted that temperature effects along the Cambridge shoreline upstream of the facility's discharge would be greater than those along the downstream shoreline, possibly due to on-shore winds that partly push the plume, which travels both upstream and downstream during low-flow periods, along the Cambridge shore. Once a sufficient amount of biological and water quality data have been collected and analyzed under this permit, EPA and MassDEP will evaluate the placement of this monitor as well as all the real time fixed monitoring stations in the lower Basin.

A discussion of gill net collection of yellow perch and associated salinity values is included in Response E20.

Comment D11: The Upper Water Column of the ZPH is Not Significant Habitat for Any Lifestages of Alewife. Mirant Kendall's gillnet data for spring 2004 confirm the findings of 2002 and 2003, that adult alewives fully utilize all oxygenated depths in the water column. Roughly equal numbers of fish were captured above and below 6 feet. The upper six feet of the water column have no special significance that would justify other than a 50% cross-sectional area Zone of Passage for this life stage.

Likewise, Mirant's beach seine and pushnet sampling of YOY alewives and bluebacks has shown extensive, preferential use of shallow vegetated areas rather than the upper water column of the ZPH. Abundance of YOY river herring in both 2003 and 2004 was generally much higher at the Hyatt station above the Harvard Bridge than in the lower river (including the ZPH) throughout the summer. Abundance at Hyatt was often greater than all of the downstream stations by an order of magnitude whether or not the temperatures in the ZPH were elevated by the plant discharge. (See MK Comment Ex. No. C3).

The pushnet and gillnet data from both 2003 and 2004 show negligible daytime use of the upper 6 feet of the ZPH. Matching day/night pushnet collections were conducted throughout the July to September period in 2004 to expand the data base on this topic. Like the 2003 results, these comparative collections showed negligible numbers of YOY alewives and bluebacks near the surface at all stations (fewer than 30 fish total per day throughout July and August). By contrast, the numbers at night were ten to fifty times greater. The 2004 gillnet data from the ZPH show that 85% of the YOY fish caught in the daytime were deeper than 6 feet.

Response to D11: Based on Mirant's beach-seine data, the surface along the shorelines was used by juvenile alewives and bluebacks during 1999 in the daytime (see MKS Permit

Application, February 2001). Night-time sampling in later years along the shoreline appeared to be best for alewives, as alewife juveniles were found both near the Hyatt Station (1.6 miles upstream of the discharge) and in much smaller numbers at the Lagoon station (about 0.6 miles across the river and upstream from the discharge). Most alewives were found far upstream of Mirant's plume at the Hyatt Station near the B.U. Bridge.

Push-net sampling was initiated in 2003. Only 5 juvenile alewives were found that year in 237 separate surveys (July-October). However, in 2004 juvenile alewives were found throughout the lower Basin, albeit in extremely low numbers. See Response to C3. Most were found upstream of Mirant's plume at the Hyatt Station, in-between the Harvard and B.U. Bridge. They were also found, but in lower numbers, across the basin from Mirant at the Fiedler and Lagoon Stations, as well as in very low numbers, downstream of the Longfellow Bridge. Push-net sampling is conducted by boat and was conducted to capture juveniles away from the shoreline. The push-net data from 2004 is important because it establishes that the surface of the water column, away from shore, is important habitat for juvenile alosids throughout the summer and fall.

Thousands of juvenile bluebacks (about 15,000 in two years of sampling in the July-September period) were found throughout the lower Basin downstream of the B.U. Bridge (including areas within the ZPH) in push-net sampling at the surface. This indicates that, at least for bluebacks, the ZPH was viable habitat, although a comparison of the relative length/weight of bluebacks upstream and downstream of the discharge has not been presented. Were it not for excess heat, it appears that this area should also be viable habitat for juvenile alewives because blueback and alewife juveniles feed on similar food items. According to the analysis presented in Response C3, it appears that proximity to the discharge and the higher temperatures associated with nearness to the discharge were highly correlated with a decrease in juvenile alewife as well as juvenile blueback capture rates. Thus, Mirant's contention that the ZPH is "not significant habitat" for alewives, a contention apparently based on capture rates, may be due to the fact that juveniles were avoiding the area because of high water temperatures.

Temperature limits, if only monitored at the 6 foot depth and as currently configured in the permit, would not be protective for juvenile alewives. Push-net data shows that the mid-basin surface is extremely important for both bluebacks and alewives at night. Based on the 2004 push-net sampling, juvenile alewives and bluebacks use the surface of the water column ten to fifty times more at night than during the day, proving that the surface is crucial habitat for juveniles. Therefore, the surface of the water column is extremely important during the period when alosid juveniles are present, i.e., from late June through the end of the fall, and needs protection via a permit limit at the surface to ensure that temperatures are not so high that juvenile alewives avoid this area from dusk to dawn.

Since Mirant’s comment contended that the upper water column is not significant habitat for any lifestage of alewife, the importance of this layer to the larval stage is also discussed. Temperature limits set at the 6-foot depth in the early summer will not be protective for alosid larvae. River herring larvae were captured throughout the water column. If protective temperatures were only specified at depths of 6 feet and below, there would be no assurance that

protective temperatures would be maintained for those larvae that are at the surface. The thermal plume is buoyant. In the late spring and early summer, when herring larvae are present, temperature limits at the six-foot depth will not protect larvae that are found higher in the water column because the water above the 6 foot depth will have higher temperatures.

Thus, to address these needs to ensure sufficiently protective near-surface temperatures, EPA has retained the two foot monitoring depth in the Final Permit.

Comment D12: For adult alewives, the ZPH is only important as a Zone of Passage. Section 5.7.1 of the DD states that the "lower Charles River Basin serves as a passage way and spawning location in the spring, and a development nursery area for eggs, larvae and juveniles from the spring to the winter." Mirant Kendall agrees that the ZPH is a passageway, as shown by its tagging studies of adult alewives. However, Mirant Kendall believes that its field data show that without the restoration of oxygen to the ZPH, the Agencies' proposed ZPH is really just a zone of passage. This is because any alewife spawning that occurs this far downriver results in one of two outcomes. First, eggs in the upper water column are already too far downstream to remain in the river. Second, eggs which reach the lower water column have little or no chance of survival because the lower water column has insufficient oxygen.

Section 5.7.3c, regarding alewife, states that "out-migrations continue to occur long after in-migrations have ceased." This is true, but it does not provide support for a temperature difference between entry and spawning temperatures. There may be a lag between in-migration and spawning at the very beginning of a run if upstream migration is triggered by a brief high temperature excursion followed by a drop in temperature. In such an instance, fish may move upstream, but do not actively spawn until temperatures rise to appropriate levels. However, during the major portion of any spawning run, temperatures are sufficient for fish to spawn throughout the entire period. Thus, fish entering will spawn when they are present in appropriate spawning locations and do so continuously throughout the run, not at some specific temperature. The fact that out-migrations continue long after in-migrations have ceased is simply a result of spawned-out fish remaining long after completion of spawning. In Richkus' thesis (Richkus 1974b), he documented spawned out adults moving downstream throughout the summer. He offered no specific explanation for the delay in out-migration of these fish, but found no link between that behavior and water temperatures.

Response to D12: EPA disagrees that for adult alewife, the ZPH is only vital as a zone of passage. There is not sufficient evidence that eggs in the upper water column are already too far downstream to remain in the river. This is discussed in Response D9.

In addition, eggs which reach the lower water column in the spring are not expected to be exposed to a water layer with greatly depleted oxygen. Please see Response H22 for a full discussion of expected dissolved oxygen levels in the lower Charles River Basin when alewife eggs are present in the spring.

Mirant's statement that "The fact that out-migrations continue long after in-migrations have

ceased is simply a result of spawned-out fish remaining long after completion of spawning." seems to support the position that the ZPH provides habitat for adult alewife. If the spawned-out fish spawn in the ZPH, the fish likely remain in this part of the Basin before leaving the Charles River, thus using the zone as habitat.

Comment D13: Yellow Perch do not Move Enough to Require a Zone of Passage. Mirant Kendall's tagging studies have shown that yellow perch and their offspring are more abundant elsewhere in the lower Basin, in areas with littoral habitat, compared to the deep water of the ZPH, regardless of temperature. Further, the tagged fish remain in the same areas and do not move into the ZPH.

Response to D13: Yellow perch, characterized as a resident species, typically spend most of their lives in the lower Basin and do not use the ZPH as a zone of passage in the same manner as the anadromous alewife. Although this is referred to as a ZPH in the yellow perch discussion in Section 5.6 of the DD, the same term is still used when discussing the anadromous species, the alewife, for consistency, as it is designated as the same area in the lower Basin. In addition, it is not consistent with the objectives of the permitting process to separate fish downstream of the Museum of Science from those upstream by an area that is thermally unfit for habitation by resident species. Indeed, Massachusetts WQS for Class B waterbodies, such as the Charles, state that there shall be no changes to background conditions that would impair any of the designated uses of the waterbody. The thermal blockage of any segment of riverine areas to upstream/downstream movement by resident species would constitute an impairment of a designated use and is inconsistent with a healthful habitat of a Class B water. While the terms of the Massachusetts WQS do not control the terms of a variance from those standards under section 316(a), it is sometimes useful to understand the biological values recognized in the applicable standards in determining what is necessary to protect the BIP. In Response C3, EPA and MassDEP have determined that the effect of habitat exclusion caused by the Kendall Station's thermal discharge is an appreciable harm to the BIP. EPA and MassDEP have designed the variance to avoid segmentation caused by thermal blockage. The shoreline areas have already been shown to be used by yellow perch as habitat and the shoreline and open water areas adjacent to the Boston shoreline downstream of the Longfellow Bridge have been already demonstrated to be used by juvenile bluebacks and alewives as nursery habitat (see Responses D10 and D14).

Comment D14: In-Stream Limits for Yellow Perch Should Focus on the Upstream Boundary of the ZD. Based on physical characteristics and sampling, and the tagging and tracking of yellow perch since 1999, Mirant Kendall believes that the significant areas of suitable habitat for yellow perch spawning are distributed upstream of the Longfellow Bridge, where extensive areas of vegetated shallows are present. Further, the area above the Longfellow Bridge exhibits decreasing near-bottom salinity as one proceeds upstream, so that areas between 15 and 20 feet deep are generally more suitable for yellow perch above than below Longfellow. Therefore, any limits to protect perch spawning should be re-focused to apply to only those upstream areas suitable for that purpose.

Based on the likely location of the viable subset of yellow perch eggs in suitable habitat above the Longfellow Bridge, Mirant Kendall believes the Agencies should re-focus on a compliance location at or close to that habitat. Station 2 (see Attachment B to the Draft Permit) is above the Longfellow Bridge and closer to the discharge than the viable perch spawning areas described above. Specifically, EPA should examine the extensive available thermal data on the Kendall plume and explain how maintenance of 24-hour average temperatures below the values specified in Comment C5 at 6 foot depth at the upstream boundary of the ZD above the Longfellow Bridge from March 20 to May 10 would not protect the propagation of the BIP of yellow perch in the Lower Charles. The explanation should include the specific evidence for any claim of likely appreciable harm.

Response to D14: Please see Responses D10 and D13 relative to yellow perch and Response to C3 with respect to appreciable harm.
Mirant appears to link increasing salinities at 15 and 20 ft. water depths with declining spawning habitat for yellow perch. However, Scott and Crossman's Freshwater Fishes of Canada (1973), a standard text on freshwater fishes used in the northern U.S., states that yellow perch adults, when found in brackish water, move into freshwater to spawn. In addition, they typically spawn along the shoreline and are known to spawn in a variety of habitats, not just in weedy areas. As a result, salinity at 15-20 foot depths should not interfere with yellow perch spawning.

In addition to the above, the Boston shoreline appears to already provide nursery habitat for yellow perch, bluebacks and alewives, although the habitat in these areas may not be the same quality as in other areas. Yellow perch (assumed here to be juveniles) were captured along the Boston shoreline, by seine, downstream of the Longfellow Bridge in 2005 at the Boston seining station. These captures identify the seining area at the Boston station as a nursery area for yellow perch. In addition, both juvenile bluebacks and juvenile alewives have been caught in the upper water column in push-nets well off the shoreline downstream of the Longfellow Bridge as well as in shoreline seining in 2005 at the Boston Station. Moreover, juveniles of both species were caught in 2005 and in previous years in or near the old boat locks at the Museum of Science.

The information above indicates that a) adult yellow perch should be able to use the Boston shoreline as spawning habitat; b) shoreline areas downstream of the Longfellow Bridge have been documented as nursery habitat for yellow perch, bluebacks and alewives, and c) the upper water column downstream of the Longfellow Bridge, adjacent to the Boston shoreline, has been used as nursery habitat for juvenile alewives and bluebacks.

While Mirant's comment that areas above the Longfellow Bridge may also be suitable habitat for yellow perch has merit, this does not allow EPA to abandon temperature limits that are protective of yellow perch in areas below the Longfellow Bridge.

In response to Mirant's suggestion to "refocus" monitoring stations to protect yellow perch upstream habitat, the current location of Monitoring Stations 3 on the Boston side should provide assurance that the Boston shoreline downstream of the Longfellow Bridge, as well as adjacent areas upstream, will both be afforded protection. Moreover, Mirant's proposal to

"refocus" on the upstream habitat compromises the continuity of yellow perch habitat along the extent of the lower Basin above and below the Longfellow Bridge. See Response D13 for a further discussion of the importance of avoiding thermal blockage in yellow perch habitat.

Comment D15: In-Stream Limits for Alewife Should Focus on 50% of the Cross-Sectional Area of the ZPH. Based on the above discussion of physical characteristics and sampling of adult and YOY alewives since 1999, Mirant Kendall believes that maintenance of 24-hour average temperatures not-to-exceed the values specified in Comment C5 in 50% of the cross sectional area of the ZPH would prevent appreciable harm to the BIP of alewives in the Lower Charles. If the Agencies disagree, their explanation should include the specific evidence for any claim of likely appreciable harm.

Response to D15: Please see Response D3 with respect to the 4-hr average temperature, and Responses C3 and C23, with respect to appreciable harm from Kendall's discharge.

Comment D16: The chill period limit for yellow perch is of little, if any relevance in the ZPH. Impact on yellow perch gonadal development would only be relevant if fish resided in the location where temperature was continuously elevated. As noted above, yellow perch are currently not abundant in the ZPH because it is too saline and anoxic at their preferred depths. Therefore, the chill period standard is overly broad and of limited applicability as long as the basin is stratified.

Response to D16: EPA disagrees that lower than anticipated abundance of yellow perch in the lower Basin is due to high salinity and low DO levels in the deeper waters of the Basin. See Response to D14. No credible carrying capacity or population estimate for yellow perch in the lower Charles River Basin has been submitted by Mirant, so discussion of the abundance of this species is open to debate. Regardless of the actual abundance of yellow perch, protective temperatures cannot be relaxed for a BIP species because its abundance is claimed to be low due to other stressors. Indeed, EPA is required to take such cumulative stressors into account when establishing protective temperatures.

During most years in the winter, when the Chill Period Limit for yellow perch is in effect, the saline stratification in the lower Basin disappears. This is due to three reasons: a) a lessening of the use of pleasure boats towards the end of the summer cuts down on boat traffic through the New Charles River Dam and Locks, which results in a concomitant decline of salt intrusion due to locking these boats into the Charles; b) increased river flows during the early fall drive out the salt water in all but the deepest portions of the Basin in most years; and c) the lower Basin has been documented to become generally mixed in the winter and maintain a relatively uniform temperature from surface to bottom, where not impacted by Kendall Station's thermal plume. For example, Kendall's 2005 hydrographic data show the change in mid-depth salinity quite clearly. For example, at the Boston Station, at the 15 ft. depth, salinities in the middle of the summer reached to above 15 parts per thousand (ppt), but by the middle of October the levels were below 0.5 ppt at that depth and remained there throughout the duration of sampling which

ended November 8th, 2005, at that station. Thus, during the winter chill period for yellow perch, the salinity levels in the lower Basin at depths apparently preferred by adult yellow perch should not be problematic to those fish.

Mirant also states that the dissolved oxygen levels at the mid-depth layer would also be problematic. The 2005 hydrographic dataset from the Boston Station indicates that dissolved oxygen at 15-foot depth was sufficient for the winter chill period: it remained above 7.0 mg/L from mid-October onward. The rise in dissolved oxygen levels at the Boston Station in mid-October happened the same day that salinity levels at that station dropped. This was likely a result of the sharp increase in river flow during this time period, as recorded at the USGS Gauging Station at Waltham. According to this station, the daily flow in the Charles River increased from approximately 53 cfs on October 9, 2005, to approximately 313 cfs on October 10th, and continued to increase to over 1,100 cfs by October 15th, 2005. The increased river flow likely drove out the salt water and low dissolved oxygen levels at the 15 foot depth of the lower Basin.

Comment D17: Mirant asserts that the temperatures in the Zone of Dilution (ZD) do not reach acute effects threshold levels. Section 5.8.1c, and other parts of the DD discuss a Zone of Dilution (ZD) where "biologically based, protective water temperatures are exceeded." Throughout the document (see Section 6 for example), it is assumed that temperatures up to the maximum authorized discharge temperature (105^{O} F) are experienced in the ZD.

The State's Mixing Zone Policy, for use in conjunction with the Water Quality Standards, defines the temperature limit to apply within a Zone of Dilution as not to exceed 90 ^{O}F. Based on monitoring as closely to the discharge as possible since 2001 (MRI's "Shallow Diffuser" station), Mirant found that temperatures have not exceeded this 90^{O}F threshold even at full heat load on the warmest days (e.g., August 22, 2003).

Comment related to D17 from CLF: The permit allows the plant to discharge large amounts of heated water (105 ºF), and this will be lethal to most of the aquatic life that approaches the discharge point within the zone of dilution (ZD). The discharge water is a full 15 ºF over lethal temperature limit for the fish species. EPA's administrative record indicates that the thermal plume may extend 3 miles up river to the Boston University Bridge, covering approximately 67% of the surface area of the Basin (450 acres). Thus EPA is proposing to allow impact to a massive portion of the Basin. The conditions proposed for the ZD will result in high mortality for aquatic animals that enter this zone, including larval fishes and eggs which have little control over their distribution within the Basin. The added thermal load allowed under the draft permit would stress the biology of the Charles River beyond the conditions to which the fauna has adapted over millions of years and is not consistent with the goal of supporting a BIP. High temperature excursions do occur naturally, but they are rare and generally brief. Even these naturally occurring extremes can stress the indigenous fauna causing mortality, reduced reproductive output, and increased susceptibility to disease. The added thermal stress that would be allowed under the draft permit would be frequent and prolonged, producing conditions that

will not be tolerated well by indigenous fauna. Under the proposed permit (Attachment A), the water temperatures in the ZPH could be held near 83 ^{o}F for almost 5 months (from 12 June through 31 October). This condition would be highly unnatural, and there is no justification for an agency tasked with environmental protection to suggest that it would be supportive of a balanced indigenous population.

Response to D17: Temperatures in the ZD do in fact reach acute effects thresholds, particularly for drifting eggs and larvae. EPA's conclusion is based on species life stage acute effects levels and chronic effects, which are discussed below. Evidence that temperatures in the ZD exceed 90 °F is found in "Response F4 (part 2) and Response to Related Comment from CLF" and Response L2. However, temperatures above the 90 °F threshold are not the only elevated temperatures of concern. Mirant's reference to the 90 ºF value comes from a June 9, 1992 MassDEP memorandum that was written to assist permit writers in conducting screening evaluations of NPDES permits. This memorandum mentions that "the following should be considered for inland waters" and suggests limiting the mixing zone temperature to a 90 ºF maximum to "avoid short term adverse effects within a mixing zone". The subsequent, actual MassDEP Implementation Policy for Mixing Zones (January 8, 1993) states that "To protect swimming and drifting organisms the in-zone quality must be such that these organisms can pass through the mixing zone without acute exposure to toxicants". As explained in MassDEP's Water Quality Certification, the intent of the above referenced provision of the Mixing Zone Policy is to assure that organisms can pass through the mixing zone without being exposed to toxic conditions, including thermal impacts. In this case, site-specific information was obtained for specific organisms (see below) which demonstrates that temperatures lower than 90 ºF are toxic to indigenous organisms that inhabit the lower Charles. Because toxicity thresholds for various life stages of organisms vary, and because the presence of these different life stages within the lower Basin varies with season of the year, it follows that toxicity thresholds will also vary with season of the year. These thresholds typically change with: a) the acclimation temperature of the test organisms; and b) the duration of the exposure to the test temperature.

Toxicity thresholds for juvenile alewives are appropriately compared to water temperatures in July and August because juveniles are present in the lower Basin at this time and water temperatures are typically highest during those months. The NOAEL (No Observable Acute Effect Level) for alewife juveniles, based on research by Otto, *et al*. (1977), is 84.2ºF for juveniles acclimated to a temperature regime of 75.2 – 78.8ºF. In addition to No-Effect levels, Otto, *et al*., also reported that a mortality of 10% resulted when juvenile alewives were exposed to 86ºF and that 40% mortality resulted among fish exposed to a temperature of 89.6ºF. Temperatures higher than the NOAEL would be expected to elicit mortality if exposure duration is the same or greater than that in the test. Because water temperatures at the 90-100ºF level would not be expected to fall well-below the NOAEL temperature of 84.2ºF, or even below the 10% toxicity temperature (86 ºF) over the 500 minute range found by Otto *et al*. to induce acute effects, the Permitting Agencies contend that it is logical to assume that toxic conditions existed within the ZD in the summer of 2005.

Ambient temperatures in the lower Basin over the July-August period in 2005 were in the 70s (ºF). The mean of all temperatures reported in Mirant's 2005 Hydro dataset for the Hyatt and B.U. Stations (both located well upstream of Kendall's discharge) during the July-August period were 77.4 and 77.5, respectively. Thus, the NOAEL of 84.2 ºF developed from the Otto, *et al*., research is based on acclimation temperatures (75.2 – 78.8 ºF) that are in the same range as those at the "ambient" stations in the lower Basin during the July-August period.

Information submitted by Mirant as part of the 2005 Hydro dataset strongly suggests that temperatures exceeding the toxicity threshold for alewives juveniles (i.e., the NOAEL of 84.2 ºF) appeared to persist at some sites for periods longer than those expected to induce toxicity. Because temperature readings were not continuous, temperatures lower than the 84.2 ºF may have occurred at these stations between readings. However, temperatures at the surface of the water column exceeded the 84.2ºF value on all five dates when monitoring was conducted at the Shallow Diffuser Station from August 9 – August 22 and for all three dates that monitoring was conducted from August 29 through September 6.

There is also concern that fish exposed to high temperatures will suffer from chronic effects. Williams and Coutant (2003) published an article on heat exposure of eggs and larvae of an atherinid fish, *Atherina mochon* (Williams, M.A. and C.C. Coutant. 2003. Modification of schooling behavior in larval atherinid fish *Atherina mochon* by heat exposure of eggs and larvae. Trans. Amer. Fish. Soc. 132:: 638-645). The authors studied effects of short, daily exposures to sub-lethal temperatures in simulation of a transient thermal plume. Evaluation of larval fish at 10-35 days posthatch showed "significant modification or retardation of schooling behavior". These behavioral modifications, due to sub-lethal heat exposures, are of concern to regulators. Schooling behavior is a common behavior in certain fish and has been found to be a primary defense against predators.

In addition to the problems noted for alewives, other problems are expected with zooplankton. Daphnia pulex, one of the common zooplankters expected in the Charles, has a reported TL50 value of 80.6 °F (Craddock, 1976) and the No-Effect temperature of this species would be at a temperature lower than 80.6 ºF. Thus, assuming this TL50, lethal effects to D. Pulex are likely in the ZD when thermal areas are not avoided. In general, temperatures sustained above 77 °F for more than 7-10 days are detrimental to zooplankton communities in the northeast (Moore et al., 1996). With a 5 °F delta T, Kendall's discharge is expected to increase the number of weeks greater than 77 °F from 0-1 without the discharge to 8-12 weeks with the discharge (see Section 5.8.2l of the DD).

There is sufficient direct and indirect evidence that acute toxicity to aquatic life in the lower Charles is likely to occur. ZD temperatures are expected to have the greatest Delta temperature compared to ambient river temperatures when river flows are low and it is during these times that acute toxicity to aquatic life has the greatest potential of occurrence. The areal extent, frequency, duration and magnitude of any naturally occurring high temperature events are all expected to be increased by Mirant's discharge.

Response related to D17 comment from CLF:

1.) One likely characterization of the Zone of Dilution may generally predict this area to follow along the Cambridge shoreline, out to Monitoring Station 7, over to Monitoring Station 4, then to the middle of the Basin where Station 2 is currently configured, and then along a line perpendicular to the river flow back to the Cambridge shoreline. This is about 60 acres in size. The total size of the segment of the water body where the B.U. Bridge begins to the new Charles River dam is about 430 acres. Thus, the allowed Zone of Dilution is about 14% of the river segment surface area.

2.) Although the Final Permit end-of-pipe discharge temperature limit is 105 °F, other permit conditions prevent continuous high-volume discharge at that temperature for long periods of time. Based on an analysis of ambient temperature conditions in the lower Basin, the ΔT limit of 5 ºF, the placement of the individual temperature monitors in the ZPH, and the operational profile of Kendall Station, it would be highly improbable for any portion of the ZPH to be held near 83 ºF for long periods of time. Assuming that Mirant complies with the conditions of the permit, the prospect of the entire ZPH being near 83 ºF without abatement for almost five months is extremely unlikely.

As discussed in the Kendall Station Determination Document (DD, Section 5.7.3g), when continuous ambient temperatures in the lower Basin are reviewed from 1995 to 2002, it is evident that a temperature of 83 ºF could not be maintained in the ZPH for any appreciable length of time. Both diurnal temperatures and the temperature record over the course of any 10 day period show very few instances with stable, constant temperatures for any length of time. Rather, changes as great as 8 to 10 ºF can be seen over the course of two weeks (September 1996, 1997, 1999, 2000 and 2001; Figures 5.9.2-17, -18, -20, -21, -22).

These ambient temperature readings were taken after a wedge of water representing the upper eleven feet of the water column was mixed and withdrawn into the Station. The permit requires individual temperature monitors placed at various depths, including a depth of two feet. Temperatures measured in this way have been shown to document even greater temperature variability than the eleven foot mixed water column temperature. Ambient temperatures recorded near the B.U. Bridge in the summer of 1999 and 2002 also show changes in temperature over approximately a two week period of approximately 7 ºF (DD Figure 5.9.2-3,and 5.9.2-4).

Thus, the Delta T limit of 5 ºF plays an important role in ensuring that the receiving water does not reach and maintain maximum temperature limits for prolonged periods of time. The natural variability in ambient temperature, as discussed above, coupled with a ΔT limit of 5 ºF over ambient conditions in the ZPH, make it a permit violation for temperatures in the ZPH to remain at 83 ºF when, for example, temperatures drop more than 5 ºF below this limit.

The number and position of real time, in-situ temperature monitors required for the ZPH will

almost certainly have only one or two monitors that approach the maximum temperature allowed at any given time. The Station will be required to take action to reduce their thermal discharge when only one of the identified monitors in the ZPH reach the maximum temperature allowed. The remainder of the monitors will likely not come in contact with the higher temperatures before action is taken at the Station. This is especially likely as Kendall Station maintains a near surface discharge point on the Cambridge side of the Charles River. Temperature monitors deeper than two feet and closer to the Boston side of the river will not likely be the first compliance monitors to come in contact with the Station's surface thermal discharge plume. Based on vertical profile data submitted by the permittee (Mirant Kendall, September 2005) temperature compliance points below two feet and closer to the Boston shore of the ZPH should never be warmer than compliance points at a depth of 2 feet that are closer to the Cambridge side of the Charles River.

Finally, the reality of Kendall Station operation makes it nearly impossible to maintain a ZPH with water temperatures consistently at or near maximum limits for extended periods of time. Kendall Station's present operation does not have the ability to make small changes in discharge temperature to react to changes in ambient river conditions with the goal of maintaining, but not exceeding, a certain target temperature in the ZPH. Once a maximum temperature limit is approached, the Station only has the option to modify operation to noticeably reduce the discharge temperature (see Section 5.11 of the DD). Modifying Station operation in graduated, refined increments to stay within a one degree Fahrenheit target in the ZPH is not feasible in order to be consistent with Mirant's participation in the energy supply market.

For all the reasons listed above, it is not realistic that "…the water temperatures in the ZPH could be held near 83 ºF for almost 5 months (from 12 June through 31 October)." This statement does not take into account many interrelated aspects of ambient river conditions in the lower Basin, the design of the permit requirements, or the operational realities of Kendall Station.

Comment D18: Delta T Issues - Misunderstanding and Mischaracterization of Data in Record Regarding Response of Various Species to Delta T from Thermal Plume. Section 5.8.2 of the DD presents a series of discussions regarding the potential biological effects to fish associated with the spatial and temporal temperature changes potentially resulting from Facility operation. Mirant Kendall believes that this section is heavily flavored by misunderstanding and misconceptions concerning the shape of the thermal plume and Mirant Kendall's past proposals. Those misconceptions are reflected most directly in Section 5.8.2b-1, but if reconciled, affect the entire section and its endpoints.

Specifically, it appears that the Agencies seek a 5 ºF "horizontal" Delta T requirement to prevent exposure of fish swimming horizontally upstream to rapid temperature changes. They wish to maintain a 5 ºF Delta T component at the edge of the ZD. Mirant Kendall disagrees with the necessity for those requirements in view of contrary biological evidence, but believes the objectives can be accomplished as described below.

Comment related to D18 from CLF: The method proposed by EPA for determining delta T is flawed because the intake can be contaminated by the discharge – corrupting the delta T measurement for facility *temperature rise* and for other uses of delta T. EPA discusses this "re-entrainment" problem on page 81 of the Determination Document. This problem will cause an underestimate of delta T for facility *temperature rise* and this will translate into a corresponding underestimate of the thermal load. The baseline temperature for determining this and other delta T values should be based on a series of up-stream monitoring stations as discussed above.

Response to D18 and related comment: The submission of a validated hydrodynamic model would have greatly assisted EPA in evaluating the shape of the thermal plume from Kendall Station's discharge. Perceived inaccuracies in the expected shape of the thermal plume cannot be challenged with any degree of confidence using only the information submitted by the permittee. The permittee does not state in this comment what biological evidence there is that is in disagreement with the need for a Delta T of 5 °F. As a result, EPA cannot comment on the validity of the evidence. Additional discussion of the biological basis for the Delta T of 5°F is provided in Response D19.

It is not clear from CLF's comment whether it addresses the Delta T limit of 5 °F across the lower Basin or the Delta T limit of 20 °F within the plant. As to the limit in the lower Basin, EPA has attempted to place the background monitor used to implement this Delta T requirement in a location that will not likely be affected by the discharge plume from the facility. As to the limit in the plant, it is possible that the intake for the Kendall Station might be influenced by the discharge plume under certain conditions. Ultimately, however, that discharge cannot exceed a maximum temperature of 105 °F and the in-stream temperature compliance must be attained. These permit requirements limit the effects of a rising intake temperature. The Delta T limit of 5 °F in the lower Basin will also help prevent extreme effects from the Station's intake re-entraining the discharge.

Comment D19: The Agencies' Contention that Individual Fish in a School are Traveling in Different Isothermal Lines is Not Plausible. Section 5.8.2b-2 of the DD focuses on data from Mirant Kendall's November 5, 2002 correspondence, (A.R. No. 244) to argue that fish may have been traveling linearly rather than across the observed Delta T of 8 °F.

This supposition is wholly inconsistent with the principles of natural selection (which would rapidly extinguish any estuarine fish which traveled that way). It is also inconsistent with years of observation of schooling behavior of alosids, which shows them to move throughout the water column. Further site-specific data demonstrating the same type of distribution pattern, across greater Delta T's of at least 12 ºF, was submitted in 2003. A.R. No. 489. Those data were collected from gillnets set for only 1-2 hours, casting doubt that multiple schools of fish were involved or that water temperatures changed during capture. In fact, water temperatures were measured several times on those dates, and did not change by more than 1-2 ºF at the involved depths.

Response to D19: Mirant maintains that because fish were gill-netted at different depths, and

because temperatures from the upper waters where fish were captured to the lower depth where fish were captured were up to 8°F different, that it follows that the fish captured in the gill-net must routinely move across a delta temperature of 8°F. EPA disagrees that the capture location of a fish within a column of water that also displays vertical changes in temperatures with depth is evidence that the fish routinely moves vertically through the differences in temperature. Mirant fails to provide documentation that the fish actually moved routinely through the vertical thermal gradient. It is just as plausible that the fish captured at a certain temperature had remained within this preferred temperature and depth gradient until it was gillnetted. In addition, much of EPA's concern over delta temperatures is linked to travel from Boston Harbor into the Charles and from the Charles out to Boston Harbor. Concerns over delta T's greater than 5 °F within the Charles and their effect on the delta temperatures experienced by fish moving between Boston Harbor and the Charles are discussed in Sections 5.8.2d - 5.8.2k of the DD.

Several other issues are of great concern to EPA with regard to increases in the allowable delta temperature: effects to zooplankton and to juvenile alewives.

Increases in allowable delta temperatures will protract the duration, areal extent, frequency and magnitude of high-temperature events in the lower Basin. This is discussed at length in Section 5.8.2l of the DD. Negative effects to zooplankton are also discussed in this section of the DD. Protracted high-temperature events above 77 ºF are known to negatively affect zooplankton. See Response to D17.

Surface temperatures that exceed 81 °F appear to present problems in the lower Basin of the Charles for juvenile alewives. This is evidenced by the near-complete lack of juvenile alewives in Mirant's beach-seine and push-net datasets in the lower Charles over the years 1999-2004 and much-reduced catch-per-unit-effort of juvenile alewives above 81 ºF in 2005. American shad have been shown to be even more temperature sensitive than alewives, and EPA is concerned that delta temperatures induced by the facility will create a wide margin of poor quality habitat for American shad at the surface downstream of the B.U. Bridge during low-flow summers. See Responses to C51 and C52 regarding American shad restoration efforts being conducted in the Charles River. As mentioned above, the magnitude, frequency, areal extent and duration of these events all will be increased with increasing delta temperatures.

Comment D20: Mirant Kendall Does Not Change the Severity of Vertical Thermal Stratification. The thermistor data provided to the Agencies show that the severe vertical stratification of temperature in the ZPH occurs independent of Kendall Station's operations. At whatever heat load the plant is discharging, the abrupt thermocline creating vertical Delta Ts of more than 10 °F in the ZPH always occurs below the depth of influence of Mirant Kendall's thermal plume. Importantly, Mirant Kendall's proposed diffuser would alleviate the chronic severe vertical stratification in the ZPH by its mixing of the water column.

Response to D20: Again, a validated hydrodynamic model would have assisted EPA in evaluating the influence of Mirant's discharge. That said, EPA believes that the discharge does affect the thermal stratification present in the lower Charles Basin. Although it appears that

natural stratification would be expected in the absence of Kendall Station's thermal discharge, the thermal discharge accelerates the degree of stratification. The warmer, and thus more buoyant water discharged near the surface of the river at Kendall Station Outfall 001 has been documented to float, or remain near the surface, as it is discharged. This prevents deeper, ambient temperature river water from moving to the surface as a result of wind or wave action. This process is thought to accelerate the overall stratification in the lower Basin. EPA and MassDEP have commented that this stratification could be diminished with the introduction of a deep water diffuser, but as stated in the supporting documents of the Draft Permit as well as this response document, there are other coincident concerns with the operation of a diffuser that must be addressed before the diffuser discharge is allowed. See Section E.

Comment D21: The Agencies Misunderstood Delta T Characteristics of the Thermal Plume. Section 5.8.2b-2 of the DD hypothesizes that a combined Delta T of 15 °F could result from an approach proposed by Mirant. This is impossible. It has been mistakenly assumed that the temperature pattern could go from lowest at the upstream location (Station 1) to highest at the downstream location (Station 8). To the contrary, the pattern is one of progressive cooling in all directions from the discharge, so that an overall Delta T of 5 ºF between the upstream and downstream borders of the ZPH (Stations 2 and 8) would be maintained.

Response to D21: Although theoretically allowable, based on the proposed permit provisions, a 15 ºF Delta T would not likely occur, at least horizontally, as under most conditions there is progressive cooling in all directions from the discharge. A suitable hydrodynamic model would provide the necessary information to clarify this point.

Under this description, and in the absence of a model, the overall Delta T of 10 ºF from ambient conditions could result – a Delta T of approximately 10º F or higher (see Tables F4.P2.CLF-1 and -2) within the vicinity of the outfall, and a Delta T of approximately 5 ºF at upstream and downstream borders where the thermal plume has dispersed and cooled somewhat. A sustained Delta T of 10 ºF or greater is not considered protective of the BIP. See Response D23 for further information regarding the potential biological effects of a Delta T greater than 5 ºF.

Comment D22: Agencies have Exaggerated Delta T Seen by Fish Entering the River. Section 5.8.2d of the DD states that "[h]eated water, discharged from Mirant Kendall's facility, increases the temperature differences between the two bodies of water and increases the potential for thermal shock to anadromous fish."

Continuous monitoring during spring 2004 showed Delta T's of only about 1 ºF between the Harvard Bridge and the Charlestown Dam in April when the plant was running at 90% heat load for days at a time. Because of high spring flows, the Agencies' assumptions of 5 ºF Delta T's during the spawning run are wrong. Even under seasonal extreme low flows in the spring (40 year minimum about 100 cfs), Delta T's of 5 ºF would not be approached. Maximum Delta T's of only about 3 ºF or less would occur at the dam, too small to have the exaggerated effects discussed throughout Section 5.8.2.

The severity of the interface at the dam is mischaracterized and exaggerated by the Determination Document, invalidating many conclusions in this section. Mirant's vertical profile data, collected and forwarded to the Agencies in 2000, 2002, 2003 and 2004, show that the near surface water just below the Charlestown Dam in the harbor and lower depth water just above the Dam in the river are at virtually the same temperatures and salinity. These waters mix when the fish enter. The speculation about stress is therefore unsupported.

Response to D22: These comments are addressed in Response C6 . Additionally, MassDEP and EPA note that Mirant's observations about the low level of Delta T observed in the lower Basin when the Station was operating at high capacity suggests that the Station should have little trouble complying with the Delta T limit in this permit. Therefore, to the extent that there is a dispute over the biological necessity of avoiding extreme shifts in temperature across the lower Basin, it is reasonable to err on the side of including the limit to assure protection of the BIP in the event that such temperature shifts are biologically significant. If Mirant's understanding of Delta T in the lower Basin is correct, this limit should constrain the facility only in the most extreme circumstances, which is likely precisely when the BIP will most be in need of protection.

Comment D23: Agencies' Discussion of Acclimation to Delta T Compounds Speculation. Section 5.8.2f of the DD quotes from Cooper (1961) regarding the inability of the alewife to acclimate readily to rising or fluctuating temperatures. Here, the Determination Document is employing speculation by Cooper, not any specific scientific finding, as the basis for support for their own further speculation. On p. 131, Cooper's speculation is presented as virtually fact "and is at least 5.6 ºC higher than the temperatures associated with large-scale adult mortalities witnessed by Cooper in RI fish." Cooper did not observe mortalities, he assumed that they must have occurred.

Response to D23: The DD cited Cooper's study and its findings as one of several studies showing that delta T's of 5 °F or more present lethal and sub-lethal consequences to fish. The weight of evidence, along with the State's delta T requirement, points to the appropriate delta T limit of 5 °F to protect fish in the lower Charles River Basin. The DD clearly lays out the adverse effects of elevated delta Ts and provides a clear rationale for the need to impose this limit.

Regarding a Delta T of 5 °F, in "Temperature Criteria for Freshwater Fish: Protocol and Procedures," a National Technical Advisory Committee (EPA 1977) recommended "To maintain a well-rounded population of warmwater fishes…heat should not be added to a stream in excess of the amount that will raise the temperature of the water (at the expected minimum daily flow for that month) more than 5 ºF." EPA (1977) further states that, "A casual reading of this requirement resulted in the unintended generalization that the acceptable temperature rise in warmwater fish streams was 5 ºF. This generalization was incorrect. Upon more careful reading the key word 'amount' of heat and key phrase 'minimum daily flow for that month' clarify the erroneousness of the generalization. In fact, a 5 ºF rise in temperature could only be acceptable

under low flow conditions for a particular month and any increase in flow would result in a reduced increment of temperature rise since the amount of heat added could not be increased."

Response D31 lists some other states where a Delta T limit has been incorporated into regulations for the protection of aquatic life.

Comment D24: Agencies' Speculation on Avoidance Behavior is Contradicted by Field Data. Section 5.8.2g of the DD citing Dixon (1996), suggests that alewives and bluebacks both seek to stay at light levels allowing them to maintain a school. Dixon's observations with regard to this behavior were of juveniles of these species, not of adults undertaking spawning migrations.

Mirant Kendall's gillnet data since 2000 and biosonic monitoring in 2002 show that the river herring are fully distributed throughout the oxygenated portions of the water column, with as many or more caught at depths of 6 feet or deeper than at shallower depths.

These data also show that horizontal Delta Ts lower than the ranges of concern to the Agencies have always been available to the fish, even when the plant ran at 90% heat load in mid-to-late April 2004. During each year's run, alewives have been captured equally or more often in gill nets set just off the Cambridge shore upstream of Kendall (MRI's Below Broad Canal Station) than at any other station. The speculative avoidance behavior described here by the Agencies is contradicted by these results. The Agencies should reconcile these data with the discussion in 5.8.2 and revise the discussion to reflect the data.

Response to D24: Mirant is correct in specifying that Dixon's work pertained to juveniles, not adults. However, the citation by Bigelow and Schroeder describes the same behavior pattern for adults that Dixon found for juveniles, i.e., that adult alewife have a vertical, diurnal movement in the water column.

Regarding delta temperatures above and below the New Charles River Dam, EPA currently lacks information regarding what percentage of alewives or bluebacks or other species of anadromous fish are held back by the dam due to delta temperature differences between a) water temperatures at which fish attempting to enter the Charles have acclimated to; and b) water temperatures in the Charles. Movement of fish past dams, even those without a large delta temperature difference, has been known, at times to be limited to a small percentage of the population of migrants, especially if the fish ladder at the dam, or dam operation is faulty (Dick Quinn, U.S. Fish and Wildlife Service, pers. comm. to Gerald Szal, May, 2006; also see Sprankle, 2005. Interdam movement and passage attraction of American shad in the lower Merrimack River main stem. North American Journal of Fisheries Management. 25: 1456-1466. AR #633)). An additional drop in the percentage of fish moving into the Charles could result in a substantial, negative impact to populations already at extremely low stock sizes. The review of delta temperature differences presented in the Determination Document was conducted to determine the potential for high delta temperature effects in the Charles, effects that are predicted from studies reported in the literature.

Mirant's information from the gill-netting does not address the questions for which the delta temperature analysis was conducted in Section 5.8.2g. These questions include what percentage of fish are potentially held back by delta temperature differences between the two waterbodies at the New Charles River Dam, and how an increase in the permitted Delta T would affect these fish. The primary issue addressed in Section 5.8.2g is that of temperature differences above and below the dam and entry into the Charles, not movement upstream once entry has been achieved. Regarding other Sections of 5.8.2 and potential avoidance, Mirant's biosonic monitoring data were somewhat disturbing to EPA because a number of the fish in the survey did not move past the facility's discharge. Some of the fish did not move past the old boat locks at the Museum of Science and others appeared to have spent a lot of time in the vicinity of the facility's discharge (see Response C10 (continued) and Responses D26 and D27). This is not avoidance, but an attraction to the discharge, probably because of the increased velocity of water near the discharge rather than an attraction to any temperature difference. Mirant also provided a video to regulators that clearly showed river herring exhibiting spawning behavior *inside* Kendall's discharge pipe.

Fish drawn to discharges can be lost to the population at large. This behavior has been observed at Brayton Point Station, where striped bass congregate within the discharge canal in large numbers, and overwinter there rather than continuing their migration farther south. Spawning inside the discharge pipe at the Kendall station is not expected to result in viable offspring for a number of reasons discussed in the Determination Document. In addition, the simple attraction of fish to the discharge can keep them from moving upstream. These are of considerable concern to EPA. Mirant's gillnet data that show that alewives have been captured equally or more often in gill nets set just off the Cambridge shore upstream of Kendall does confirm that alewife can move past the Station's thermal plume. However, it may also indicate that their full migration well upstream could be interrupted from other facility impacts.

Comment D25: Avoidance Would be Expected to Mitigate Potential for Lethal Effects. The speculative presentation of the major temperature change that upstream migrating fish encounter, and the lethality of the thermal plume of the plant ignores the fact that fish will avoid lethal temperatures, as was noted by Klauda for juvenile shad.

Comment related to D25 from CRWA: Documentation supporting the permit states that, "A key aspect of the Massachusetts WQS subject to this variance is the mixing zone policy which calls for no lethal affects (sic) in the Zone of Initial Dilution." The permit appears to waive this requirement. It also appears that the requirement in DEP's Mixing Zone Policy stating that, "to protect swimming and drifting organisms, the in-zone quality must be such that these organisms can pass through the mixing zone without exposure to toxicants." has been waived. EPA should explain how adding so much heat to the system is protective. CRWA believes that this permit will violate the anti-degradation provisions of the Massachusetts SWQS by eliminating or impairing existing uses.

Response to D25: A discussion of river herring avoidance is found in Response C3. Avoidance

is an effect that must be accounted for in protecting the BIP. To the extent that avoidance due to absolute temperatures or delta Ts cause excessive habitat to be lost or avoided, EPA and MassDEP have established permit conditions to protect against such eventualities. EPA and MassDEP believe that the combination of instream temperature limits and delta T limits will minimize such occurrences.

Mirant is at least partly correct in stating that avoidance should mitigate for lethal effects. However, there are conflicting issues here. First, if fish at the New Charles River dam "sense" that temperatures are too warm, based on Mirant's statement, these fish would avoid entry to the system. Thus, avoidance at the dam will reduce the entry of fish to the Charles.
Second, avoidance of high temperatures, when other stimulants such as increased water velocity are present, can apparently be "over-ridden" by the attraction to a second stimulant. When there are conflicting stimuli, river herring – such as those attempting to spawn in Kendall's discharge pipe – do not appear to always act in a fashion that benefits their own reproductive success.

Third, if fish are driven to avoid unacceptably large areas of the Basin, that in itself constitutes appreciable harm to the BIP and is not consistent with EPA's obligations under CWA 316(a).

Response to Comment related to D25 from CRWA: EPA agrees with CRWA that Mirant's discharge does not qualify for a mixing zone pursuant to MassDEP's Mixing Zone Policy. This Permit is not based on a mixing zone. It is based on a CWA 316(a) variance. See also Response to C1. As explained extensively in this document and in MassDEP's certification, the permitting Agencies acknowledge that the permit will allow for potentially toxic thermal conditions in the mixing zone. But EPA and MassDEP have concluded that permit enforces conditions in the ZPH that are consistent with protecting the BIP, and therefore, the Permitting agencies are authorized under 316(a) and Massachusetts' WQS to vary from the MassDEP's Mixing Zone Policy.

EPA and MassDEP do not agree with CRWA's contention that "this permit will violate the anti-degradation provisions of the Massachusetts SWQS by eliminating or impairing existing uses". First, the protective temperature limits and other provisions included in the Final Permit are far more protective than provisions in the former permit. This determination is consistent with the CWA and State WQS antidegradation requirements. The core requirement is that "[i]n all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." 314 CMR 4.04. The protective provisions included in the permit will only improve the Basin as a habitat for fish. Massachusetts has provided a CWA 401 certification specifying the conditions on protective temperatures and the cooling water intake, including the specified entrainment reduction requirements, which are required to satisfy the Commonwealth's WQS, including the antidegradation provisions. EPA has included these conditions in the Final Permit.

Comment D26: Mirant contends that tracking studies show that the fish are not significantly

distracted and that Section 5.8.2h of the DD speculates that the thermal plume distracts the fish and delays migration. Mirant Kendall's tracking studies show that there is no significant effect, if any.

Response to D26: Mirant's tracking studies were limited and inconclusive. During the permittee's tracking studies, although many fish traveled upstream, there were several that lingered below the area of the discharge or were presumed dead. In one study, covering the period of May to July of 2001, 9 out of 80 tagged fish did not move above the Museum of Science and were presumed to have died or regurgitated their tags. The specific operating conditions at Kendall Station during the days when these fish were released were not assessed as part of the overall study. In general, June of 2001 had monthly heat load discharges of 183 million BTU/hour. The study does not clearly show that migrating herring were not distracted, even with heat loads well below what they could be during certain months and at higher generating periods. It may be possible that fish simply swam at lower depths near the discharge where temperatures were generally several degrees lower than at the surface. Depth tracking did not provide reliable information, so this possibility can not be evaluated using the data collected. Response D27 provides additional information on Mirant's fish tagging studies.

Comment D27: Agencies' Speculation about Fish Navigational Difficulties is not Plausible. Section 5.8.2j of the DD describes a variety of hypothetical difficulties of detection and navigation of migrating river herring around the horizontal Delta Ts in the ZPH. The Agencies should explain what, if any evidence, they see of significant effects of this type for each of the tagged and tracked fish in Mirant Kendall's studies. Also, they should explain why all of these hypothetical concerns are focused on horizontal Delta T's that only reach 2 ºF to 3 ºF over distances of 1,000 feet or more in the spring migration, yet these fish are almost always swimming within less than 20 feet of vertical Delta Ts (caused by stratification, not the plant) in excess of 10 ºF.

Response to D27: EPA and MassDEP acknowledge the substantial effort undertaken by the permittee in conducting fish tagging and tracking studies in 2001 and 2002. However, it is not appropriate to characterize the behavior of a subset of tagged and tracked fish as "significant," primarily because the overall number of tracked fish that yielded sufficient tracking data (16 blueback herring total in May and early July of 2001; 28 fish in 2002, with complete tracking records for 20 of those fish) was relatively low. (Mirant Kendall NPDES Permit Application, 2001, Volume II, Appendix 5-7; MRI Charles River Sonic Tracking Study, February 6, 2003). It is reasonable, however, to use the information gained from the tracking results, along with information from other sources, to support a "plausible" position regarding the effect of the thermal plume.

As detailed in the DD, most fish that were tracked in 2001 swam past the thermal plume from Kendall Station without displaying obvious behavior that would indicate their movement was disrupted. However, a small number of fish were observed meandering in the basin, between the Museum of Science and the Harvard Bridge, for two weeks to a month. Because the overall number of the tagged fish was small, it is difficult to say with certainty whether or not the

behavior of this subset of fish was a significant indicator of fish passage disruption from the Station's thermal plume. Similarly, sonar-tracking of a small number of blueback herring in 2002 appeared to show that some bluebacks may have had trouble negotiating passage upstream of the portion of the basin generally influenced by the Kendall Station discharge. Some of the fish released above the New Charles River Dam wandered in the area downstream of the Mirant discharge for weeks. Once again, it is unknown what percentage of alosid in-migrants are affected in this manner, so a determination of a significant disruption can not be made given the sample size. It is plausible, however, that thermal plume from the station may play a leading role contributing to this observed behavior. Bluebacks are supposedly more tolerant of heat effects than the closely-related alewife. If bluebacks had problems navigating past the Mirant discharge due to the effects of the thermal plume, there is a concern that alewives would also have problems. Therefore, the documentation that some river herring did not proceed past the thermal plume to spawn upstream remains a concern of EPA and MassDEP. The agencies hope to work more closely with Mirant in the future to develop information from sonar tracking to address some of these issues.

As highlighted in Response H22, pronounced stratification that would be expected to cause large vertical temperature differences as well as low DO levels in the deeper water is generally not observed during spring in-migration of anadromous fish into the Charles River. When these conditions do occur in the late summer, Mirant has offered no evidence that river herring routinely travel to deep, cooler water that is low in oxygen and back to the epilimnion, thus experiencing delta T's in excess of 5 °F. In fact, one of Mirant's most often repeated arguments in favor of the deep water diffuser has been to open up this deep water habitat to fish that Mirant contends, and EPA agrees, are excluded from these waters now. Please see Responses to E1(3) and E5 regarding the quality of this habitat.

Comment D28: Outmigration of YOY Herring Occurs Over Large Temperature Range. In Section 5.8.2m of the DD, the Agencies extrapolate Crecco's study on juvenile shad survival in the Connecticut River to assume that the longer that YOY alewives and bluebacks remain in the Lower Charles, the less likely they are to survive. The assumption is then compounded with another assumption, that Kendall Station's discharge increases the duration that alosid juveniles remain in the Charles, to conclude "Delta T from Mirant's discharge in the final few miles of the Charles would likely have a negative effect on alosid recruitment to the system."

There are several fundamental flaws in this sequence of speculative, unsupported assumptions and conclusion. First, the YOY herring leave in waves throughout the summer and fall over about a 25 ºF range of declining temperatures. Given this fact, how can the Agencies conclude that a 5 ºF difference on a given day is likely significant?

Second, there is no evidence to support the assumption that YOY alosids in the Charles are worse off the longer they remain in the system. The shad nurseries in the Connecticut which are referred to by the Agencies are not comparable to the Lower Charles. The Connecticut nurseries are hundreds of miles further upriver than the nursery area in the Charles.

The agencies should discuss how the successful runs of alewives are sustained in the Monument River when those out-migrating fish, upon exiting the river to the Cape Cod Canal, may encounter not only a Delta T leaving the river, but a second up-to-20 ºF Delta T when the tide stage is such that they encounter the abrupt front of Cape Cod Bay water that is up to 20 ºF colder than the Buzzards Bay water it replaces.

Response to D28: EPA agrees that YOY river herring leave the Basin as temperatures decline. With a maximum temperature limit in effect in the absence of a Delta T limit, it is possible that portions of the lower Basin could be kept at an artificially high temperature for a longer period of time than would be seen with a Delta T limit of 5 °F. That is why EPA and MassDEP agree once again with Mirant that a 5 °F difference on a given day is not likely significant. However, Delta Ts above 5 °F for extended periods of time would disrupt the timing of out-migrating YOY river herring that are keyed to certain natural temperatures as part of their cue to leave the lower Basin.

EPA does not agree with Mirant's statement that the shad nurseries in the Connecticut are not comparable to the lower Charles. Setting this point aside, it must be noted that one objective to support the protection of the BIP involves the maintenance of the natural seasonal cycles in the lower Basin. Elevated temperatures in the ZPH as great as 5 °F above ambient conditions resulting from Kendall Station's thermal discharge likely disrupt the natural seasonal cycle to some extent. Limiting the Delta T to 5 °F ensures this disruption does not have a large impact on the BIP. Response C32 discusses the negative impact associated with delayed out-migration of river herring, in contrast to Mirant's assertion.

Mirant discounts shad nurseries in the Connecticut River as not comparable to the lower Charles River Basin, but in the same comment, Mirant challenges EPA to discuss why conditions in the Monument River are not also applied to the lower Charles River Basin. Without additional specific information on the amount of mixing that takes place at the mouth of the Monument River and at what point in the tidal cycle, if any, periodic out-migration takes place, what types of temperature changes these fish undergo, whether or not they spend time in a thermally mixed area, follow outgoing currents or travel upstream against these currents, EPA is unable to fully address Mirant's request for a discussion of alewife runs in the Monument River and how they relate to out-migration in from the Charles River.

Mirant also submitted juvenile alewife data from a river in Virginia (see Comment C13(j)). This is another case where the permittee offered data they maintained had a bearing on Charles River alewife, while discounting Connecticut River information discussed by EPA and MassDEP. Rather than discounting the Virginia data outright, EPA and MassDEP reviewed the data to determine its usefulness when applied to the Charles River (see Response to C13(j)).

Comment D29: Summertime Impacts to Zooplankton, Larval and Juvenile Fish are based on Inappropriate Comparison. The foundation for the Agencies' discussion of this topic is incorrect because of differences between the stratified semi-estuarine lower Charles and the freshwater lakes studied. The Agencies should explain how this speculation could be valid when all the

site-specific studies of zooplankton, larval abundance from year-to-year, and juvenile abundance from year to year completed and entered into the record by Mirant Kendall show no evidence of this effect in the Charles.

Response to D29: EPA does not agree that the freshwater, impoundment-like characteristics of the lower Basin are so dissimilar from the lakes studied that appropriate comparisons cannot be made. The hydrologic nature of the lower Basin changes dramatically over the course of the year. During higher flows, the lower Basin acts like a river, with short-duration retention times. By contrast, during most summers, as river flows are lessened, retention time in the lower Basin increases and the lower Basin becomes much more lacustrine. Indeed, the permittee argues that the lower Charles River Basin should be characterized as a lake in Comment H1. This is addressed in Response H1.2.a. It is these summer periods which are most important to river herring juveniles as they begin to appear in the Basin in late June and use the area as a nursery throughout the summer and into the fall. During this period the quality and quantity of zooplankton is most important to river herring. With the recent release of over a million American shad fry into the Charles in 2005, this area is also expected to be important as a nursery to juvenile American shad which also prey on zooplankton. In the summer, the epilimnion of the lower Basin is very low in salinity and with the notable exception of Kendall Station's thermal plume, is comparable with a freshwater lake. Moreover, the lower Basin does not behave like most estuaries. There is no gradual shift of salinity and temperatures in a progression from a marine to a riverine environment. The lower Basin sometimes behaves much more like a lake into which salt water intrudes.

EPA's concern regarding the zooplankton communities was not the quantity of the zooplankton as a food source but the quality. Moore et al.'s research found that zooplankton communities that were characterized by large zooplankters, when subjected to temperatures in excess of 77 ºF for 7-10 consecutive days, experienced a substantive change in community structure. Large forms, preferred by alosids for food, were replaced by smaller forms. Thus, the food base of alosids is expected to deteriorate when subjected to temperatures in excess of 77 ºF for 1-1.5 weeks. See Response to D17. In addition, EPA and MassDEP do not agree that juvenile abundance from year to year has been similar. On a catch per unit effort basis, juvenile alewife abundance has changed substantially from 1999 to later years. In addition, in 2004 and 2005, juvenile abundance drops significantly with increasing proximity of stations to the discharge. See Responses C3 and C49 for additional information.

Comment D30: Data on Length/Weight of YOY alewives Casts Doubt on Agencies' Speculation about "Multiple Stressors". The Agencies' discussion of Effect of Multiple Stressors on Populations is speculative and contradicted by field evidence of fish behaviors and year class successes in the Charles. Also, initial examination of length/weight relationships for YOY Charles River alewives indicates that this measure of the condition the Charles River fish compares favorably with that of coastal fish from other areas.

Response to D30: There is evidence of river herring attempting to spawn at Kendall Station's discharge pipe and there is also tracking evidence of river herring halting upstream movement to

natural spawning areas above Kendall Station. This behavior could be considered a result of stress to these organisms (Responses C29 and D27). The low numbers of alewife collected, especially in 2003 and 2004, reflect very poor recruitment for some year classes as well.

Regarding the metric of length/weight ratios of YOY alewife as a way to evaluate potential stress, EPA exercises caution when evaluating this measurement. Mirant's demonstration that the growth rates of early life stage juveniles was greatly increased over that of several other populations may not be indicative of high-quality conditions for the alewives of the Charles. A high growth rate can be associated with an abundance of food. However, based on Kellogg's research, "super-sized" YOY would be typical of a temperature-stressed population with a low survival rate.(see Responses C23 and C44)

Comment D31: The Agencies' Compliance Approach to Delta T is Unjustified and Overbroad - Suggested Alternative Approach. For the reasons identified in the preceding comments, Mirant Kendall submits that a Delta T of 5 ºF is biologically irrelevant to the species of concern in these waters because the species are adapted to prosper across much larger temperature Deltas. The Agencies' discussion of Delta T in the Determination Document focuses on the general effects of much larger temperature differences, but does not show that temperature differences of slightly over 5 ºF between the ZPH and some specified background point – specifically, the approximately 6 ºF that Kendall Station's discharge would cause at maximum would have any biological significance whatsoever. The Agencies should grant a variance under section 316(a) of the Clean Water Act allowing Mirant Kendall occasionally to cause a Delta T of somewhat over 5 ºF, as it requested in its February 2001 Supplemental Application.

But if the Agencies determine to include a system to enforce a Delta T of 5 ºF in the final permit, they should substantially revise the compliance approach proposed in the draft permit. For several reasons, the approach in the draft permit is flawed and overbroad.

The Agencies propose to use a 24-hour block average of the temperatures at two depths at a monitoring station near the B.U. Bridge to establish the ambient conditions in the Charles River from which no more than a Delta of 5 ºF is allowable for the same 24-hour block average of the temperatures at the same two depths at the separate monitoring points in the ZPH, excepting that a third depth may be substituted at Monitoring Station 7. See Draft Permit Attachment A at p. 5. The apparent goal is to keep temperatures in the ZPH within 5 ºF of the temperatures at the B.U. Bridge location, which apparently was selected because it is the first upstream location that is almost always unaffected by Kendall Station's discharge.

But the Agencies have not examined whether keeping 24-hour average temperatures across the entire ZPH within 5 ºF of the 24-hour average temperatures at the B.U. Bridge, a mile upstream, is a useful or appropriate goal for any biological reasons. In fact, there is no biological significance to that difference in these waters.

Nor do they address whether 24-hour average temperatures between the area of the B.U. Bridge and the area of the ZPH can naturally differ by more than 5 ºF for reasons unrelated to Kendall

Station's discharge. In fact, the area near the B.U. Bridge is quite different than the area of the ZPH: it is shallower there and the River is narrower, so the volume of water in that area is much smaller. The smaller volume makes it much more responsive to changes in flow and weather, whereas the larger volume at the ZPH will change temperatures much less quickly. As a result, in any one 24-hour block, midnight to midnight, the temperatures in the ZPH will lag the differences occurring at the B.U. Bridge and temperature differentials of more than 5 ºF are likely whatever is occurring at Kendall Station.

Nor do the Agencies address the fact that surface temperatures in the middle of the Charles River Basin naturally increase as the Basin deepens and widens below the B.U. Bridge, even without the influence of the Kendall Station. By selecting an upstream reference location without allowing for any intervening natural increases, the Agencies have ensured that the ZPH will be out-of-compliance even if Kendall Station's discharge is causing much less than a 5 ºF change from temperature changes in the intervening waters unaffected by Kendall's discharge. Note that Kendall Station's actual discharge typically is at far less than its maximum thermal load, does not affect those intervening upstream waters, and does not cause a 5 ºF change even within the waters of the ZPH; yet Kendall Station would be forced to curtail its operations anyway as those intervening waters and the ZPH become warmer than the waters at the B.U. Bridge.

The Agencies' proposed approach also is overbroad for another reason. By requiring compliance with the 5 ºF Delta at each of the monitoring stations in the ZPH, the Agencies' approach unnecessarily magnifies the likelihood that natural temperature variations would cause exceedances of the 5 ºF Delta. An exceedance at even one of the monitoring stations in the ZPH would constitute a permit violation even if the entire rest of the ZPH was in compliance. But if the rest of the ZPH has less than the 5 ºF Delta, there is no reason to conclude that any biological harm, significance or risk occurred.

The Agencies have not adequately justified the proposed Delta T compliance approach or using the area of the B.U. Bridge as the reference location for Delta T compliance. Mirant Kendall suggests that a more appropriate location for determining the Delta effect of its discharge is the upstream edge of the ZD, which is in the vicinity of proposed Monitoring Station 2 in the broad area of the lower Basin between the Harvard and Longfellow Bridges. From the 24-hour average temperatures at that point at a depth of 6 feet, the Agencies should consider a requirement that 24-hour average temperatures in the proposed ZPH at the same depth should not be more than 5 ºF warmer. That would ensure that any fish passing through the ZPH do not experience any abrupt temperature change due to the Plant, which, after all, is the principal goal of a Delta T requirement. To the extent that another potential goal of a Delta T requirement is to assure that in-stream temperatures are not pushed beyond the range of variability present in the ambient waters, the application of absolute in-stream temperature limits based on the statistical analysis suggested on Comment C5 will provide the assurance; there is no need for a separate Delta T requirement.

Response to D31: The location of the background station (Station 1) is not perfect in every respect, but necessary due to the documented "upstream" movement of the Kendall Station

thermal plume under certain flow and meteorological conditions. This is fully discussed in Section 5.10.2a of the DD. Many aspects of the calculation of the Delta T, including the averaging of temperature information based on the 2 foot and the 6 foot depth, and the calculation of a 24 hour average to demonstrate compliance, were included in the permit to address the points raised by Mirant in this comment.

New Mexico, Washington, Florida, Mississippi, Colorado, Georgia, Virginia, Vermont and Michigan, in addition to Massachusetts, recognize that a limit to the change in temperature above ambient must be controlled from a man-made discharge. A Delta T of approximately 5 °F, less in some cases, has been included in those states' water quality regulations.

Mirant has not submitted information to support the position that natural temperature variation between the background station (Station 1) and the ZPH would violate the Delta T limit of 5 °F, even without the thermal discharge from Kendall Station. Section 5.10.5 of the DD characterized the differences in temperature between the background station (Station 1) and a monitoring point within the ZPH, using continuous temperature data collected by Mirant. Unfortunately, Kendall Station was discharging heated effluent during the time period studied (July 23 to August 23, 2002). The influence of the thermal discharge from Kendall Station could not be factored out when temperature data from the two locations was compared. Section 5.10.5 of the DD also listed the many challenges resulting from the necessity of the placement of the background station near the B.U. Bridge. Temperature data collected to satisfy the Final Permit will be summarized as part of the Annual Monitoring Report and this information can be used to assess the appropriate location of all continuous monitors.

EPA acknowledges that as fish move, they may naturally experience changes in water temperature. The change in temperature generated by an industrial discharge such as Kendall Station's results in an increase in temperature that has the potential to exacerbate any natural change experienced by the fish. The fact that the fish might naturally see variations in temperature does not mean that they will thrive in the face of larger temperature changes made artificially high or pronounced by a thermal discharge. The Delta T limit in the permit is designed to avoid such amplification of existing temperature shifts in the lower Basin.

Comment D32 (from CRWA): ZPH definition, MASWQWS- Since Station 4 is located 60% of the distance from Cambridge to Boston and is therefore, only protective of 20% of the surface area, this seems to violate the DEP's requirement that "The ZPH must make up a minimum of 50% of any cross-sectional area, bank to bank area of the Charles River Basin." The permit and supporting documents should indicate the boundaries of the Mixing Zone under various conditions.

Response to D32: EPA acknowledges that there may be brief periods when less than 50% of the surface area is part of the ZPH, as monitored by the 2 ft depth cross-section of the river at Monitoring Stations 3, 4, 5 and 6. EPA does not judge that this occurrence will destabilize the BIP or violate the objective of the ZPH, which must occupy a minimum of 50% of any cross-sectional area, from bank-to-bank and surface-to-bottom. When measured in this way, the 2 ft

monitors along the transect could meet the ZPH temperature limit at only Station 3, nearest the Boston shore (which is required at all times), but also meet the temperature limits at a sufficient number of monitoring points at lower depths to maintain an overall cross-sectional area of 50% or greater of the transect. Also, river temperature data collected by the permittee throughout the year from 2002 through 2005 demonstrate that for substantial periods of time, far greater than 50% of any cross sectional transect will meet the requirements of the ZPH. Again, this Permit is not based on a mixing zone but rather on a CWA 316(a) variance. See also Response to comment related to D25 from CRWA and Response to C1.

Comment D33 (from MA DMF): We recommend the relocation of the Station 2 monitoring point closer to the Cambridge shore at approximately 20% of the cross-river width to better estimate the temperature in the thermal plume. We also recommend that the Station 7 monitor be placed on the Cambridge side of the Museum of Science passageway to better estimate any increase in temperature. We recommend that continuous temperature and DO monitoring be collected beginning March 1st to account for smelt spawning activity and this time period is also relevant to the migration of other diadromous species.

Response to D33: Under certain river flow and meteorological conditions, the thermal plume from MKS has been documented to travel "upstream" adjacent to the Cambridge side of the Charles River. The placement of a fixed monitor in this area is not necessary to confirm this periodic occurrence. Temperature data collected through required monitoring using vertical profiles for temperature and a towed array of temperature monitors will fully characterize the thermal profile of the lower Charles River Basin on a monthly basis for two years and quarterly thereafter (see Part I.A.14.c.1). This temperature profiling will further document temperatures along the Cambridge side of the river.

EPA and MassDEP have not stipulated which side of the Museum of Science Boat Lock that Monitoring Station 7 must be attached to in order to provide the permittee flexibility when installing the monitor. Information that will influence the ultimate location of Monitor 7 may include as yet unknown factors such as access to a potential power source as well as the features and condition of the sides of the boat lock. Temperature data collected in the Museum of Science Boat Lock do not present a compelling argument that one side of the lock is more thermally influenced than the other.