

Enclosure 2

PPL Response to SRBC letter dated December 21, 2011, including

- a. **AMENDED SECTION 5 – WATER QUALITY ASSESSMENT OF SHALLOW AREAS USED BY FRY AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS**
  - i. Appendix 5A – Chronology of Observations on Smallmouth Bass
  - ii. Appendix 5B – Thermal Response Data - Tabular
  - iii. Appendix 5C – Thermal Response Data - Graphic
  
- b. **STUDY PLAN TO COLLECT SUPPLEMENTAL DATA TO ASSESS THE POTENTIAL EFFECTS OF THE BELL BEND PROJECT ON WATER QUALITY OF BACKWATER AREAS USED BY FRY AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS**

**PPL RESPONSE TO SRBC COMMENT LETTER DATED DECEMBER 21, 2011****GENERAL PPL RESPONSES:**

With regard to Section 4 comments, supplemental thermal plume analysis was performed by PPL at the request of the SRBC and filed with the SRBC in the June 2011 draft report. The SRBC comments below were discussed with the SRBC and the PA Department of Environmental Protection (PADEP) on January 30, 2012. At that meeting all parties agreed that any additional thermal plume analysis is not required at this time in support of SRBC project action. Any additional analysis needs would be considered at a later date within the context of an application to the PADEP for an NPDES discharge permit. Therefore, responses provided below are solely for the purpose of clarifying analysis performed to date or for correcting draft report content.

With regard to Section 5 comments, due to the extent of SRBC comments and the expressed desire for additional data collection and analysis in 2012, PPL has amended Section 5 of the 2011 report in order to incorporate the SRBC recommendations from its comments thus far. The revised report section is being provided in the attached Enclosure 2a in advance of the amended Aquatic Studies report in order to facilitate timely dialog regarding a 2012 study plan. PPL is also providing as Enclosure 2b a draft 2012 study plan for discussion. A meeting with SRBC staff and the resource agencies is desired before April 15 in order to discuss the revised Section 5 and to finalize a 2012 work plan.

Specific responses to Section 5 comments below explain PPL's rationale for Section 5 report changes contained in Enclosure 2a.

**SPECIFIC PPL RESPONSES:**

SRBC comments below pertain to the Joint Permit Application (JPA) Binder 3, Appendix B, Section 7, Subsections 3, 4, 5, and 6. SRBC comments are shown in italics and are followed by a PPL response. PPL has sub-numbered paragraphs of SRBC numbered comments as (a), (b), (c) etc.

1. *In Section 3, the response provided in BNP-2011-071 was sufficient to satisfy the Commission regarding dilution of acid mine drainage from Nescopeck Creek.*

**PPL Response:**

No response.

2. (a) *In Section 4.3, first paragraph, there is a statement that the CORMIX model has no calibration parameters. The Commission is concerned that the CORMIX model does not accurately model the heated effluent from the Susquehanna Steam Electric Station (SSES) diffuser. As noted in Table 4-2, there is significant discrepancy between the observed distance to the 0.5°F isotherm and the distance to the 0.5°F isotherm computed by the CORMIX model. This comment was previously transmitted in a letter dated September 23, 2011. A sensitivity analysis should be performed to assess the potential plume dimensions using a*



*range of input parameters and environmental conditions (depth, velocity). This section should include a description of how the difference in modeled / observed results was applied to the scenario simulations in Section 4.5 (Thermal Plume Size and Configuration Estimates).*

**PPL Response:**

We previously responded to SRBC's concern regarding the 0.5°F isotherm in our letter dated October 31, 2011. We refer you to that letter but have included here the summary of our response for reference.

***Summary***

Five separate surveys of the SSES blowdown plume at a range of Susquehanna River flows show that the diffuser performs as designed and mixes the discharge with the Susquehanna River within a short distance. Because the BBNPP diffuser is nearly identical in design, the BBNPP thermal plume will also be confined to a small region of the Susquehanna River. The small extent of the SSES plume can be confirmed by overlaying the largest observed plume (September 2003) onto the full width of the Susquehanna River.

CORMIX reproduces the length of the observed 1°F isotherm quite well, overestimating the length by no more than several feet in all five cases. With respect to the 0.5°F isotherm comparison, certain field data are questionable due to instrument standard error. The only other widely accepted model, Visual Plumes, does not correlate well to either the 0.5°F or 1°F observed isotherms.

As noted in our October response, there are several sources of uncertainty in developing observed centerline distances to the 0.5°F isotherm: instrumentation accuracy, natural variations in temperature over the time necessary to perform the surveys, and the visual interpolation of observations necessary to draw and measure contour lengths. However, SSES data indicate that the lateral extent of the 0.5°F rise isotherm is small relative to the width of the Susquehanna River.

A sensitivity analysis is a better way to address SRBC's concerns about the accuracy of the model than projecting differences between observed and modeled results onto model results. A sensitivity analysis will be provided in the amended Aquatic Studies report in which depth and velocity will be increased and decreased by 5% from the base case values for the summer low flow scenario. Results in the form of centerline lengths and widths for the 0.5°F and 1°F isotherms will be tabulated.

2. *(b) In the third paragraph, the plume edges were defined by one standard deviation from the centerline. The Commission questions this assumption based on the configuration of the diffuser, which is 120 feet long with 72 ports. Additionally, the data set used for the standard deviation calculation should be described. The Commission will correlate our response to BNP-20 11-202, dated October 31, 2011, regarding the CORMIX model, pending resolution of the above comment.*

**PPL Response:**

We assume that the SRBC's concern is that the CORMIX model treats the 120 ft. diffuser as a point source and that a Gaussian distribution of temperature from the plume centerline would not represent the full width of the diffuser or of the thermal plume. In fact, CORMIX explicitly considers the overall diffuser dimensions and the individual port diameter, spacing, and orientation. The calculated plume exits the diffuser with a width of 120 ft.

CORMIX calculates entrainment of ambient water into the plume based on shear and other factors. The rate of entrainment dictates the reduction in temperature perpendicular to the plume centerline. The resulting reduction, computed internally by CORMIX, is expressed as a Gaussian distribution. The CORMIX output files, which provide the coordinates of the centerline of the computed plume and the plume width and depth developed from the Gaussian distribution, will be provided to the Commission provided in the amended Aquatic Studies report. This data package will also include the CORMIX input files.

3. *In Section 4.4, the Commission considers summer low flow conditions to be the most critical because they represent flows in the range where a passby flow is most likely to be required. In Table 4-3, we question the water temperatures in the summer low flow scenario. Based on the sonde temperature recordings in Section 5.0, the 62.3°F water temperature for the Susquehanna River and the 62.4°F temperature for the SSES blowdown are inappropriately low. The summer low flow scenario should be based on worst case, most likely in the July to August time frame, and the temperatures should be peak temperatures which are over 90°F as indicated by the sonde measurements in Section 5.0. Additionally, we question the blowdown flow rate and blowdown temperature attributed to BBNPP as measured on September 23, 2004. For BBNPP, the calculated peak values should be used. The SSES blowdown flow rate for the summer low flow scenario should not be the December mean, as listed in Table 4-3. The peak summer blowdown should be used. It appears as though the information in the table is reversed for SSES blowdown temperature. The inputs to the model should be verified for correctness and the model input / output should be provided. The Commission requires Tables 4-3 and 4-4 be revised based on resolution of the above comments.*

**PPL Response:**

The scenarios analyzed were presented to the Commission for concurrence in PPL's 30 March 2011 letter (BNP-2011-071) in response to SRBC's Comment 9.

The largest thermal plume resulting from the blowdown discharge occurs when the difference between the discharge temperature and the Susquehanna River temperature (the " $\Delta T$ ") is the greatest and the Susquehanna River flow is the lowest. The parameters selected for the Summer low flow scenario reflect this approach to estimating the size and configuration of the largest thermal plume. The maximum  $\Delta T$  is a function of both the blowdown temperature and the river temperature and that the maximum  $\Delta T$  cannot be obtained by examining one or the other separately.

To obtain the parameters for the Summer low flow scenario (shown in Table 4-3), the daily differences ( $\Delta T$ 's) between calculated BBNPP discharge temperatures and observed

Susquehanna River temperatures were examined for the period when the 7Q10 is most likely to occur (September). These daily differences were determined for the period August 2004 through July 2007. This period was selected because a record of monitored daily SSES blowdown flows and daily SSES water temperatures was available. BBNPP blowdown flows and temperatures were then simulated for this same period. A three-year period was judged to be of sufficient length to represent the range of  $\Delta T$  values. The maximum  $\Delta T$  in the three-year record (16.9°F) occurred on 9/23/2004 when the observed Susquehanna River temperature was 62.3 F. The data used to develop Susquehanna River temperatures were measured by Ecology III upstream of the SSES intake.

All other parameters were selected from September values to be consistent with the seasonal behavior of the cooling tower performance, e.g., blowdown rates corresponding to the date of maximum  $\Delta T$  were selected for this analysis instead of the overall maximum temperature values.

The maximum Susquehanna River temperature during the three-year record period was 84.9 F (7/10/2007). The corresponding value for the BBNPP blowdown temperature would be 86.3 F which would result in a  $\Delta T$  of 1.4°F. This would produce a significantly smaller thermal plume.

As noted by the Commission, the SSES blowdown temperatures were reversed in Table 4-3. This will be corrected in the amended report.

4. *In Section 4.5, Figures 4-10 and 4-11 should be revised to add a 0.5°F isosurface to more fully depict the thermal plume from the blowdown effluent.*

**PPL Response:**

We will show the 0.5°F isosurface in the amended report.

5. *In Section 4.6, the Commission considers summer low flow conditions to be the most critical with regard to potential impacts; therefore, the summer low flow end of the near field should be used for dissolved oxygen (DO) calculations.*

**PPL Response:**

These values were used and are presented in Table 4-7.

6. *In Section 4. 7, Figure 4-13, the vertical axis is labeled Fahrenheit; however, the values appear to be Celsius.*

**PPL Response:**

We will correct this typo in the amended report.

7. (a) *In Section 5, the design of the study does not allow for full evaluation of the objectives outlined in this section and in Section 9 of the Aquatic Impact Studies*

*Work plan transmitted by BNP-2010-103, dated April 29, 2010. The location of the sondes, the defined critical period for young-of-year (YOY) smallmouth bass (SMB), and the use of different temperature and DO concentrations in the analysis should relate directly to the purpose of the study. As noted below, the Commission requires additional study before modification of our standard passby flow guidance can be considered.*

**PPL Response:**

As noted above, PPL is amenable to additional data collection and analysis in 2012. Field work must commence by late April, therefore a meeting is requested prior to April 15 in order to discuss the amended report and draft work plan which are attached to this response.

7. *(b) The stated purpose of the study was to evaluate whether stressful water quality conditions occurred in 2010 in microhabitats and main channel habitats during the critical period for juvenile SMB, and to assess if consumptive water use may exacerbate these conditions in microhabitats concomitant with depth changes. Juvenile SMB spend the first 2 to 3 months in backwater microhabitats where they may be stressed by high temperatures and low DO leading to infection by the bacterium *Flavobacterium columnare* as reported by Chaplin et al. (2009). Adult fish in main channel habitats do not appear to be affected by the bacterium, likely due to the availability of more favorable water quality during the summer (typically cooler and better oxygenated); therefore, it is not clear why main channel habitats were evaluated since YOY SMB do not use these areas during the critical period. Evaluation of additional backwater or shoreline habitats where YOY SMB have been observed would have yielded more data from these more critical habitats.*

**PPL Response:**

Regrettably, due to joint PPL/agency focus on resolving the IFIM portion of the study plan, Section 9 of the study plan was never fully discussed and vetted with the resource agencies prior to commencement of data collection in 2010. Nevertheless, as noted in the last paragraph on Page 71 of the April 2010 Study Plan, the study was designed "...to provide information on the degree to which depth changes related to consumptive water use modifies the temperature and DO regime of the backwater pools."

In formulating the study plan PPL proposed to evaluate representative and accessible backwater or side-channel areas in the general vicinity of the Bell Bend project. Final site selection was based on field reconnaissance, known use of the areas by young-of-year smallmouth bass, the degree to which areas could become segregated from main channel flows during low flow periods, and as a result of flow reductions due to consumptive water use. It was not a specific focus of the study to evaluate the impact of Bell Bend on water quality conditions in a particular backwater area, but rather to evaluate if small flow changes could exacerbate detrimental water quality conditions more generally.

As discussed in the study plan (page 67), the microhabitat areas that were the subject of the 2010 field effort are characterized by low velocities and shallow depths. The potential for wide fluctuations in dissolved oxygen and elevated temperatures exist under certain flow conditions due principally to isolation of these microhabitats from main channel flows, and associated flow

replenishment. In contrast, mid-river or shoreline shallows or low velocity habitat are not isolated from main channel flows to the same degree as side-channel (backwater) areas. It should be noted based on the IFIM analysis that YOY smallmouth bass habitat far exceeds microhabitat that could be characterized as backwater. As a result, the analysis stemming from the 2010 data collection as summarized in Enclosure 2a is only applicable to a small segment of the total available YOY bass habitat.

It should also be noted that water quality conditions postulated by Chaplin et al. to be potentially detrimental to YOY bass were not observed until July 2010. As a result, the data analysis in the draft report focused on the mid-summer period as opposed to May through July. A revised and more thorough data analysis is provided in the enclosed Section 5 revision to attempt to resolve the apparent confusion over this prior time period analysis. Additional explanation regarding Section 5 revisions are provided in the response to comments below.

In specific response to the SRBC question regarding mid-channel placement of sondes we refer you to page 69, last paragraph of the Study Plan. It states:

"As in the Chaplin et al. (2009) study, paired sondes will be deployed, one each in a backwater and a corresponding main channel location to monitor DO and water temperature. This pairing will be designed to document the extent of differences in water quality between main channel and backwater locations."

7. (c) *The critical period for YOY SMB is defined in the current study differently than in Chaplin et al. (2009). Based on the life history of SMB in the Susquehanna River, the critical period for YOY SMB (the first 2 to 3 months after swim-up) was estimated as May 1 through July 31 (Chaplin et al.; 2009), while the current study evaluated the critical period as July 1 through September 30. The rationale for the use of this time period is not provided, and it is likely YOY SMB move from the microhabitats in August.*

**PPL Response:**

Please see page 68, Section 9.1 of the original Study Plan. It states:

"A program of continuous monitoring of DO and water temperature in off-channel habitats, combined with weekly depth measurements and visual observations (hydrological conditions permitting) of potential smallmouth bass spawning areas along the shore lines will be conducted. The monitoring program will begin in May. If spawning activity is observed or emerging (black) fry are noted, the frequency of depth measurements and visual observations will be increased. These observations may also be used to adjust the locations of the continuous monitoring locations described below. In addition, observations of potential areas where mussels may be vulnerable to exposure will also be recorded."

The critical period was not defined differently but rather data collection was driven by the biological behavior of the YOY SMB during the study. As indicated in the SRBC comment, the critical period for the life history of SMB in the Susquehanna of May 1 through July 31 is estimated. The critical period for the study was based on 1) the behavior observed in the field by Ecology III biologists and 2) the measured water quality conditions that have been identified as being potentially stressful to YOY SMB. During 2010 potentially stressful water quality

conditions were not observed until July. For completeness, studies extended through August and September. An amended data analysis that encompasses the May to June period is included in the attached amended report Section 5 (Enclosure 2a).

7. *(d) Reference to temperature and DO concentrations that may be stressful to YOY SMB are given as greater than 84°F and less than 5.0 milligrams per liter (mg/L) in Section 5.1, although temperatures greater than 87°F and DO less than 4.0 mg/L are evaluated throughout the rest of the study. Regardless of Pennsylvania Department of Environmental Protection (P ADEP) water quality criteria, temperature and DO concentrations that are critical to YOY SMB survival should be evaluated to understand the potential for stressed and diseased fish.*

**PPL Response:**

The apparent inconsistencies have been addressed in the attached draft amended report Section 5.

8. *In Section 5.1, last sentence, it is important to note that at low flows in the Q7 -10 range, many areas of the river become characterized as backwater or shallow shoreline because of the damming effect of emerging rock strata, reduced flow, and reduced water depths. The Commission requires a more rigorous review of the study area to determine the size and location of these backwater areas during low flow conditions. This determination will help assess the magnitude of the potential impact to YOY SMB caused by reduced flow due to BBNPP consumption.*

**PPL Response:**

We respectfully disagree that many areas of the river become characterized as backwater at low river flows. Emerging rock strata in mid-river areas or shoreline habitat are not necessarily or sufficiently separated from main channel flows to exhibit typical water quality characteristic of backwater areas. It is appropriate to conclude that flow dependent intermittent microhabitats do form at various points in the river that are suitable for both SMB fry and YOY SMB but it is important to emphasize that these locations may vary intra-seasonally and year to year.

In light of the request by the SRBC to provide additional data collection and analysis, PPL has prepared a draft study plan for the 2012 field season with an emphasis 1) to include additional sampling of backwater and shoreline areas where young smallmouth bass (YOY SMB) are known to occupy so that a more complete evaluation of the effects of consumptive use can be made based on multiple years of data collection and, 2) to determine the size and location of these areas at low flow conditions.

If implemented, additional field data will be collected and subsequent evaluation and analysis of that data will be completed. The work would consist of observations of smallmouth bass spawning activity (nesting, fry emergence, rearing, and nursery) DO, water temperature, pH, and depth data at six backwater and shoreline areas including the Rocky Island vicinity. The plan assumes that there is sufficient flexibility to respond to changing and/or prevailing hydrological and meteorological conditions. The data collection would cover the period from mid-April to mid-August 2012.

9. *In Section 5.2, Table 5-1, details should be provided to indicate if these temperatures are daily averages or an instantaneous maximum limit.*

**PPL Response:**

Table 5-1 was taken from Pa. Code, Chapter 93, §93.7 and describes maximum temperatures in the receiving water body resulting from heated waste sources regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. The maximum temperatures are instantaneous values measured as a cross-sectional average.

10. (a) *In Section 5.3, the statement that BBNPP consumptive water use is "approximately 1% of the average flow" is not relevant. At the Q7-10 flow of 843 cubic feet per second (cfs), the BBNPP consumptive use of 43 cfs constitutes approximately 5.1% of the river flow individually, and much greater when considered cumulatively with other known consumptive uses upstream.*

**PPL Response:**

The statement provides context to the statistical aspect of low flow exceedance which as indicated in the Report was sampled during a low to average river flow condition. PPL believes that consumptive use as a percentage of average flow is a relevant factor. Similarly, the frequency of occurrence of Q7-10 flows (approximately 1% of the time) is also relevant to an analysis of potential effects.

10. (b) *On page 67, the analytical approach presented, increased duration of potential exposure, is not comprehensive. Data from more than 2 years must be analyzed to draw valid conclusions regarding the increased duration of potential exposure. Periods of low flow, such as the early 2000's and mid-1960's, should also be analyzed to assess the impact. Additionally, analysis is required for the time period from July 1 through September 30, evaluating the increased magnitude of the impact, defined as temperature over 87°F and DO less than 4 mg/L, on YOY SMB caused by increased temperature and decreased DO resulting from BBNPP consumptive use. Additionally, a similar analysis should be performed using 84°F and 5 mg/L DO as limiting criteria to be consistent with Section 5.1 and the Chaplin et al. (2009) study. The sonde data presented in Sections 5.5.1 and 5.5.2 would indicate there are days that the additional 0.5°F will result in the maximum temperature for the day exceeding 87°F. Similarly, there are additional days that the DO is less than 4 mg/L because of the BBNPP consumptive use. Both effects will potentially increase stress on juvenile SMB. Finally, the period being analyzed should be expanded to include May and June to determine if there are impacts to SMB fry.*

**PPL Response:**

The original Section 5 analysis in the Report evaluated the possible impact of consumptive use on smallmouth bass juveniles in backwater areas correlated to the increased duration of potential exposure to the stress-related condition caused by the potential for reduced flow by consumptive use at the BBNPP and the associated decreased depth, increased temperature, and decreased DO. That analysis looked at the incremental effect of the 43 cfs BBNPP consumptive use by performing a flow exceedance analysis. In the original analysis, using the daily data for the Wilkes-Barre USGS gage, flow exceedances were developed for all daily flows for the period of concern. That period of concern was based on a review of actual water temperatures and was chosen to be July 1 through September 30 because that period exhibited the time period where either potential biological thresholds or state WWF standards were exceeded. The percent exceedance was determined for the average flow during the period of concern and then compared to that flow reduced by 43 cfs. The difference (or "delta") between the two exceedance percentages was then multiplied by the number of data points to convert back to days and then divided by the number of years. The result was the number of equivalent extra days per summer that the stress-related condition would persist due to the potential reduced flow.

Based on comments from the SRBC, the amended analysis evaluates potential impacts from consumptive use based on a calculated thermal response due to change in depth. The average change in depth was based on a maximum consumptive use of 43 cfs and was determined by the IFIM PHABSIM analysis to be approximately 0.5 inch. For the impact assessment, the change in temperature due to the maximum expected reduction in depth was estimated with a thermal response calculation that uses meteorological data to assess heat transfer. The estimated changes in temperature were then applied to the sonde temperatures to obtain a modified sonde record. The observed sonde temperatures and the modified sonde temperatures were compared to both the PA WQ standard and the "possible biological threshold" to determine how often the number of exceedances increased for the reduced depth case. Our conclusion in the amended report is consistent with our previous interpretation. The study results of the amended report are consistent with the findings in our original assessment and continue to indicate that consumptive use by the proposed BBNPP has no significant effect on exposure duration for smallmouth bass juveniles to additional stress-related temperature and low DO conditions. A more detailed description of the methodology and the results is provided in the amended Section 5 study report.

11. (a) *In Section 5.4, the two sondes located at the Environmental Lab are out of the study area and produce data that are not relevant to the purpose of the study. Similarly, the two sondes located at the Berwick Test Track Ramp are out of the study area and produce data that are not relevant to the study. Additionally, the data are not relevant because the flows in that area of the river do not meet the criteria of "backwater" defined in Section 5.1.*

**PPL Response:**

The purpose and objective of this study effort was to identify representative areas where YOY – SMB fry and juveniles may be present and to demonstrate what impact if any may occur from the consumptive use of the proposed Bell Bend Project. It was not the stated purpose of this study to evaluate all potential areas or types of microhabitats or to quantify them. The areas



evaluated at the Environmental Lab and the Berwick Test Track Ramp do in fact represent microhabitats that would constitute "backwater" areas. Upstream (Environmental Lab) and downstream (Berwick Test Track Ramp) locations were selected as they are characteristic backwater areas in the vicinity of the project, and to determine if there was any correlation between upstream and downstream water quality. However, in light of the SRBC request for additional data gathering and analysis in 2012, PPL has identified additional representative sites within the study reach (See enclosed draft Study Plan).

11. (b) *In Section 5.4, second paragraph, using paired sondes in this study with one of the pair in deeper water does not address the objective of this study. Placing additional sondes in backwater or shoreline habitats would provide more relevant data. A location closer to the area of interest where YOY SMB have been observed in the past should be used, allowing for a more complete assessment of these microhabitats within this shallow water area of the river.*

**PPL Response:**

The paired sondes approach was taken from the previous work by Chaplin (2009). By including both a sonde in the designated backwater area as well as the river channel, the river channel sonde provides a control while the backwater sonde provides a measure. Paired measurements using a control station is a standard scientific approach to data gathering.

11. (c) *In Section 5.4, fifth paragraph on page 70, the need for determining the relationship between the upstream and downstream locations has not been provided in the objectives and, therefore, the rationale for the upstream location and downstream location is not justified. To fully evaluate potential impacts of consumptive use on YOY SMB habitat, microhabitats primarily within the riffle portion of the study area where YOY SMB have been documented should be evaluated.*

**PPL Response:**

See response to Comment 11 (a) above.

11. (d) *On page 72, the Pennsylvania State Water Quality Criteria provides useful parameters for analysis; however, the purpose of the study is broader than meeting these criteria. The objective of the study, as defined in Section 5.1, is to analyze the impact of the consumptive use of water by BBNPP on juvenile SMB and SMB fry and, therefore, other parameters should be analyzed, such as those defined in the Chaplin et al. (2009) study.*

**PPL Response:**

State water quality standards intrinsically include and consider all of the various resources needs and associated protections for a water body including those for aquatic biota. We recognize that in the case of particular permit application requests for a distinct project, SRBC and other agencies may have specific areas of focus or concerns in terms of potential water quality impacts. PPL has and will continue to support the informational needs of the SRBC and the state for the Bell Bend Project within the context of the current water quality standards but

we respectfully advocate that any parameter being considered must be within the framework of current legislative and regulatory standards.

11. (e) *On page 73, the analysis on Figure 5-6 indicates that water temperatures in 2010 were warmer than the historical average. The text should explain the data collection method and location(s) of the temperature recordings. To draw valid comparisons with the 1974 to 2009 time frame, the collection method and location should be consistent. Chaplin et al. (2009) indicates that a difference of 0.8°C in water temperature was noted in 2008 compared to the historical record (1974 to 1979), consistent with warming trends in other parts of the world. Based on this, the data from 2010 also should be compared to the more recent record (2006 to 2009). It should be noted that, if this indicates a warming trend, the impact of the BBNPP consumptive use on SMB in the future will be exacerbated because of the increased stress caused by natural conditions.*

**PPL Response:**

The comment indicated for Figure 5-6 was simply describing observed water temperature for 2010 compared to recent historical information. It was not the intent nor within the scope of this study effort to analyze that data in terms of potential climate change impacts.

12. (a) *In Section 5.5, Table 5-5, the most extreme temperature and DO recordings were at Sonde #1 at Goose Island. Additional data should be obtained from similar areas in the study area to determine the extent and magnitude of the temperatures and DO levels.*

**PPL Response:**

See attached draft 2012 Study Plan (Enclosure 2b).

12. (b) *In Section 5.5.1, first paragraph, because temperatures greater than 84°F were indicated as being stressful to YOY SMB in Section 5.1, this analysis should include the frequency of temperatures exceeding 84°F as well.*

**PPL Response:**

Analysis of the 2010 data and the proposed 2012 data collection will evaluate the frequency of water temperatures exceeding 84°F in the identified backwater areas and microhabitats. It should be noted that in July 84°F is within state water quality standards.

12. (c) *In Section 5.5.1, in the next to last sentence, what is the basis for the statement that the reduced 0.5-inch water level results in an approximate <0.5°F water temperature change?*

**PPL Response:**

The basis for the statement in the original Report is the thermal analysis and calculation performed in Section 4.7 and referenced just prior to the sentence in question. The temperature rise of 0.5°F represents the largest temperature change on the warmest day of the year due to a reduction of 0.5 inches in depth. The change in depth is based on the maximum consumptive use of 43 cfs. The amended analysis evaluates potential impacts from consumptive use based on a calculated thermal response due to the change in depth estimated at each sonde location for each hour of the 2010 record using nearby meteorological data.

- 12. (d) In Section 5.5.1, in the last sentence, the statement, "These potential changes are small in comparison to natural diurnal T and DO changes." may be valid; however, the changes in temperature and DO caused by BBNPP consumptive water use will most likely cause the peak temperature in the diurnal cycle to be higher and the lowest DO level in the diurnal cycle to be lower, causing additional potential stress to YOY SMB. The incremental increase in extreme temperatures and incremental decrease in DO levels should be noted.*

**PPL Response:**

To date we have seen no indication of the potential depth change associated with consumptive use and the associated calculated temperature effects to cause the condition asserted in this comment. The revised analysis contained in amended report Section 5 indicates that there is no apparent effect.

- 12. (e) The temperature and DO data should be analyzed to determine any relationship with flow data. These data could then be used to assess the effect of a 43 cfs withdrawal on temperature and DO, especially in juvenile SMB habitat.*

**PPL Response:**

See attached draft 2012 Study Plan (Enclosure 2b). Assuming that an additional field season is necessary, data collection for 2012 will include hourly depth measurements. Actual depth readings can then be statistically compared to temperature and DO but a thermal response analysis will still be required especially if that correlation is either weak or inconclusive.

- 12. (f) In Section 5.5.1, Figure 5-7, the figure on the bottom panel of page 76 needs to be resized to be consistent with the other graphs in this section.*

**PPL Response:**

All figures have been revised in the amended report Section 5.

- 12. (g) In Section 5.5.2, because DO concentrations less than 5.0 mg/L were indicated as being stressful to YOY SMB in Section 5.1, this analysis should include the frequency of hourly observations below this concentration as well.*

**PPL Response:**

These observations are provided in Table 5.26 of the attached amended report Section 5.

- 12. (h) In Section 5.5.2, it should be noted that the lowest DO levels were recorded at Sonde #1 at Goose Island. As noted above, additional data are required to determine the extent and magnitude of the low DO levels.*

**PPL Response:**

See attached draft 2012 Study Plan (Enclosure 2b).

- 12. (i) In Section 5.5.2, Figure 5-10, the July period for Sondes #5 and #6 includes the number of observations above each bar. The other graphs in this section should be consistent with the format used for Sondes #5 and #6.*

**PPL Response:**

The information is provided in Figure 5.26 of the attached amended report Section 5.

- 12. (j) In Section 5.5.4, second paragraph, it is noted that YOY SMB vacated areas when temperatures exceeded 87°F occasionally in July, but more often in August. These observations support the critical period for evaluating YOY, which is identified by Chaplin et al. (2009) as May 1 through July 31. Additionally, the observations from the SMB chronology indicate YOY SMB were observed with fungus at water temperatures of 84°F and higher, indicating the need to evaluate this temperature range.*

**PPL Response:**

See above comment responses and the attached amended report Section 5.

- 13. (a) In Section 5.6, first paragraph, it appears that in areas where water temperature was approaching 90°F and SMB were not observed in early July, these fish may have moved out prematurely because the observations from the appendix indicate other backwater and shoreline areas that were slightly cooler still held YOY SMB. This warrants further consideration of the statement that fry had migrated to deeper river water since they had reached juvenile size.*

**PPL Response:**

The report states the following:

"There are few if any proper or persistent backwater areas in the stretch of river associated with this study effort and these intermittent backwater characteristics are subject to seasonal variation. Smallmouth bass do spawn in the study area and fry develop throughout the month of June. Smallmouth bass juveniles tended to disperse

from the schools, but remained along the shoreline in aquatic vegetation at the river banks and the islands. Once water temperature consistently exceeded 84-85°F, fry had grown to juvenile size and migrated from the shoreline backwater habitat into deeper river water. In early July, shoreline water temperatures were approaching 90°F. At this time, juvenile smallmouth bass were not observed in these areas.”

Whether SMB had moved because they had matured or because of the thermal condition was a point of observation of the biological condition as described in the above text.

13. (b) *In Section 5.6, fourth paragraph, it is indicated that deviations in water temperature and DO from the Pennsylvania State Water Quality Criteria were of short duration and limited to shallow inshore locations. These shallow inshore locations are the critical habitats for YOY SMB that are of concern in this area. The fact that diseased and dying fish were observed indicates these were likely stressful conditions. This is understated in these conclusions.*

**PPL Response:**

See attached amended report Section 5.

13. (c) *In Section 5.6, the statement in the fifth paragraph that "the incremental effect of the 43 cfs BBNPP consumptive water use, which showed no significant change or increase in the stressors." cannot be supported by the data collected and the analysis performed in this study. Chaplin et al. (2009) demonstrated that SMB in the Susquehanna River have been declining most likely due to the stressors noted in this study: increased temperatures and decreased DO. Additional study is required to determine the magnitude and extent of the effects of BBNPP consumptive water use on SMB. Backwater and shallow shoreline areas within the study area should be identified and sondes located appropriately to gather the required data. Four of the six sondes in this study, two at the Environmental Lab and two at the Berwick Test Track Ramp, were not located in the study area and, therefore, it is inappropriate to utilize these data to draw conclusions. Data are required from other backwater areas within the study area, such as the backwater areas in the Rocky Island vicinity.*

**PPL Response:**

In Chaplin, et al. (2009), it states that, “stress factors include but are not limited to elevated water temperature and low DO...” The Chaplin study actually was based on the working hypothesis that, “dissolved-oxygen concentrations and water temperatures in study reaches of the Susquehanna River are at times stressful to YOY smallmouth bass.”<sup>1</sup> The report goes on to state that, “...there are many other pathogens (viral and bacterial) and water quality stressors like pharmaceutical and pesticide contaminants that were not part of the study but may be larger

---

<sup>1</sup> Chaplin, J. et al., Water Quality Monitoring in 2008 in Response to Young-of-the-Year Smallmouth Bass (*Micropterus dolomieu*) Mortality in the Susquehanna River and Major Tributaries, Pennsylvania, 2009, p.24.

factors in fish diseases in the Susquehanna River compared to the Delaware and the Allegheny Rivers.”<sup>2</sup>

14. *In Section 6.1, the analysis of the impact of BBNPP consumptive water use on downstream users was based on Q7 -10 flows. Because flows less than Q7 -10 were not analyzed, the Commission cannot accept a passby flow requirement less than Q7-10.*

*In Table 6-1, two downstream water users are listed, Cherokee Pharmaceuticals withdrawing 34.392 million gallons per day (mgd) and Danville Municipal Authority withdrawing 2.000 mgd on average, indicating the potential BBNPP consumptive use to impact their operations. These evaluations must be completed before conclusions can be drawn regarding the impact of BBNPP consumptive use on downstream users.*

*In Table 6-2, for four of the seven downstream dischargers listed in the table, the impact of BBNPP consumptive water use is indeterminate. The analyses on these downstream dischargers must be complete before conclusions can be drawn regarding the impact of BBNPP consumptive water use on their operations. In some cases, as noted, the analysis should include input from P ADEP.*

*The Commission recognizes that PPL Bell Bend, LLC (PPL) does not control actions or inaction of the downstream users with regard to requests that they perform an impact analysis; however, the Commission does require a level of effort analysis by PPL to address the potential impacts of the consumptive use of water by BBNPP on the downstream users. Reporting on responses from the downstream users requires some analysis by PPL to assure that the responses are adequate. In Table 6-2, apparently some of the downstream operations that discharge water into the river have conferred with P ADEP to assist with their internal analysis. This may be an option for PPL when analyzing these impacts.*

**PPL Response:**

Queries to downstream users were made on the basis of Q7-10 minus a 48 cfs consumption rate. The 48 cfs consumption rate was an early estimate of the consumption rate which was subsequently revised downwards to 43 cfs. The rate used in the inquiries was conservative.

As discussed with SRBC staff and the PADEP on January 30, 2012 the PADEP evaluates downstream dischargers on the basis of Q7-10. PPL believes that extreme event analysis for these users is inappropriate. Potential impacts on water withdrawers and dischargers will be further discussed in the amended report.

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<sup>2</sup> Ibid, p. 58.

Enclosure 2a

**DRAFT AMENDED SECTION 5 – WATER QUALITY ASSESSMENT OF  
SHALLOW AREAS USED BY FRY AND YOUNG-OF-THE-YEAR  
SMALLMOUTH BASS**

- i. Appendix 5A – Chronology of Observations on Smallmouth Bass
- ii. Appendix 5B – Thermal Response Data - Tabular
- iii. Appendix 5C – Thermal Response Data - Graphic

REPORT FOR PPL BELL BEND, LLC

Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Users

Amended Section 5  
Water Quality Assessment of Shallow Areas Used by Fry  
and Young-of-the-Year Smallmouth Bass

---

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ADVANCE COPY FOR AGENCY CONSIDERATION



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## **5. WATER QUALITY ASSESSMENT OF SHALLOW AREAS USED BY FRY AND YOUNG-OF-THE-YEAR (YOY) SMALLMOUTH BASS (SMB)**

### **5.1. OBJECTIVE**

The Bell Bend water quality study was designed to identify whether stressful water-quality conditions occurred in 2010 in microhabitats and main-channel habitats during the critical period for fry ( $\leq 25$  mm) and young-of-the-year (YOY) smallmouth bass (*Micropterus dolomieu*) (SMB). A report by Chaplin *et al.* (2009) postulated that sub-optimal dissolved oxygen (DO), particularly during the nighttime and in combination with relatively warm temperatures in habitats of YOY SMB, may play a role in predisposing the fish to bacterial infections. The bacterium (*Flavobacterium columnare*) is common in soil and water and causes secondary infections in stressed fish (PFBC 2005, cited in Chaplin *et al.* 2010).

Microhabitats in which such sub-optimal DO and warm temperatures occur are typically in side channels or shallow areas that are characterized by relatively low velocities ( $< 0.1$  ft/sec) and shallow depths ( $< 2$  ft) compared to the main river channel. These microhabitats, occupied by YOY SMB for the first 2-3 months of their lives, can be subject to wide fluctuations in DO and are susceptible to heating by solar radiation (Chaplin *et al.* 2009). YOY SMB utilizing these habitats during a sustained, extreme low river flow may be subject to potentially stressful, low DO concentrations ( $< 5.0$  mg/L) at night and elevated water temperatures exceeding both the PA WQ Standard and/or other biological threshold during the day. It is important to note that state water quality standards for Warm Water Fisheries (WWF) streams do not always coincide with the 84°F described as a possible biological threshold temperature for YOY SMB. For example, the WWF regulatory standard upper limit for temperature is 87°F from 1 July through 31 August. In addition, a 5.0 mg/L biological measure needs to be considered in light of the state regulatory standard for dissolved oxygen in a WWF which is an instantaneous lower limit of 4.0 mg/L or greater and a daily average equal to 5.0 mg/L or greater. As a result, and at the request of the SRBC, both temperature thresholds and both DO levels are evaluated in this report.

Relative to the proposed Bell Bend Project, an agency concern arose that its consumptive water use of the Susquehanna River water may exacerbate the summer water quality conditions in the SMB microhabitats concomitant with depth changes. Figure 5-1 shows SMB fry usage of shallow, low velocity areas in the study reach for the proposed Bell Bend Project.



**Figure 5-1 Smallmouth usage of shallow with negligible velocity microhabitat**

There was no attempt as a part of this study effort to quantitatively identify “backwater areas” in absolute terms based on the stated characteristics described above for such microhabitats. It may generally be assumed that these areas are typically floodplain aquatic habitats that are seasonally or periodically connected to the main channel and for the purpose of this study, support early life stage maturation habitat for fry and YOY SMB. In the project area, these microhabitats are typically found during the summer months on the shallow side of island outcrops and/or naturally formed shallow coves sheltered from higher river velocities. It is important to note that there are few if any proper or persistent backwater areas in this stretch of river and that these intermittent backwater characteristics are subject to seasonal variation. This assessment instead uses the three shallow areas where data sondes were deployed to assess shallow water conditions, which may or may not be “backwaters” in the strict meaning of the term.

According to Chaplin, *et al.* (2009), SMB typically spawn from late April to early June when temperatures reach 15°C (59°F). Eggs hatch in 2 to 9 days and they are ready to leave the nest and disperse in 5 to 6 days. Since fry are susceptible to predation and cannot withstand higher mid-channel velocities, they typically spend the first 2 to 3 months after swim up (roughly May through July) in the same microhabitat where they were born.

## 5.2. **PENNSYLVANIA WATER QUALITY CRITERIA**

The Susquehanna River adjacent to the proposed Bell Bend Project is designated as a WWF. The Pennsylvania Water Quality Standards, (PA Code, Chapter 93, §93.7) applicable to a WWF are as follows: For DO a minimum daily average of 5.0 mg/L and a minimum instantaneous 4.0 mg/L. The pH range is between 6.0 and 9.0 inclusive. Pennsylvania provides the following criteria (Table 5-1) for temperature. Maximum temperatures in the receiving water body resulting from heated waste sources are regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. The temperature values shown are considered to be instantaneous limits based on cross-sectional average temperatures.

**Table 5-1 Temperature limits applicable to Warm Water Fishery streams. Highlighted areas denote sampling period of the 2010 water quality study**

Critical Use Period:	Temperature (°F)
January1-31	40
February1-29	40
March1-31	46
April1-15	52
April16-30	58
May1-15	64*
May16-31	72*
June1-15	80*
June16-30	84*
July1-31	87*
August1-15	87**
August16-30	87**
September1-15	84
September16-30	78
October1-15	72
October16-31	66
November1-15	58
November16-30	50
December1-31	42

\* Critical Period for Fry per Chaplin *et al.* (2009)

\*\* Additional Period Evaluated by this Study

## 5.3. **FIELD MEASUREMENTS AND OBSERVATIONS**

The assessment of shallow areas in the vicinity of the Bell Bend Project was conducted during the summer of 2010 to identify water quality-related conditions that may be stressful to YOY (fry and juvenile) SMB. The assessment was also to determine if the proposed consumptive water use associated with the Bell Bend Project could potentially intensify those conditions.



Water temperature, DO, pH, and conductivity<sup>1</sup> were continuously monitored using Hydro Lab data sonde recorders at three paired locations (inshore (shallow) and main channel habitats). The three monitored locations were the Susquehanna SES Environmental Laboratory (Environmental Lab) boat ramp, Goose Island, and Berwick Test Track ramp. The former location is upstream of the proposed Bell Bend Project and the latter two are downstream of the project with the Goose Island location 2.8 mi and the Berwick Test Track Ramp 8.4 mi downstream of the proposed discharge structure, respectively.

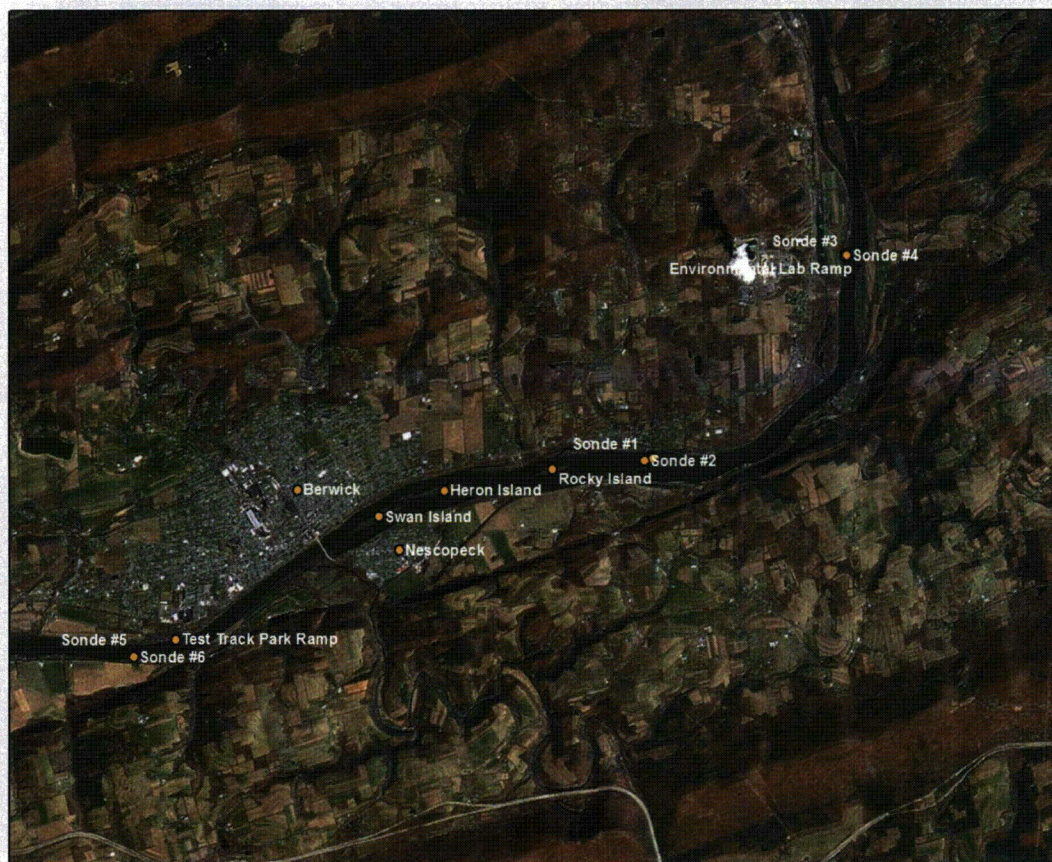
Continuous monitoring of DO and water temperature in representative shallow areas (upstream and downstream of the proposed Bell Bend Project intake) was conducted from 22 June to 3 September 2010, a potential period of high water temperature and low nighttime DO values in shallow areas. This monitoring program was implemented to identify whether stressful water quality conditions occur during the critical nursery and rearing times of fry and YOY SMB and to define the magnitude and frequency of occurrence of these conditions. The “critical period” according to Chaplin *et al.* (2009) for survival and development of SMB is 1 May through 31 July.<sup>2</sup> This study extended that evaluation through the end of August.

As in the Chaplin *et al.* (2009) study, paired sondes were deployed (one each in a shallow microhabitat and a corresponding main channel location to monitor DO) water temperature, and pH (Figure 5-2). This pairing was intended to document the extent of differences in water quality between main channel and shallow microhabitats. Table 5-2 provides descriptions of sampled locations.

---

<sup>1</sup> Conductivity data is available but not reported herein.

<sup>2</sup> Jeffery J. Chaplin, et al., Water Quality Monitoring in 2008 in Response to Young-of-the-Year Smallmouth Bass Mortality in the Susquehanna River and Major Tributaries, Pennsylvania, 2009, p. 11.



**Figure 5-2**    **Sonde locations**



**Table 5-2 Water quality data sonde locations with habitat characteristics**

Location	Sonde Number	Latitude/Longitude
Near southern tip of Goose Island - near east bank shoreline. Water depth <1.5 feet with very little current. Area contained abundant submerged aquatic vegetation. River width 1430 feet.	1	41°03.901N/076°10.151W
Near southern tip of Goose Island - approximately 100 feet from east bank. Water depth 3 feet with notably more current than Sonde 1 location. River width 1430 feet.	2	41°03.884N/076°10.160W
Near Environmental Lab boat ramp - near west bank. Water depth <1.5 feet located in an eddy situation. River width 870 feet.	3	41°05.580N/076°07.827W
Near Environmental Lab boat ramp - approximately 100 feet from west bank in main river channel. Water depth 3 feet. River width 870 feet.	4	41°05.588N/076°07.803W
Approximately ½-mile downriver from Berwick Test Track boat ramp - 100 feet from east bank in main river channel. Water depth 4 feet with a cobble substrate. River width 660 feet.	5	41°02.271N/076°16.126W
Approximately ½-mile downriver from Berwick Test Track boat ramp - near east bank. Water depth 2.5 feet near shoreline. Similar flow conditions as Sonde 5 location. River width 660 feet.	6	41°02.260N/076°16.126W

Figures 5-3 to 5-5 show the sampling locations and their habitats for this monitoring study. These locations were selected for accessibility, ease of servicing, and representativeness of potential shallow habitat for assessing SMB spawning, fry emergence, juvenile nursery, and rearing. An upstream location (Data Sondes 3 and 4 at the Environmental Lab boat ramp) was selected to determine whether a relationship exists in water temperature and DO between upstream and downstream locations within the aquatic habitat study reach.<sup>3</sup>

<sup>3</sup> No meaningful correlation between upstream and downstream 2010 water quality data was found. Therefore this is not discussed further in this report.



**Figure 5-3 Southeast shore of Goose Island on the Susquehanna River with abundant aquatic vegetation, July 2010 (data sonde locations 1, inshore, and 2, main channel)**





**Figure 5-4 Environmental Lab boat ramp on west bank of Susquehanna River, July 2010 (data sonde locations 3, inshore, and 4, main channel)**

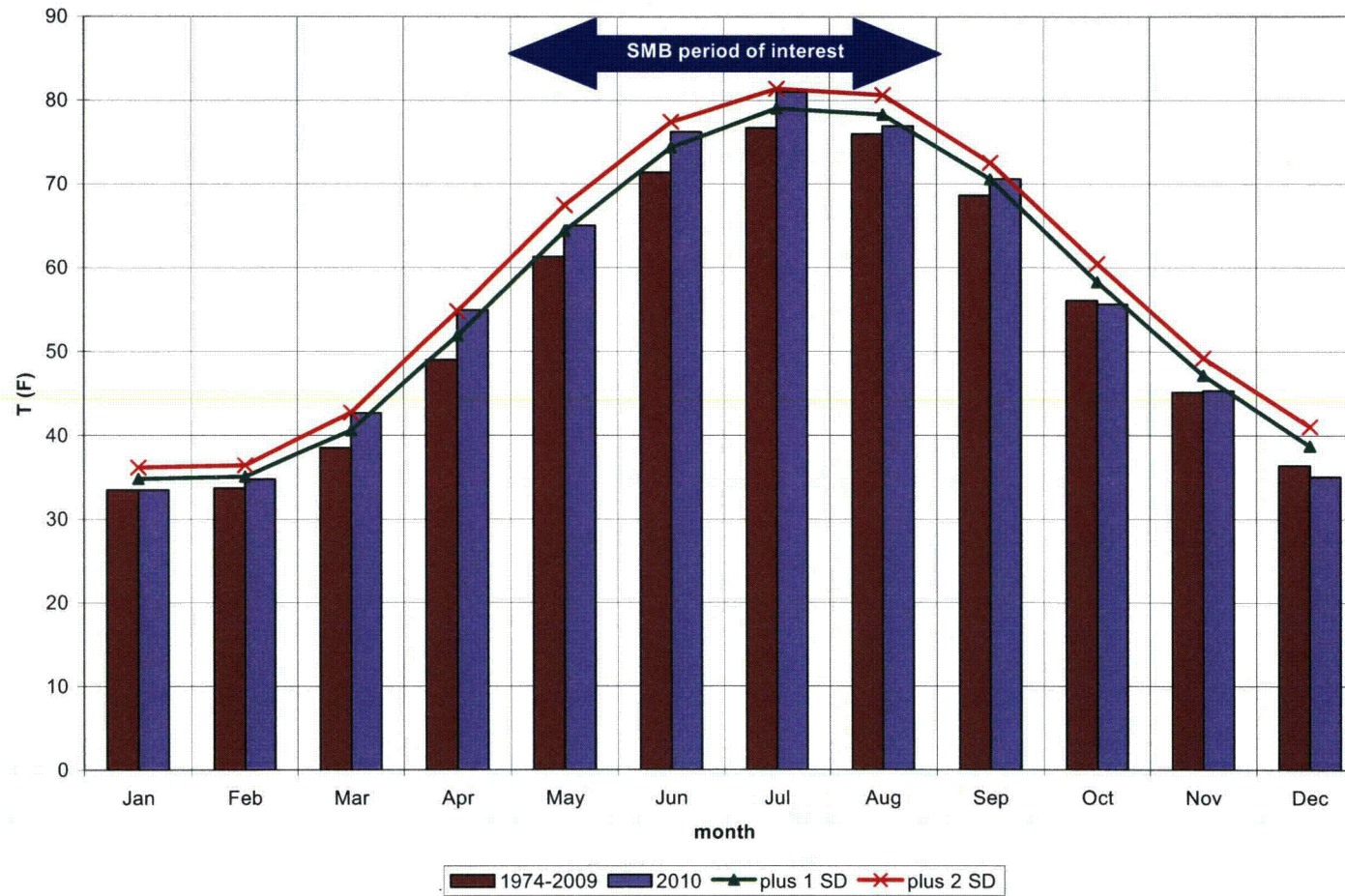


**Figure 5-5 Southeast shore of Susquehanna River across from Berwick Test Track boat ramp, July 2010 (data sonde locations 5, main channel, and 6, inshore)**



As specified in the study plan, the continuous monitoring data were analyzed for detection of deviations from the Pennsylvania State Water Quality Criteria. At the request of the SRBC, temperature data was also evaluated with respect to the possible threshold level of 84°F regardless of whether this temperature was within state water quality standards.

Mean daily temperature data by month for 2010 as recorded at the Environmental Lab shown in Figure 5-6a indicates that 2010 water temperatures in the Susquehanna River for the area of interest were higher than the average monthly historical temperature data (1974-2009). Figure 5-6a also shows the +1 and +2 standard deviation for the 1974 – 2009 period of record to further demonstrate that the 2010 water temperatures were not only higher than average, but exceeded +1 standard deviation for the May 1 through August 31 period of interest and were nearly 2 standard deviations higher in July which is the most stressed month. Figure 5-6b shows the 2010 flows relative to a historical flow period (1974 – 2011) demonstrating that 2010 was not only a high temperature year, but also a low flow year for the period of interest.



**Figure 5-6a** Average monthly temperatures compared with 2010 temperatures and showing 1 and 2 standard deviations above mean long term (1974 - 2009) averages

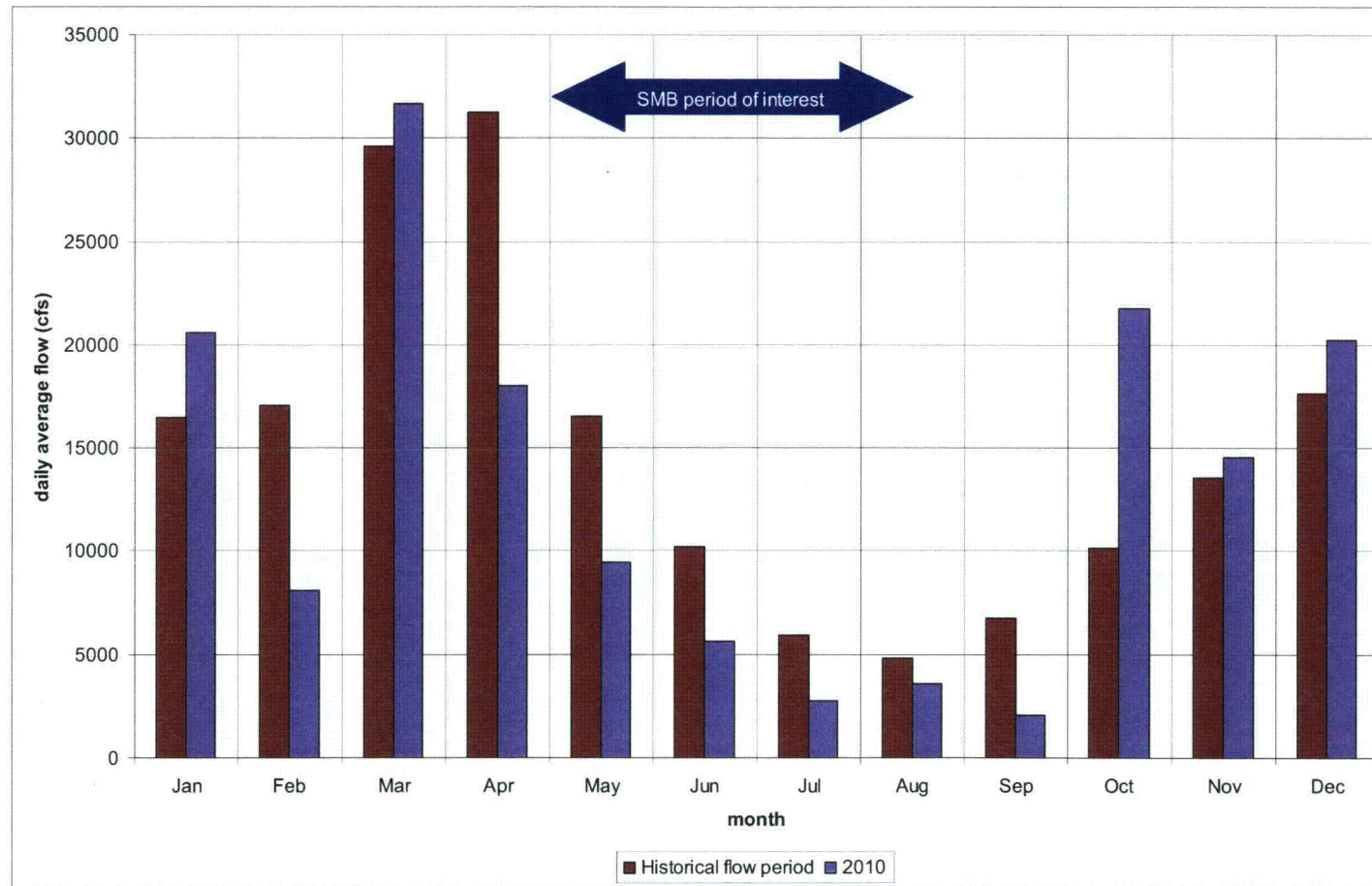


Figure 5-6b Average daily flow by month (1974 – 2011) compared with 2010 Average daily flows by month

#### 5.4. RESULTS OF CONTINUOUS MONITORING OF WATER QUALITY PARAMETERS

Table 5-3 presents overall summary statistics for water temperature, dissolved oxygen, and pH hourly measurements recorded at the three paired continuous monitors within the study reach between 22 June and 3 September 2010.

The average water temperature for the monitoring period was highest (80.0°F) in the main channel location near the Goose Island site (Sonde 2) with similarity in average temperatures (77.9 °F to 78.8 °F) at other locations (Table 5-3). The widest range (21.8°F) in water temperature was measured at the inshore location near the Goose Island site (Sonde 1).

The average DO values were lowest at inshore locations near the Goose Island (Sonde 1) and Environmental Lab boat ramp (Sonde 3). The widest range in DO values ( $\geq 11.0$  mg/L) also occurred at these locations.

Average pH values were lower at Goose Island and the Environmental Lab boat ramp locations (Table 5-3).

**Table 5-3 Summary statistics of hourly measurements of water temperature (°F), dissolved oxygen (DO), and pH recorded on Data Sondes 1-6, June 23 – September 3, 2010**

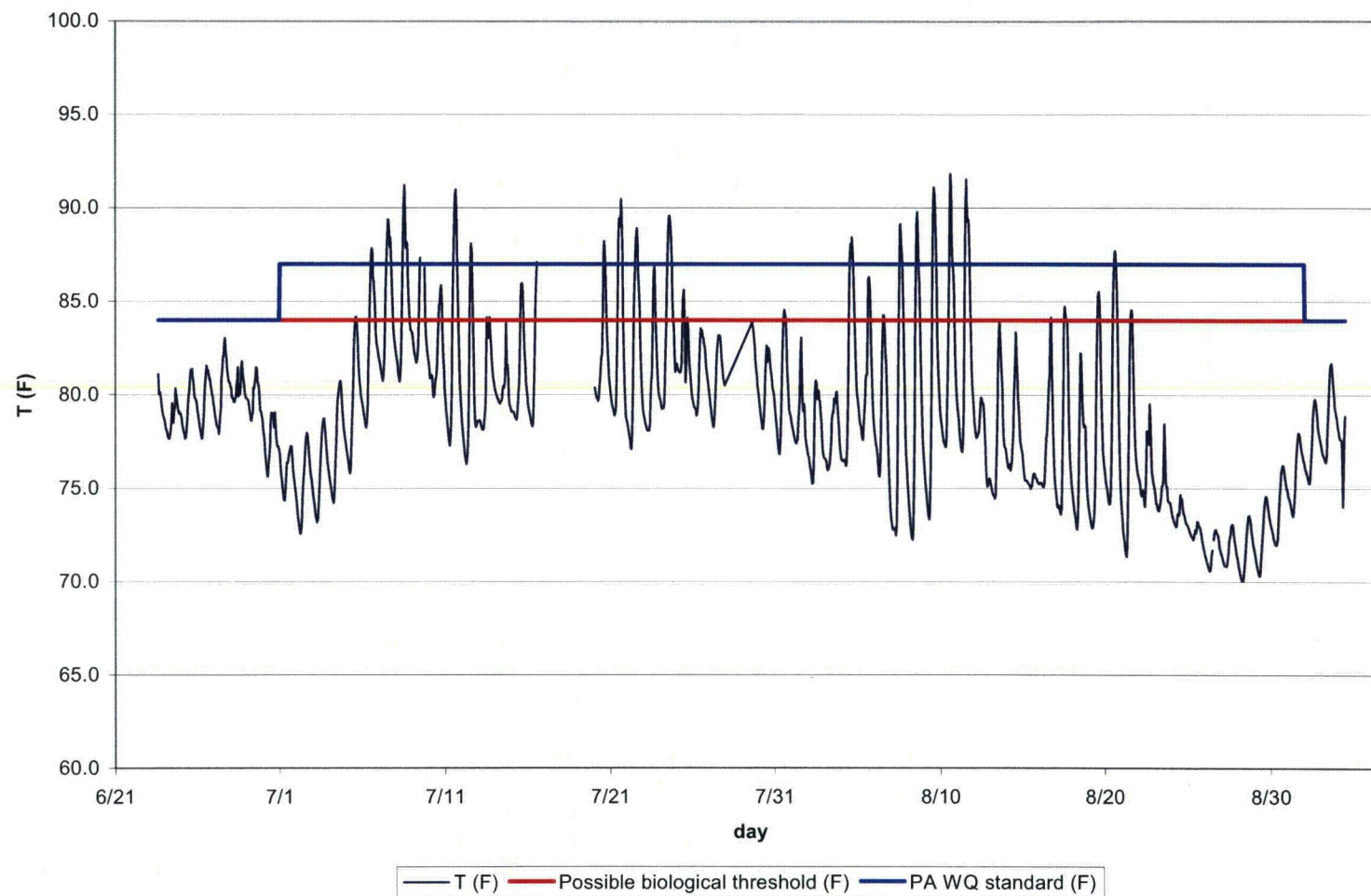
Data Sondes						
	1	2	3	4	5	6
Temp (°F)						
Range	70.0-91.8	70.3-85.8	69.7-89.0	70.5-87.1	69.4-87.1	68.7-89.6
Mean	78.8	80.0	78.3	78.6	77.9	78.3
Number of observations	1,595	1,718	1,733	1,336	1,339	1,518
DO (mg/L)						
Range	2.5-14.7	5.9-13.2	3.3-17.8	5.5-13.2	5.5-12.2	5.5-15.9
Mean	7.8	8.5	7.8	8.4	8.4	8.9
Number of observations	1,534	1,720	1,264	1,334	1,339	1,507
pH						
Range	6.7-9.0	7.1-9.0	6.9-8.9	7.2-9.1	7.3-9.2	7.2-9.0
Median	7.7	7.8	7.5	7.9	8.0	7.8
Number of observations	1,683	1,717	1,734	1,336	1,339	1,518



#### **5.4.1. WATER TEMPERATURE**

Hourly temperature data from all sonde locations is shown in Figures 5-7 through 5-12. As noted above, that state water quality standards for WWF streams do not always coincide with the 84°F described as a possible biological threshold temperature for YOY SMB. For example, the WWF standard upper limit for temperature is 87°F from 1 July through 31 August. As a result, both temperatures are evaluated in this report.

Although daily fluctuations in temperature occurred at all locations, the amplitude of these fluctuations was higher at the inshore Goose Island site, particularly in July and August. See Figure 5-7. The frequency of temperatures exceeding either 84°F or 87°F was highest at the Goose Island inshore location; with most exceedances occurring in July. This location is characterized by shallow depth and negligible current and subject to elevated temperature during the daytime. Some values exceeded either 84°F or 87°F at other inshore locations though at much lower frequencies. See Figure 5-8. Analyses provided in Section 4.7 illustrate that small thermal and DO changes will occur due to reduced depth. The approximate impact on depth based on the BBNPP consumptive use of 43 cfs throughout the study area for flows <1,000 cfs is 0.5 inches (Figure 4-12). According to the analysis, depths characteristic of spawning areas (<2 feet) produce a thermal change of approximately < 0.5°F based on a reduction in water depth of 0.5 inches under worst case summer conditions. These potential changes are small in comparison to natural diurnal T and DO changes.



**Figure 5-7** Sonde 1 (Goose Island shallow) hourly temperature data (F)

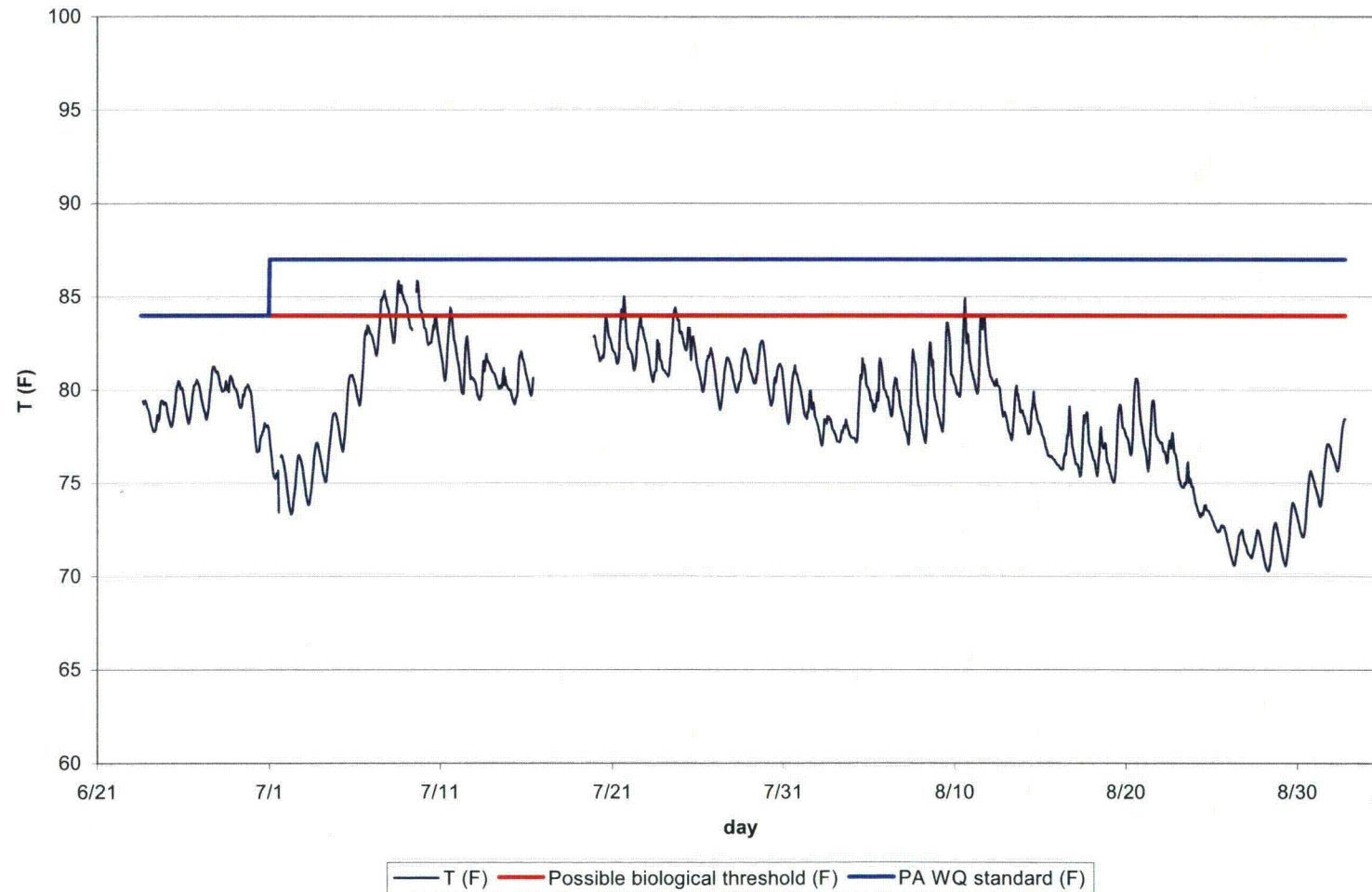


Figure 5-8 Sonde 2 (Goose Island main channel) hourly temperature data (F)

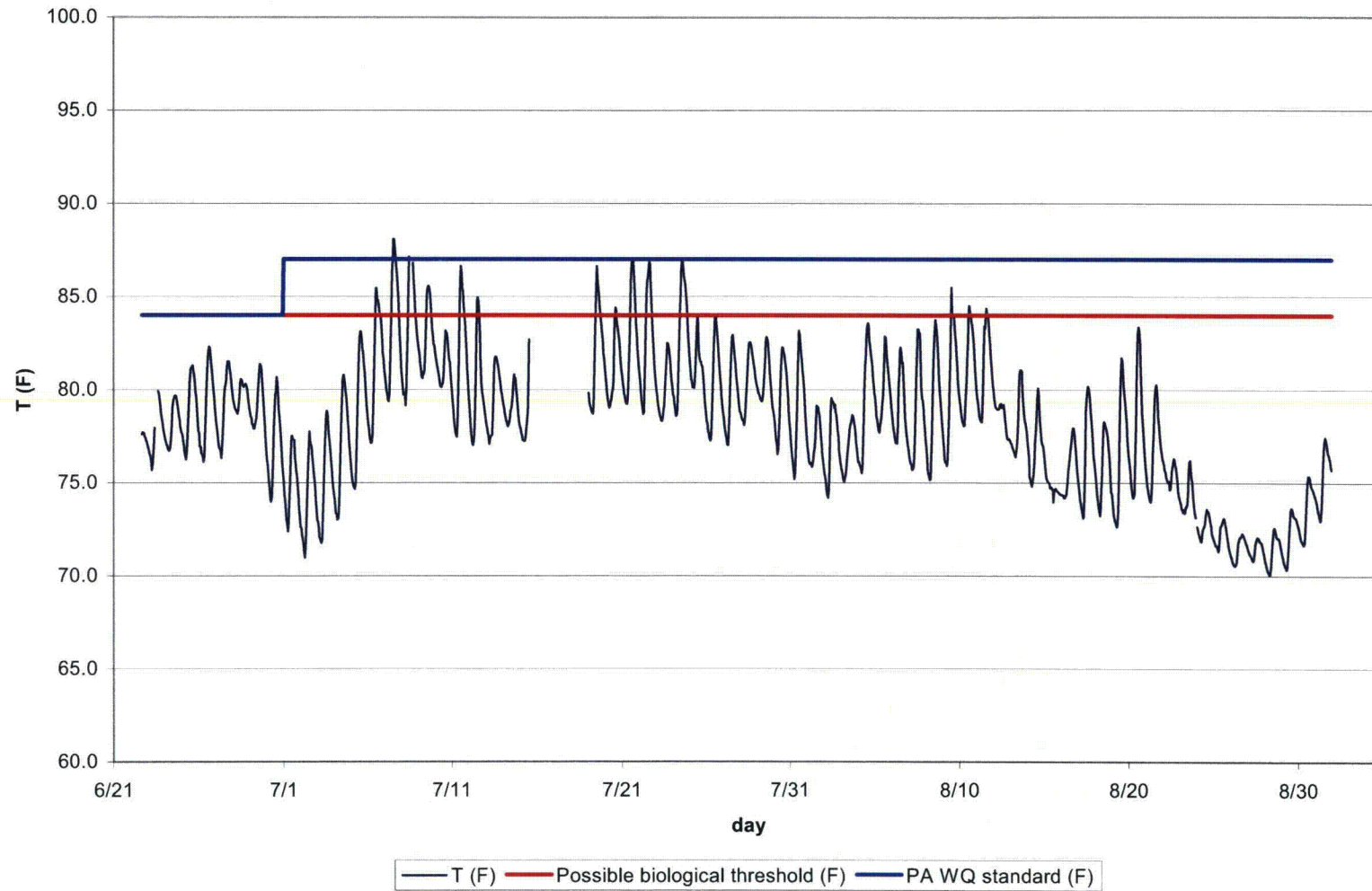


Figure 5-9 Sonde 3 (Environmental lab shallow) hourly temperature data (F)

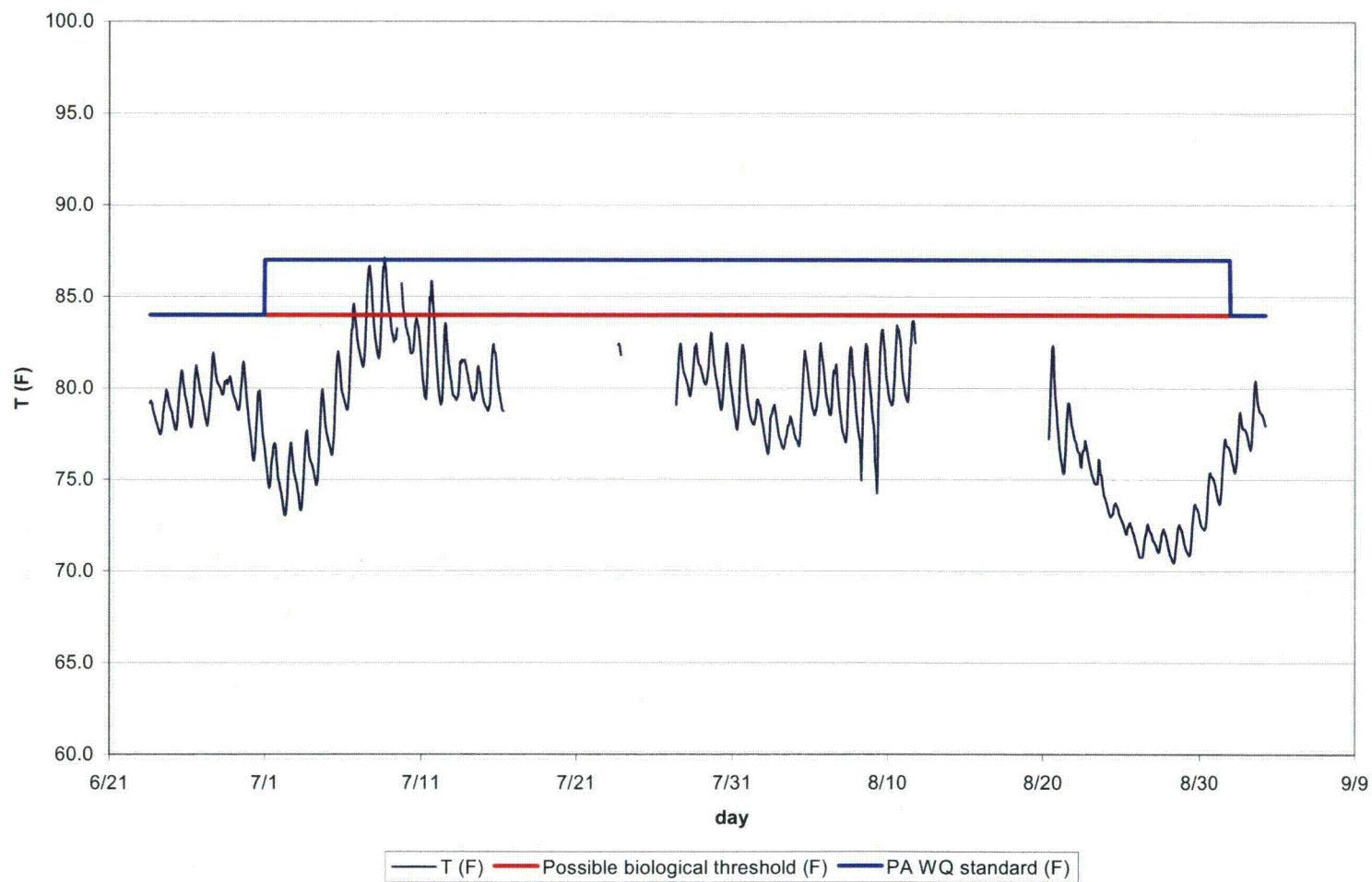


Figure 5-10 Sonde 4 (Environmental lab main channel) hourly temperature data (F)



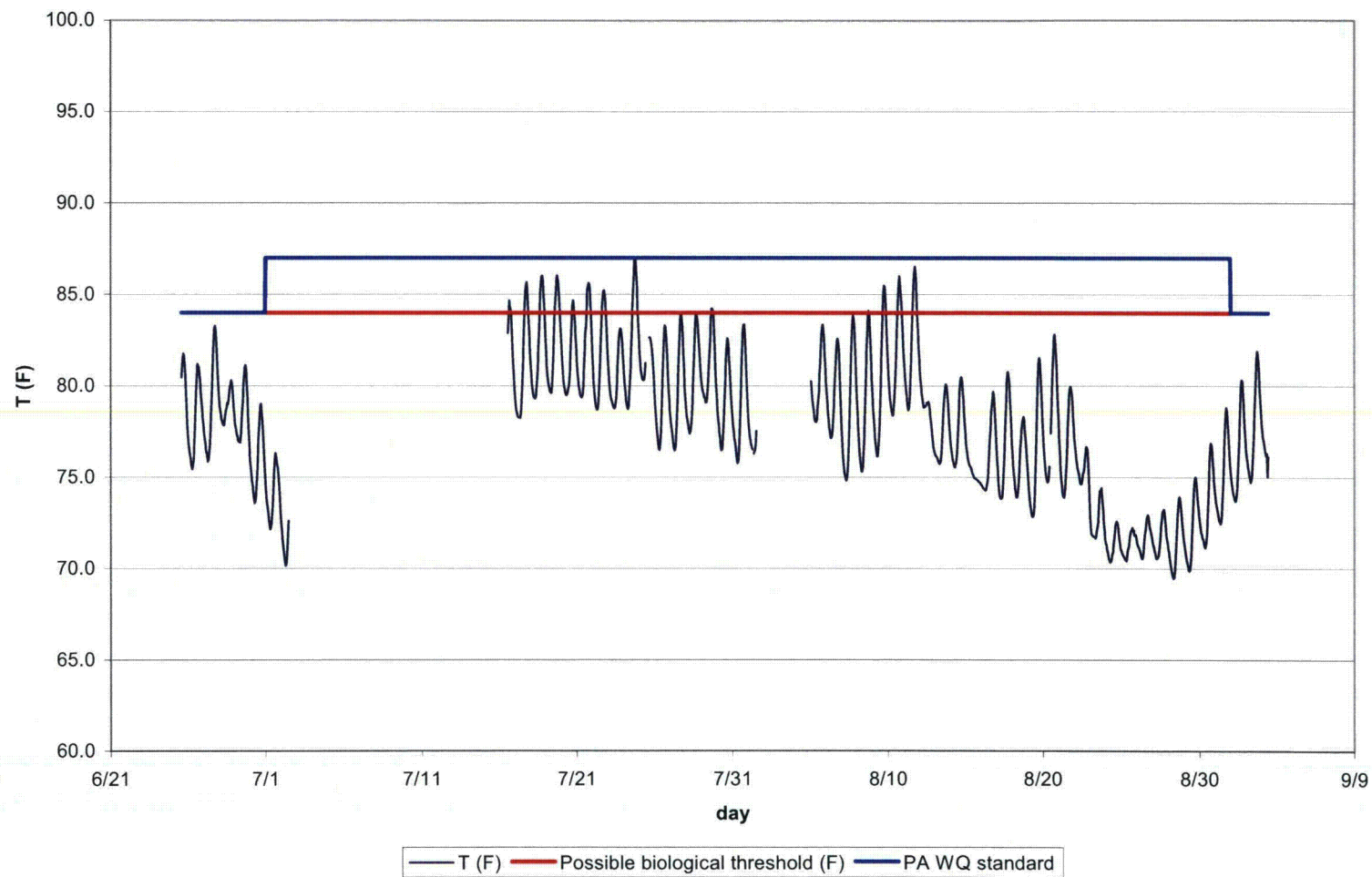


Figure 5-11 Sonde 5 (Downstream from Test Track, main channel) hourly temperature data (F)

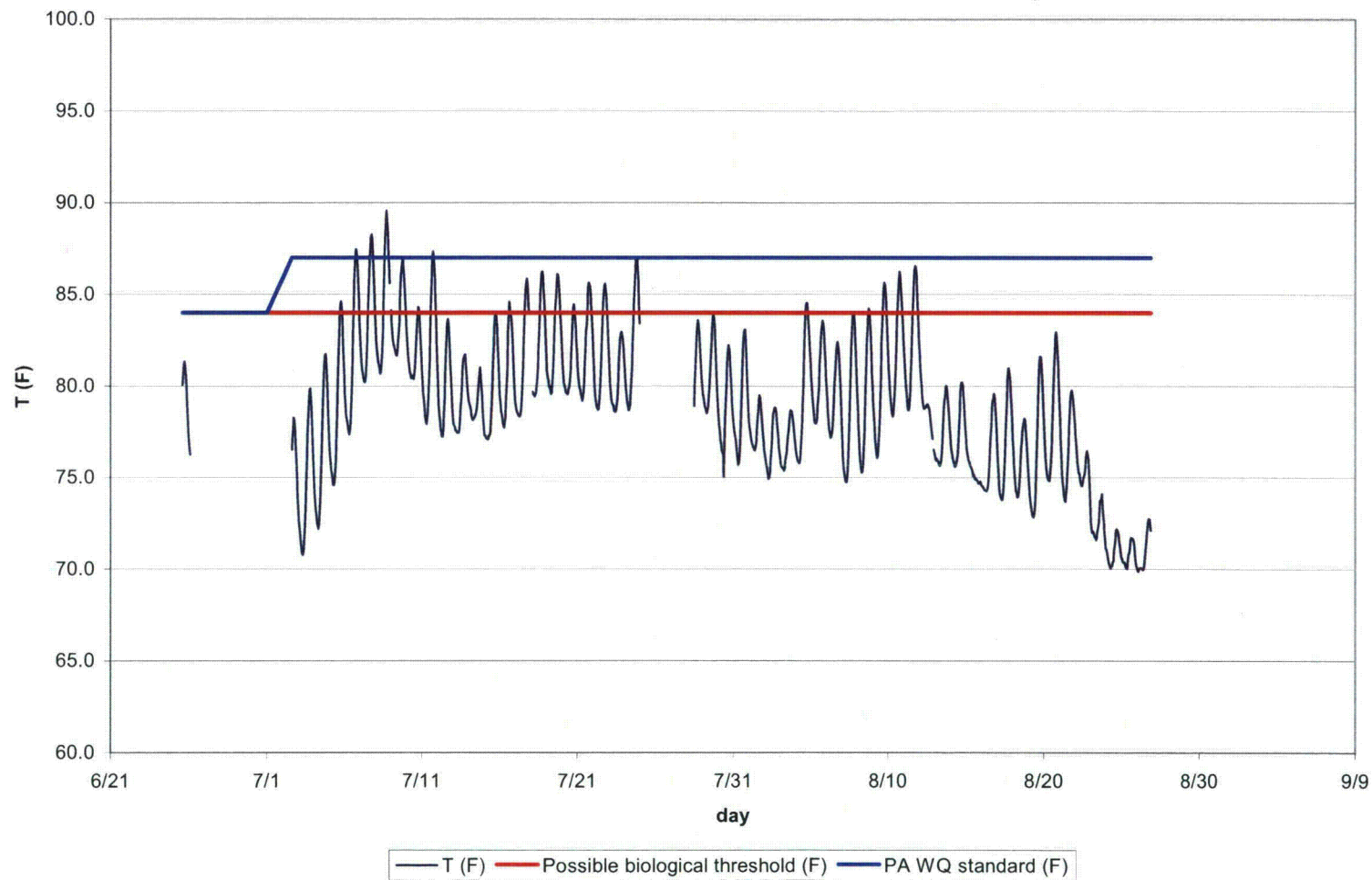
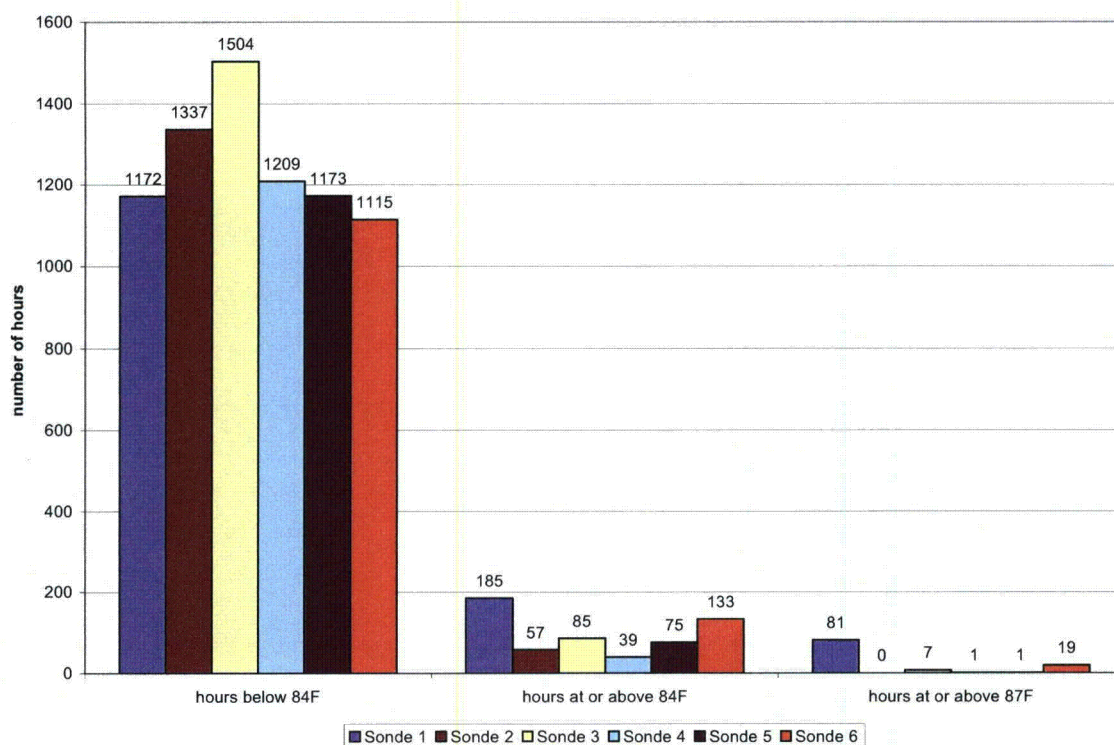


Figure 5-12 Sonde 6 (Downstream from Test Track, shallow) hourly temperature data (F)

Figure 5-13 shows a summary of the hours at each sonde above the 84°F SMB possible biological threshold for July and August data as well as the PA 87 °F water quality standard for July and August.



**Figure 5-13** Hours below 84F, above or at 84F and above or at 87F for all sondes

#### 5.4.2. DISSOLVED OXYGEN

Hourly dissolved oxygen data from all sonde locations is shown in Figures 5-14 through 5-19. Daily average dissolved oxygen levels are illustrated in Figures 5-20 through 5-25. Daily diurnal fluctuations of  $\geq 11$  mg/L were observed between the three monitored locations (Environmental Lab boat ramp, Goose Island, and Berwick Test Track ramp). The largest fluctuations were at the inshore (Sonde 1) Goose Island site (Figure 5-14).

Most hourly DO values  $< 4.0$  mg/L (instantaneous standard) occurred at the inshore Goose Island location and in July (Figure 5-14). The Environmental Lab boat ramp inshore location (Sonde 3) ranked second in exhibiting  $< 4.0$  mg/L DO. Other locations did not show DO  $< 4.0$  mg/L. Although more hourly low DO values were observed at the Goose Island location (Sonde 1), the average daily DO was  $\geq 5.0$  mg/L (daily average standard, see Figure 5-20).



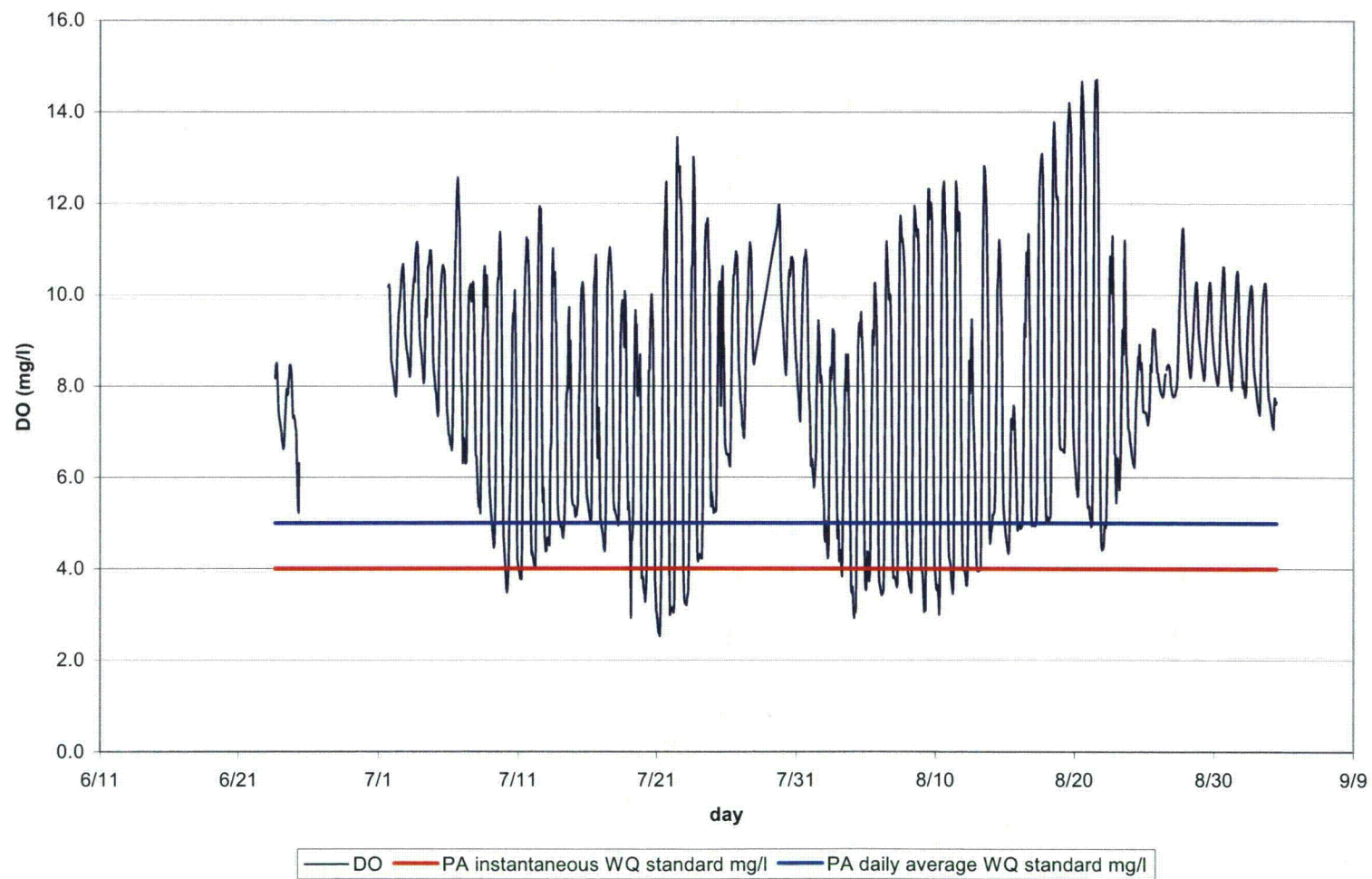


Figure 5-14 Sonde 1 (Goose Island, shallow) dissolved oxygen

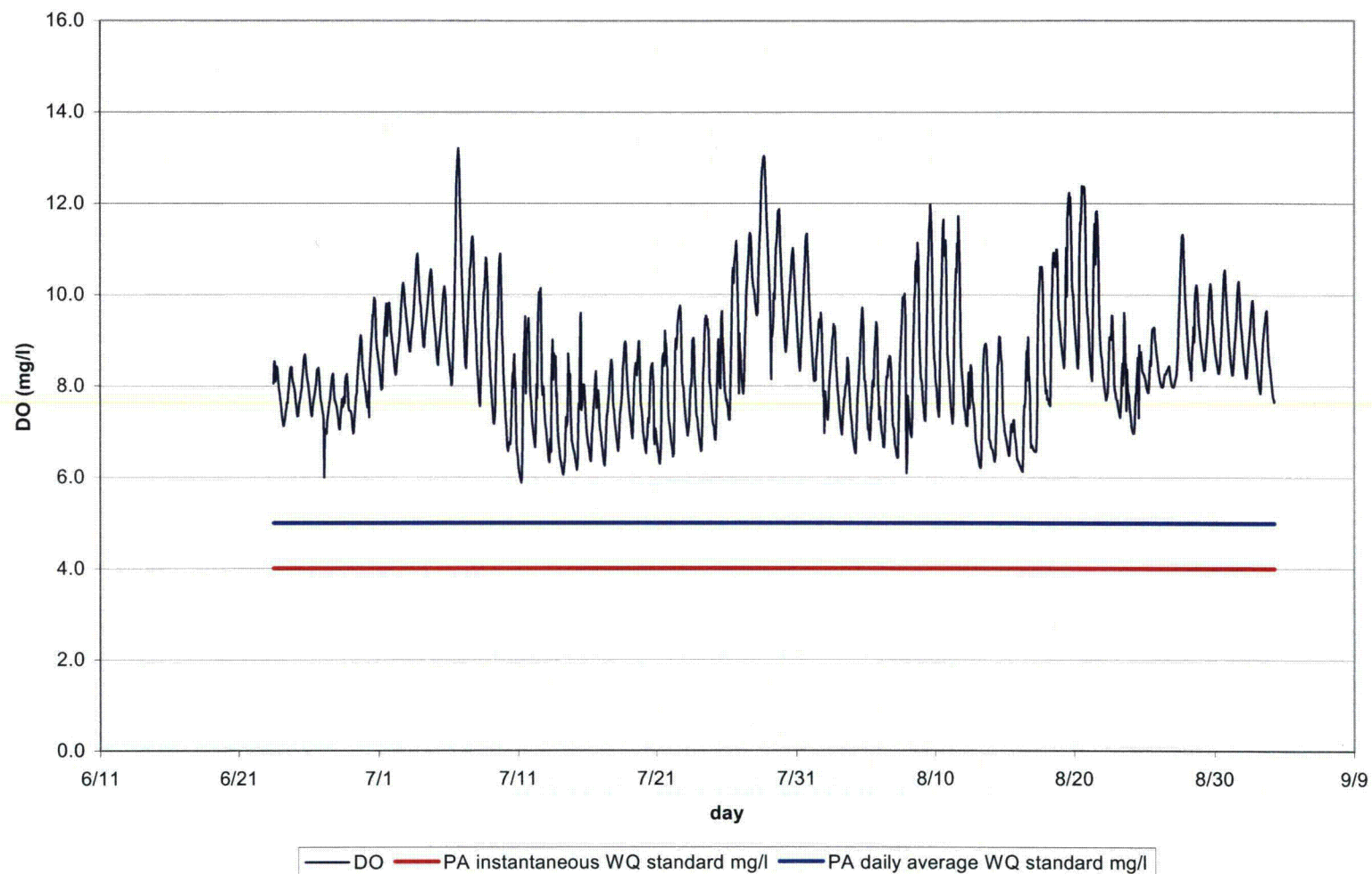


Figure 5-15 Sonde 2 (Goose Island, main channel) dissolved oxygen

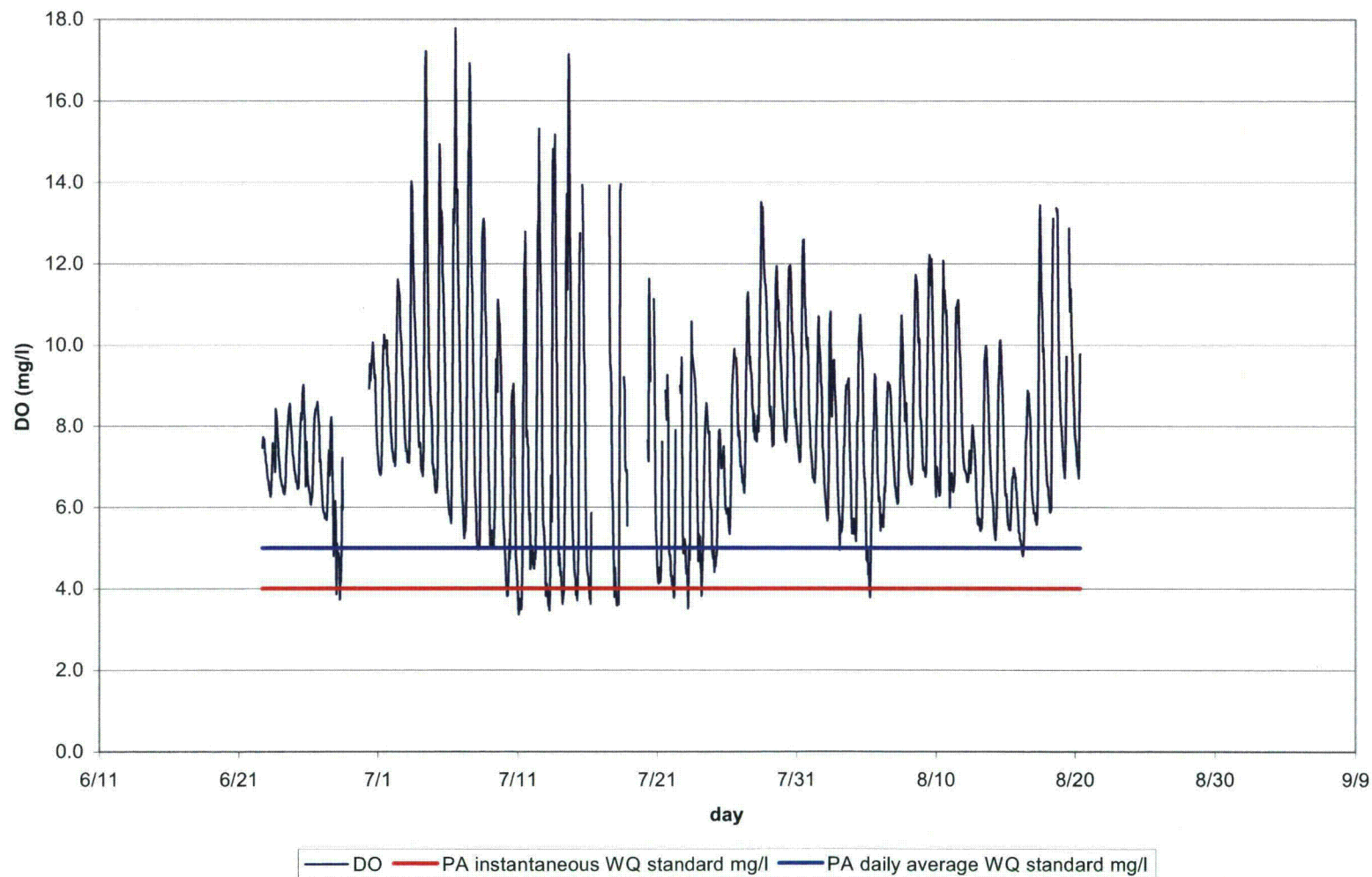


Figure 5-16 Sonde 3 (Environmental lab, shallow) dissolved oxygen

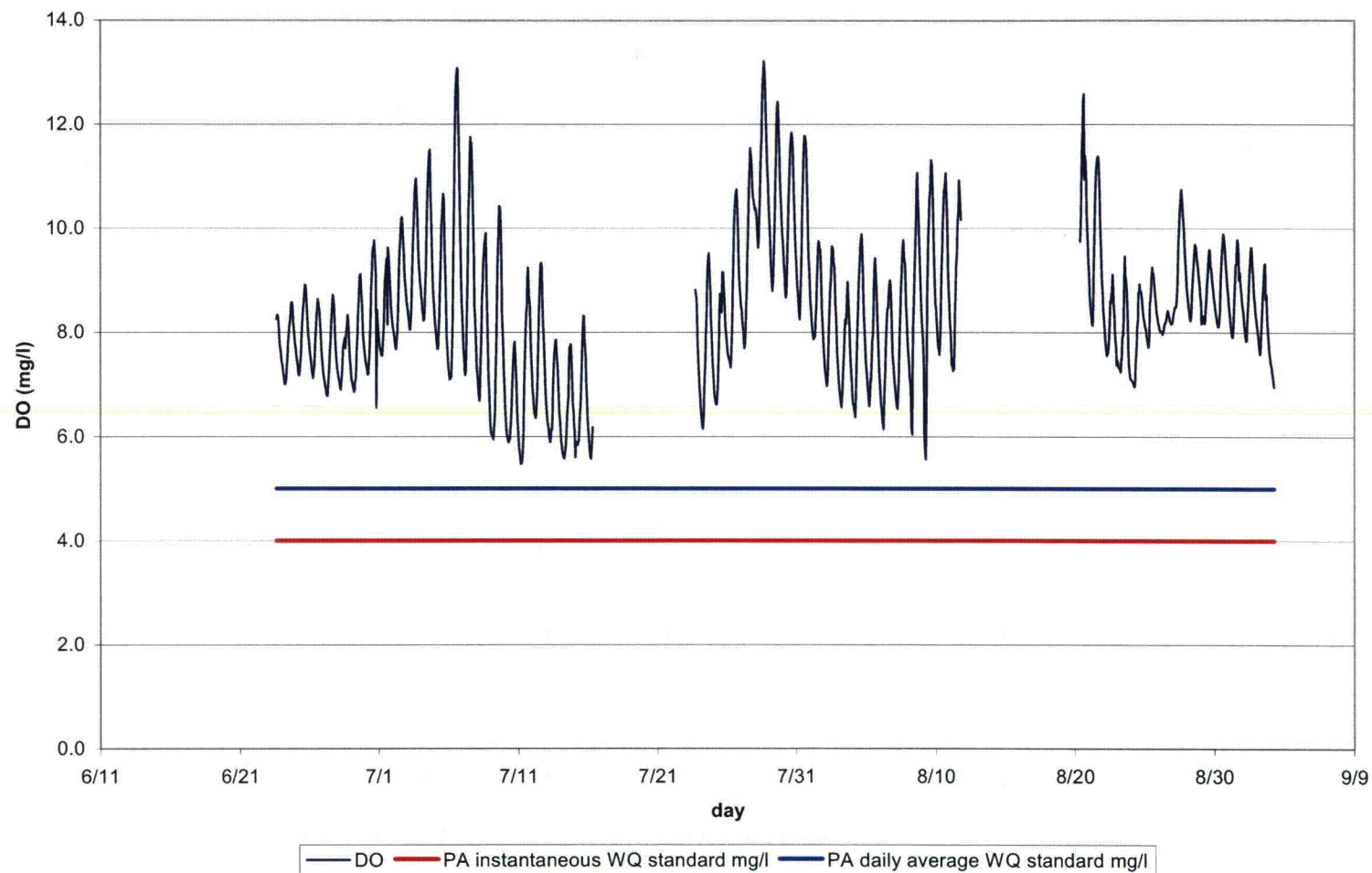
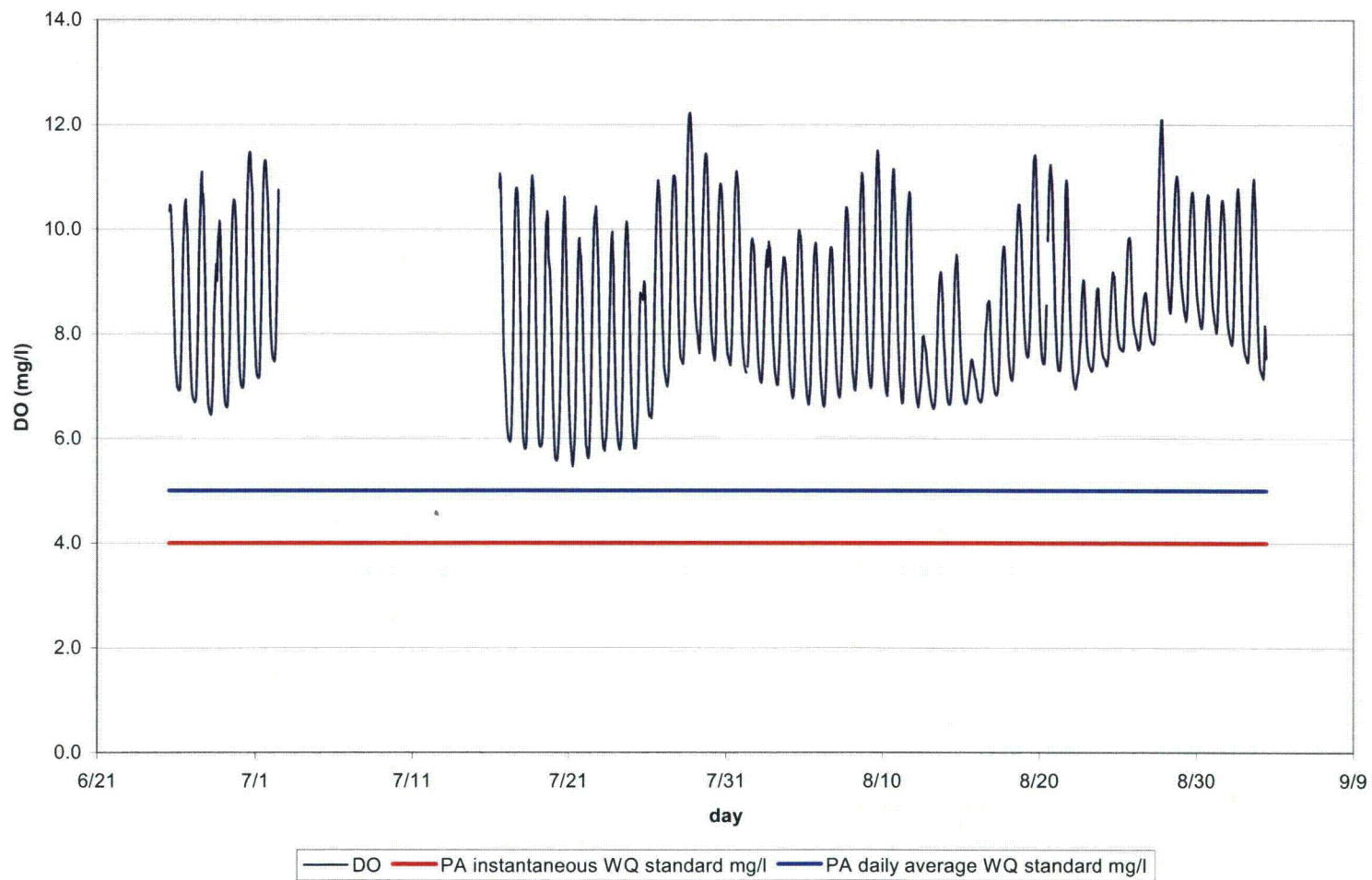


Figure 5-17 Sonde 4 (Environmental lab, main channel) dissolved oxygen





**Figure 5-18 Sonde 5 (Downstream from Test Track, main channel) dissolved oxygen**

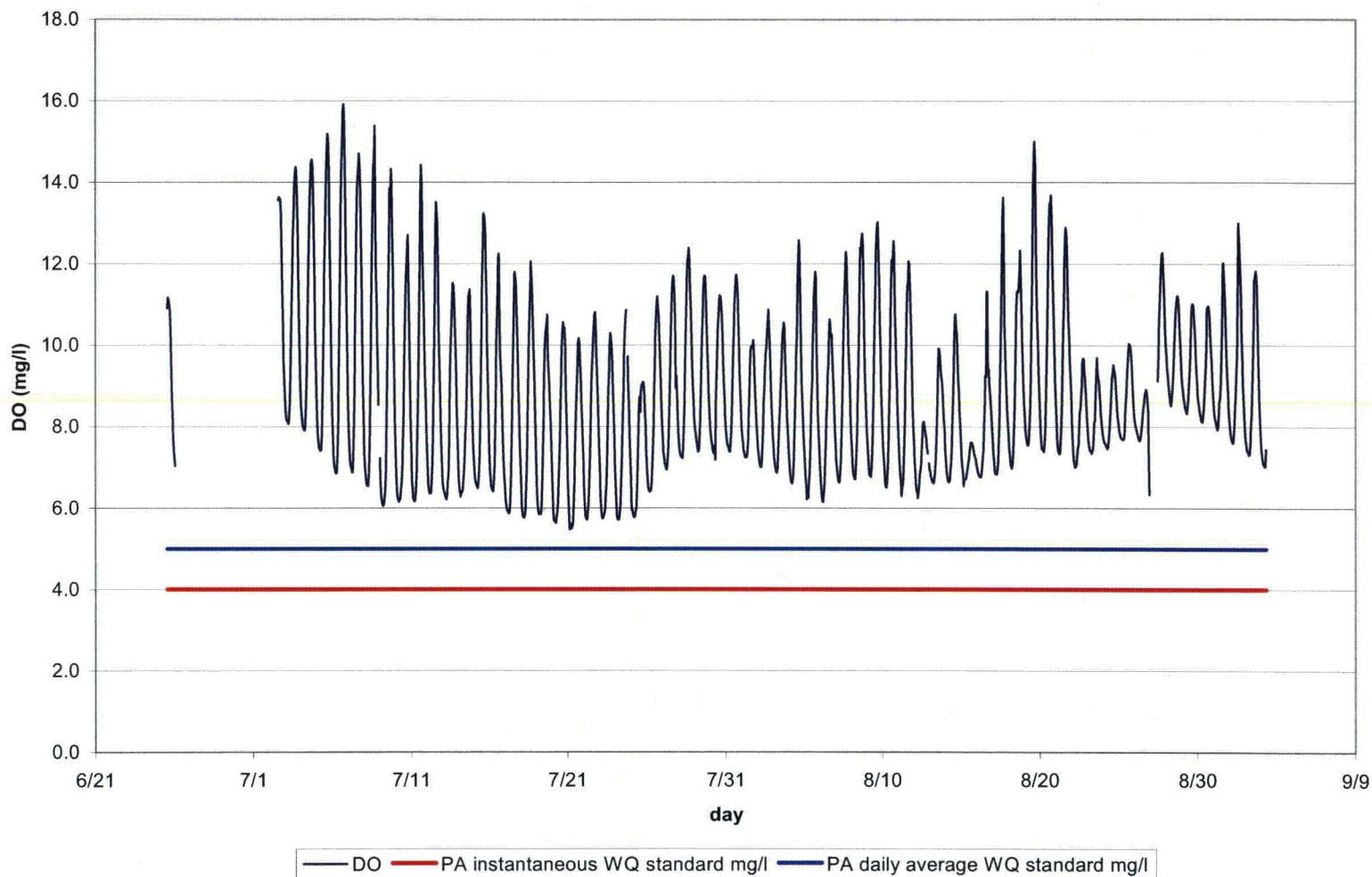


Figure 5-19 Sonde 6 (Downstream from Test Track, shallow) dissolved oxygen

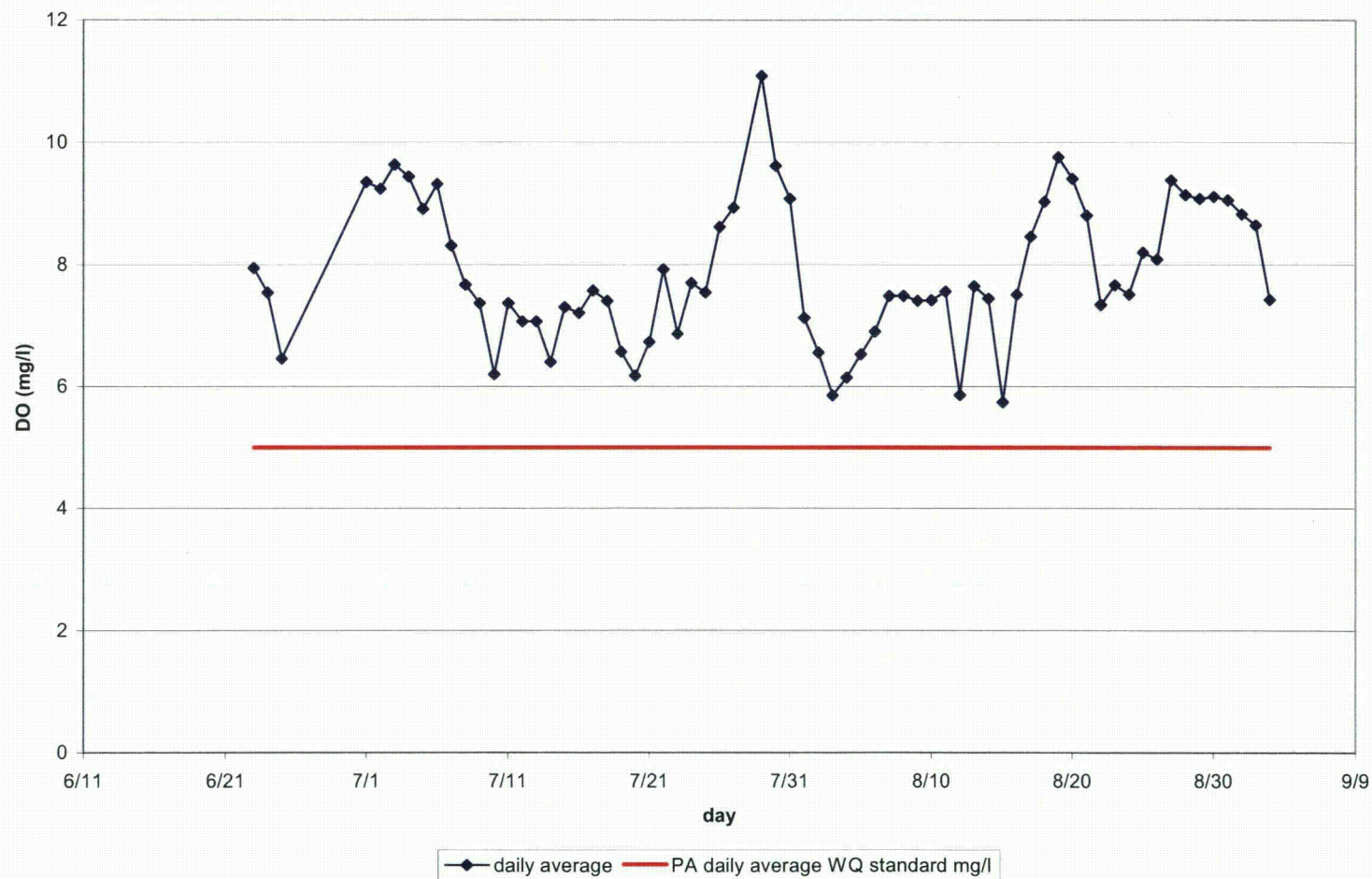


Figure 5-20 Sonde 1 (Goose Island, shallow) DO daily average

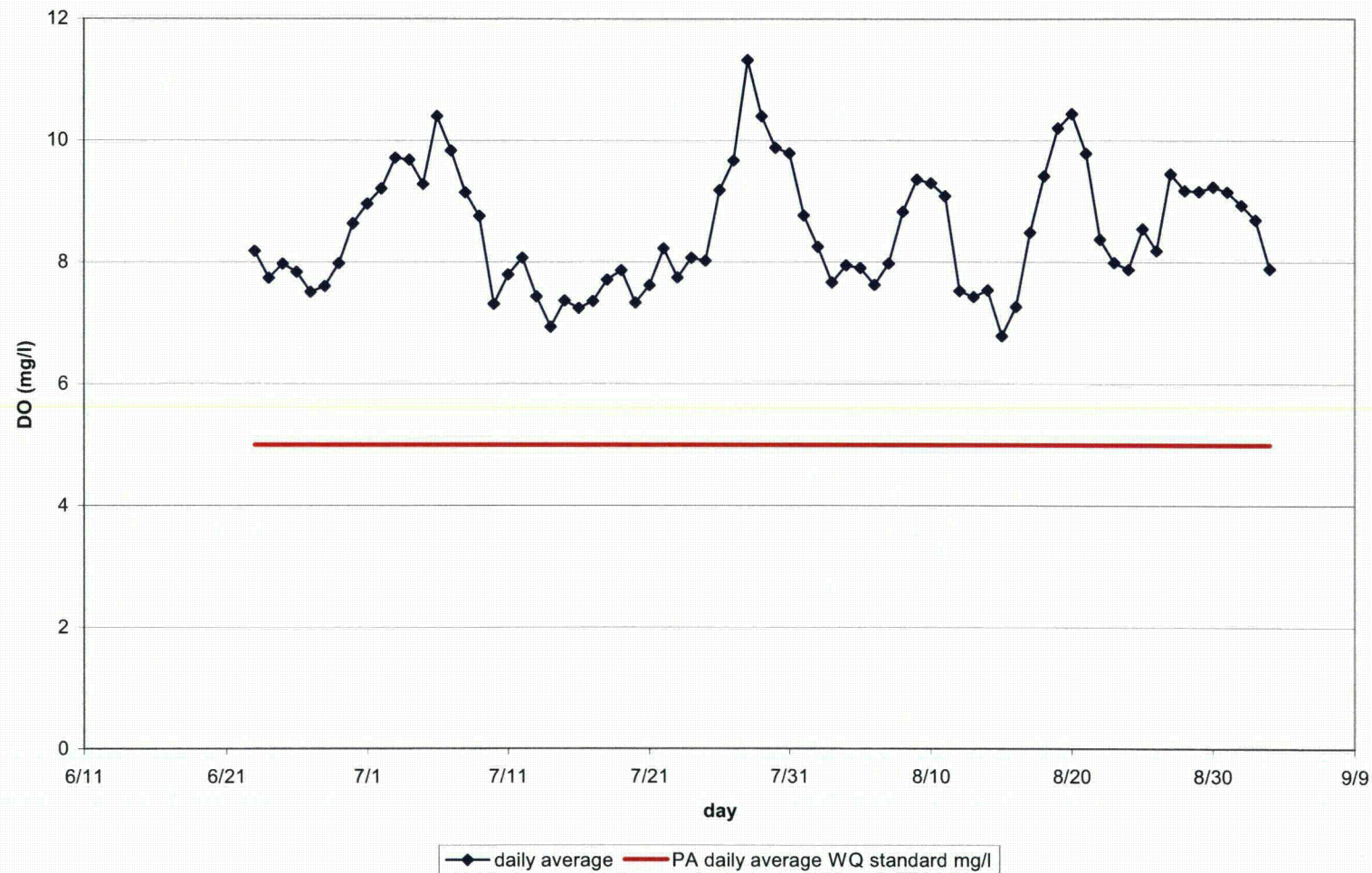


Figure 5-21 Sonde 2 (Goose Island, main channel) DO daily average



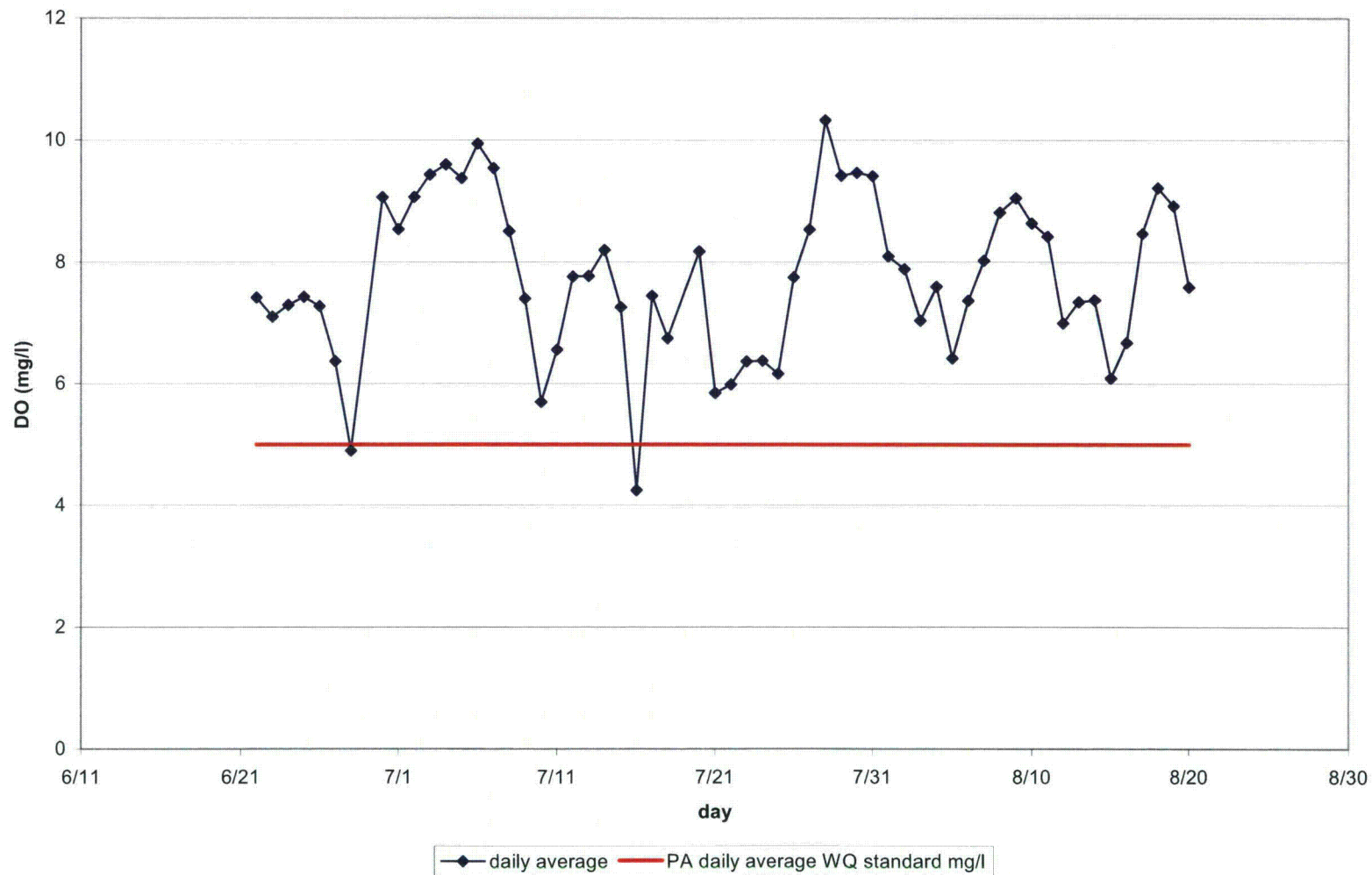


Figure 5-22 Sonde 3 (Environmental lab, shallow) DO daily average

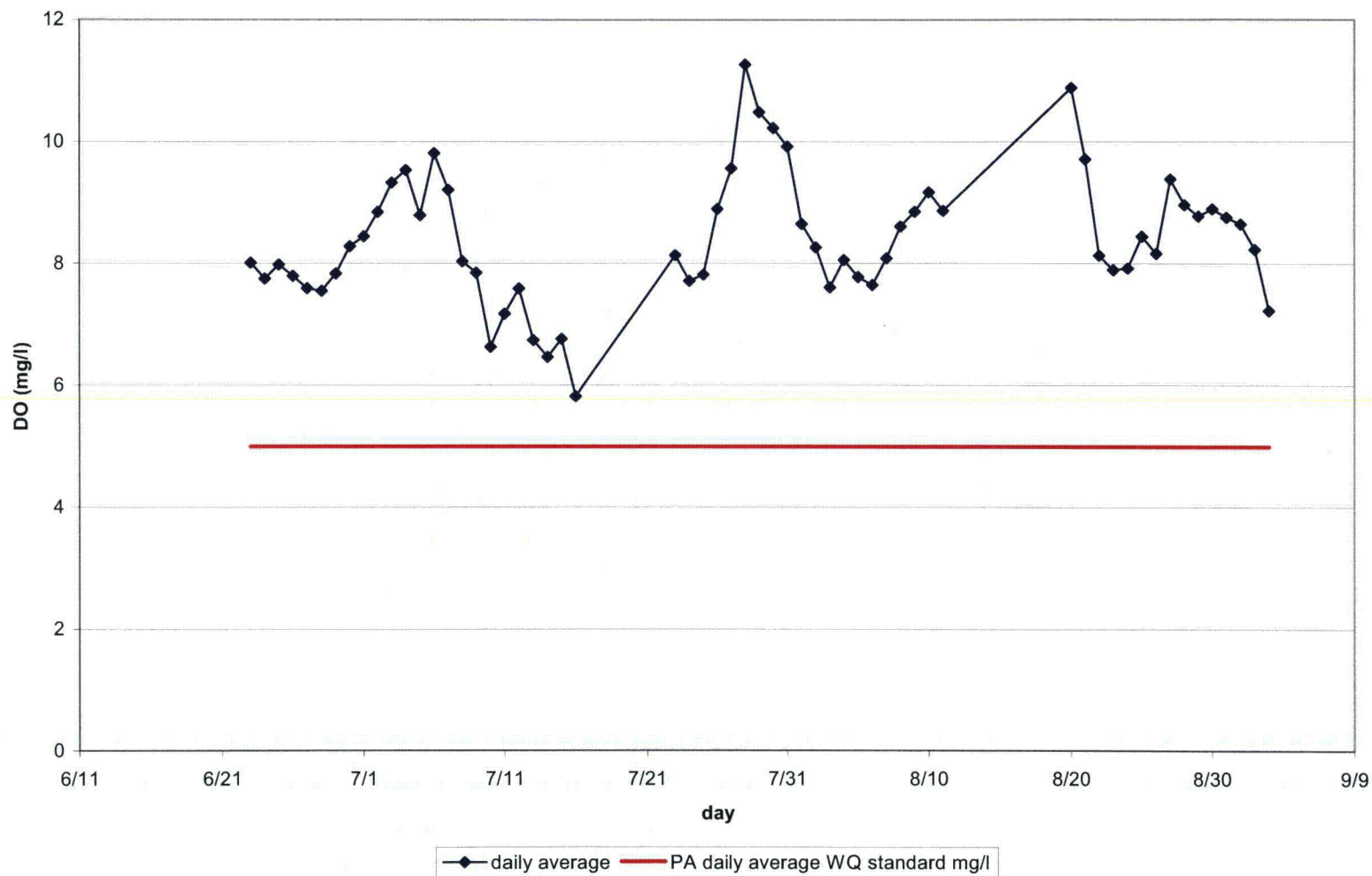


Figure 5-23 Sonde 4 (Environmental lab, main channel) DO daily average



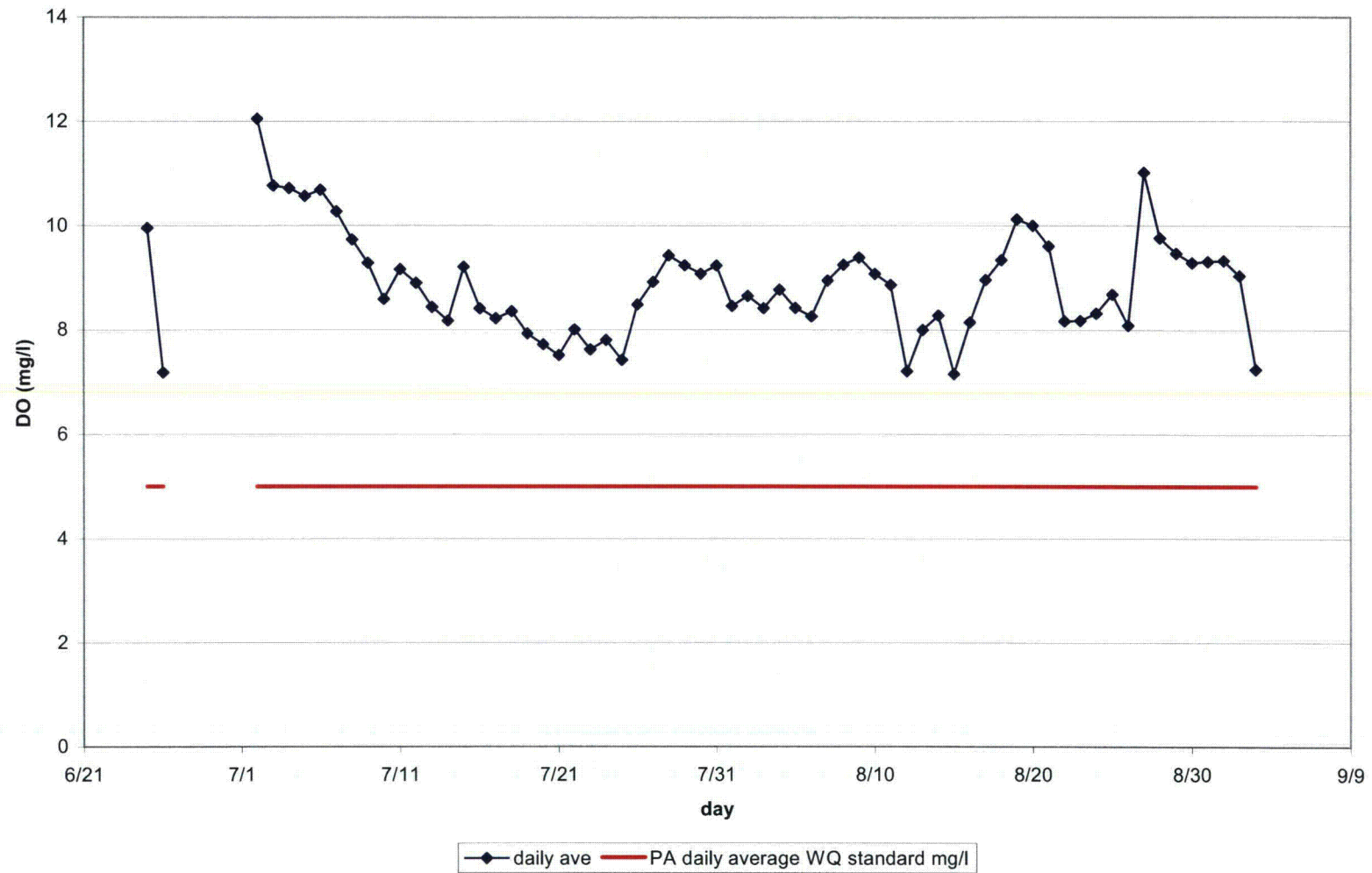
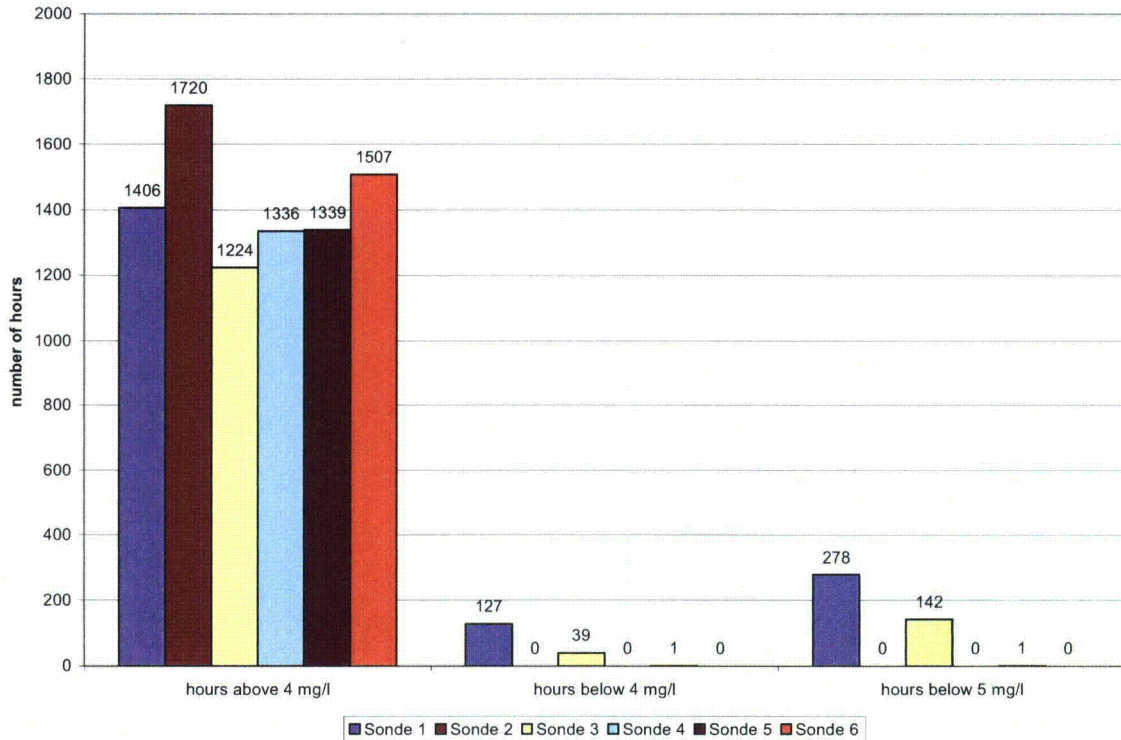


Figure 5-25 Sonde 6 (Downstream from Test Track, shallow) DO daily average

Figure 5-26 shows a summary of the hours at each sonde below 4 and 5 mg/l DO and hours above 4 mg/l.



**Figure 5-26 Hours below 4 and 5 mg/l DO and above 4 mg/l for all sondes**

### 5.4.3. PH

Figures 5-27 through 5-32 present the temporal pattern of pH recorded at the six data sondes. Although pH varied between dates, the fluctuations were generally within 1.0 pH unit and followed a similar pattern at all sites.

Approximately 30 (2.2%) pH values out of 1,339 slightly exceeded the upper range of PA State criteria of 9.0 at the main channel habitat of Berwick Test Track; five (0.3%) out of 1,336 at main channel habitat at the Environmental Lab boat ramp. All were naturally occurring events in July, and the longest consecutive period was 9 hours.



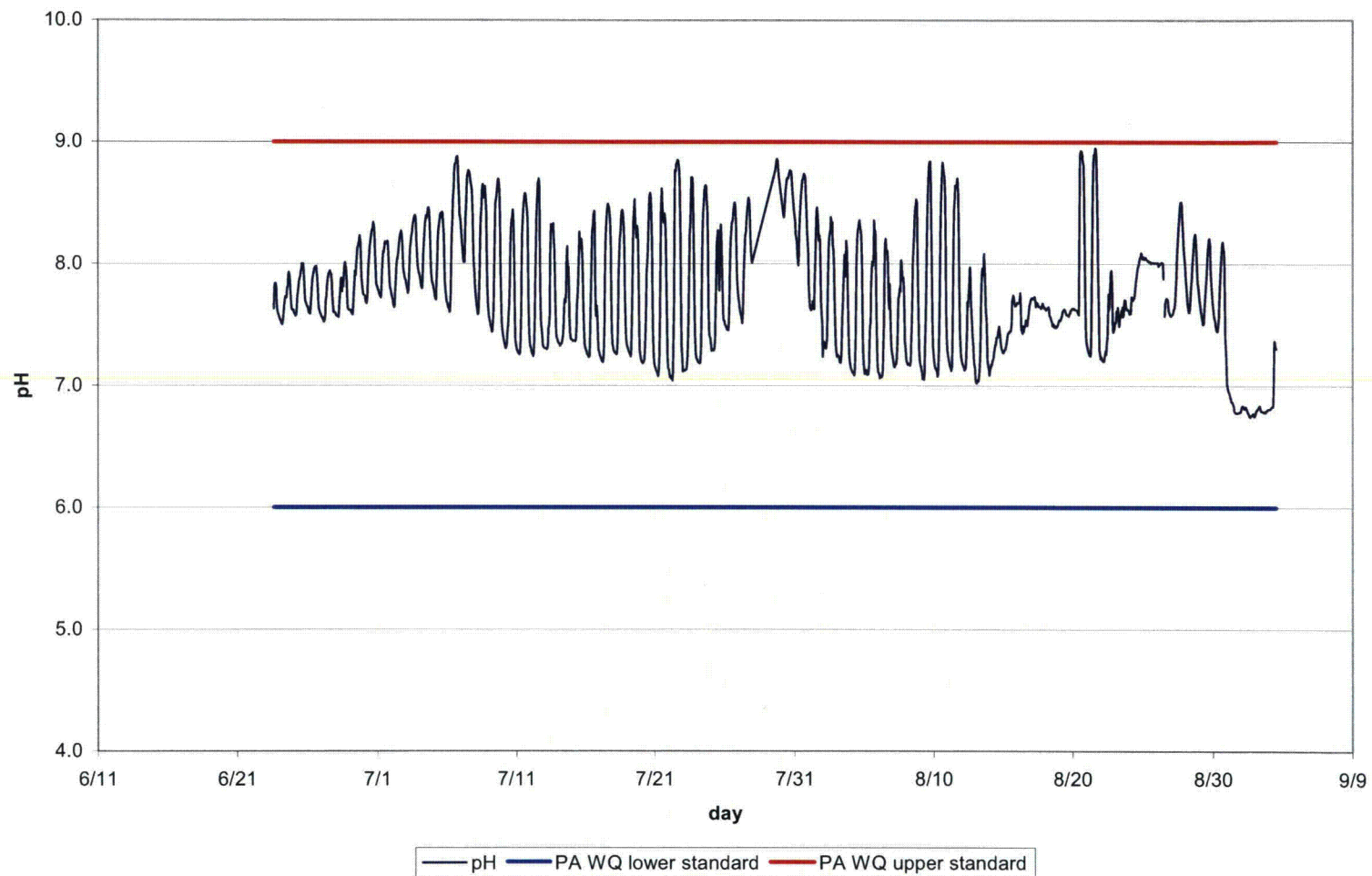


Figure 5-27 Sonde 1 (Goose Island, shallow) pH

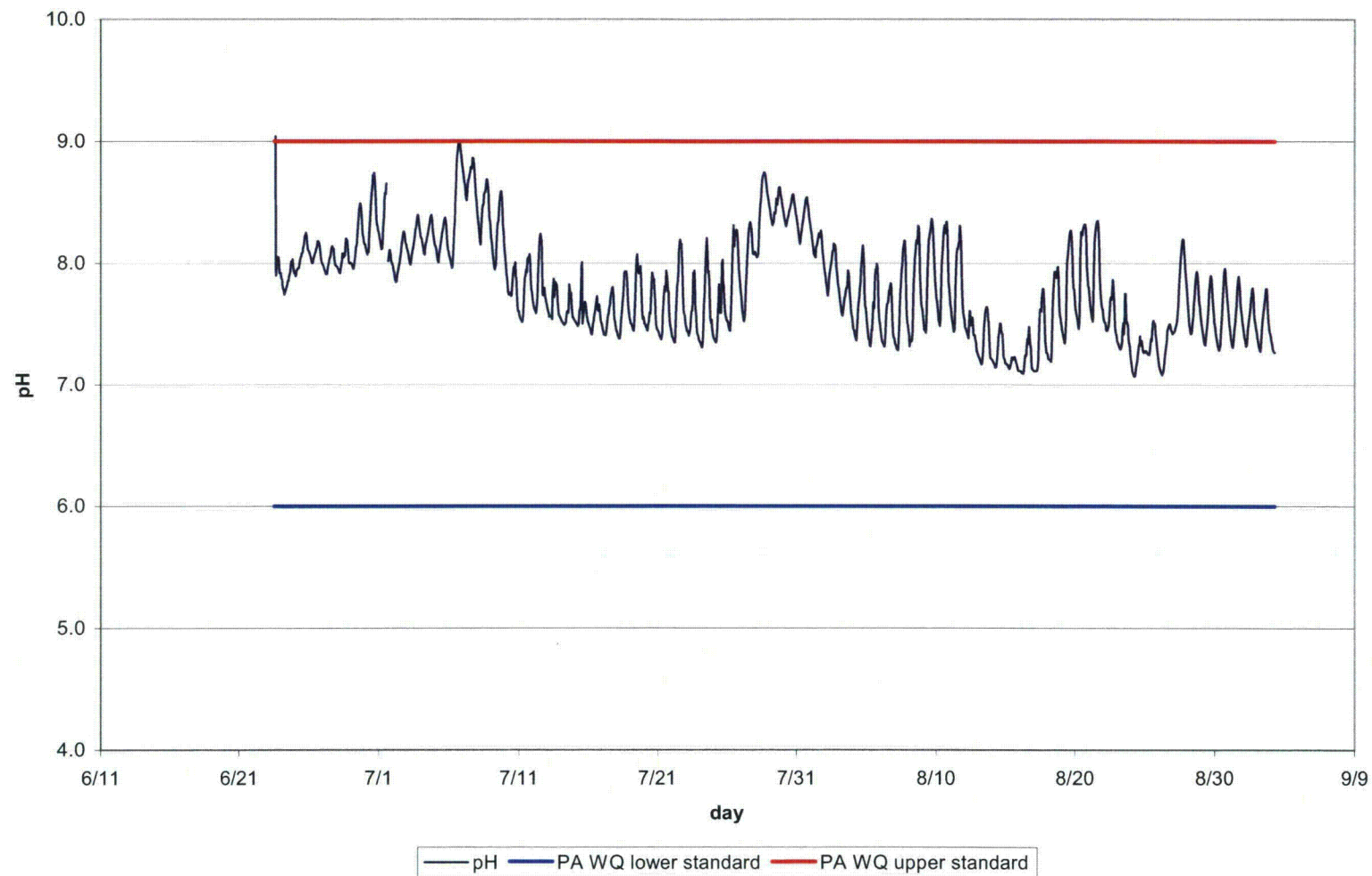


Figure 5-28 Sonde 2 (Goose Island, main channel) pH

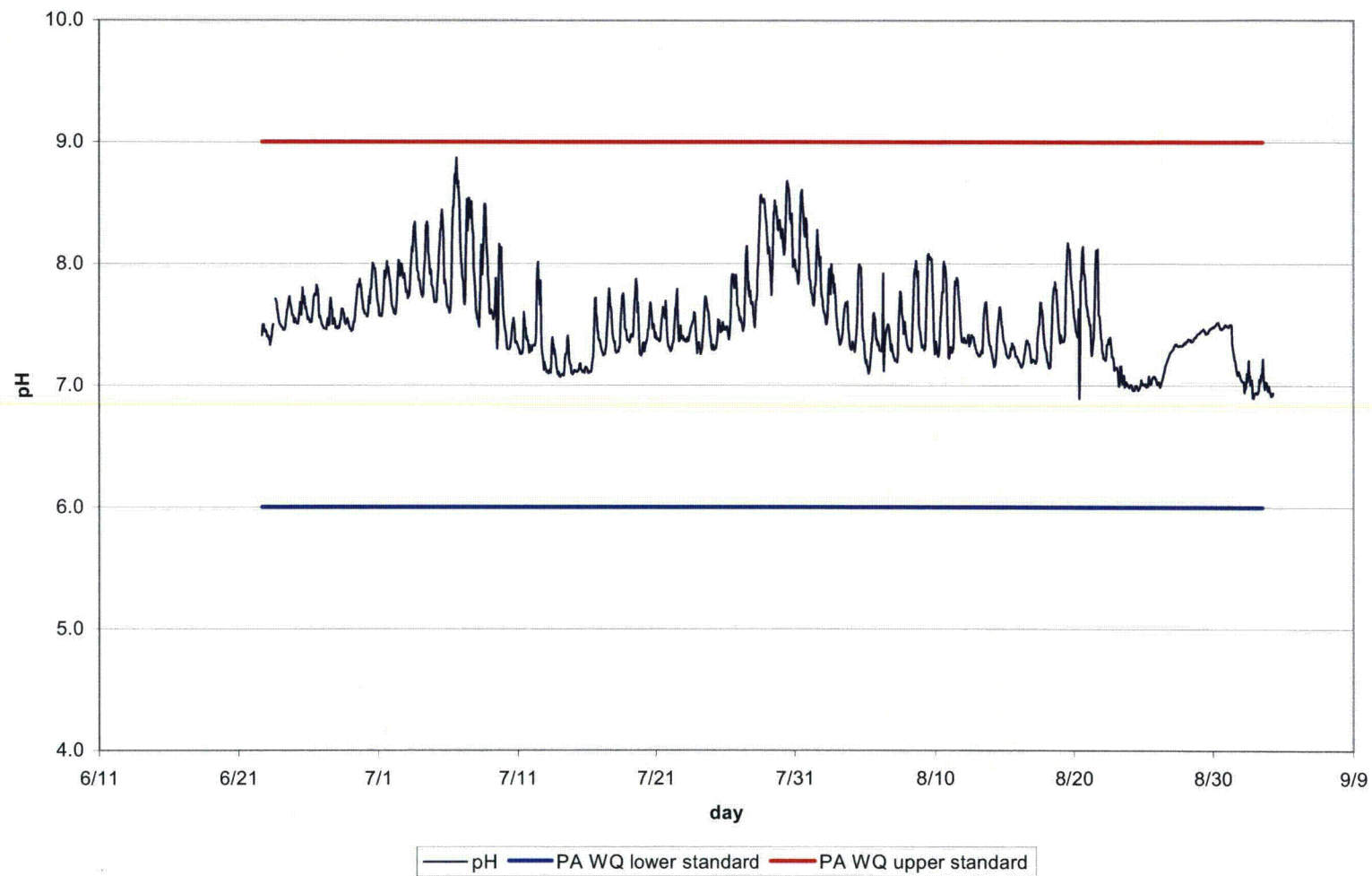


Figure 5-29 Sonde 3 (Environmental lab, shallow) pH



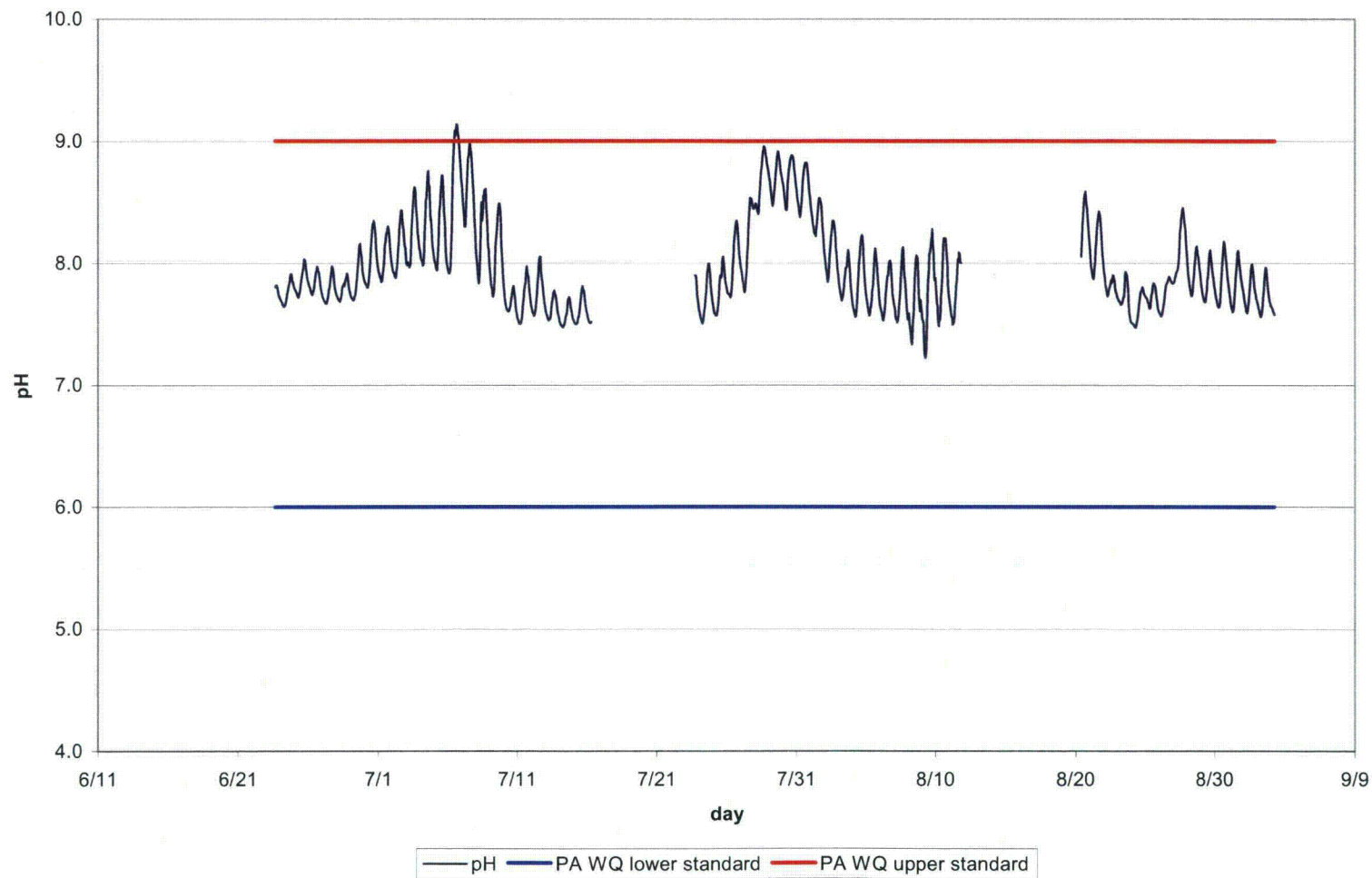


Figure 5-30 Sonde 4 (Environmental lab, main channel) pH

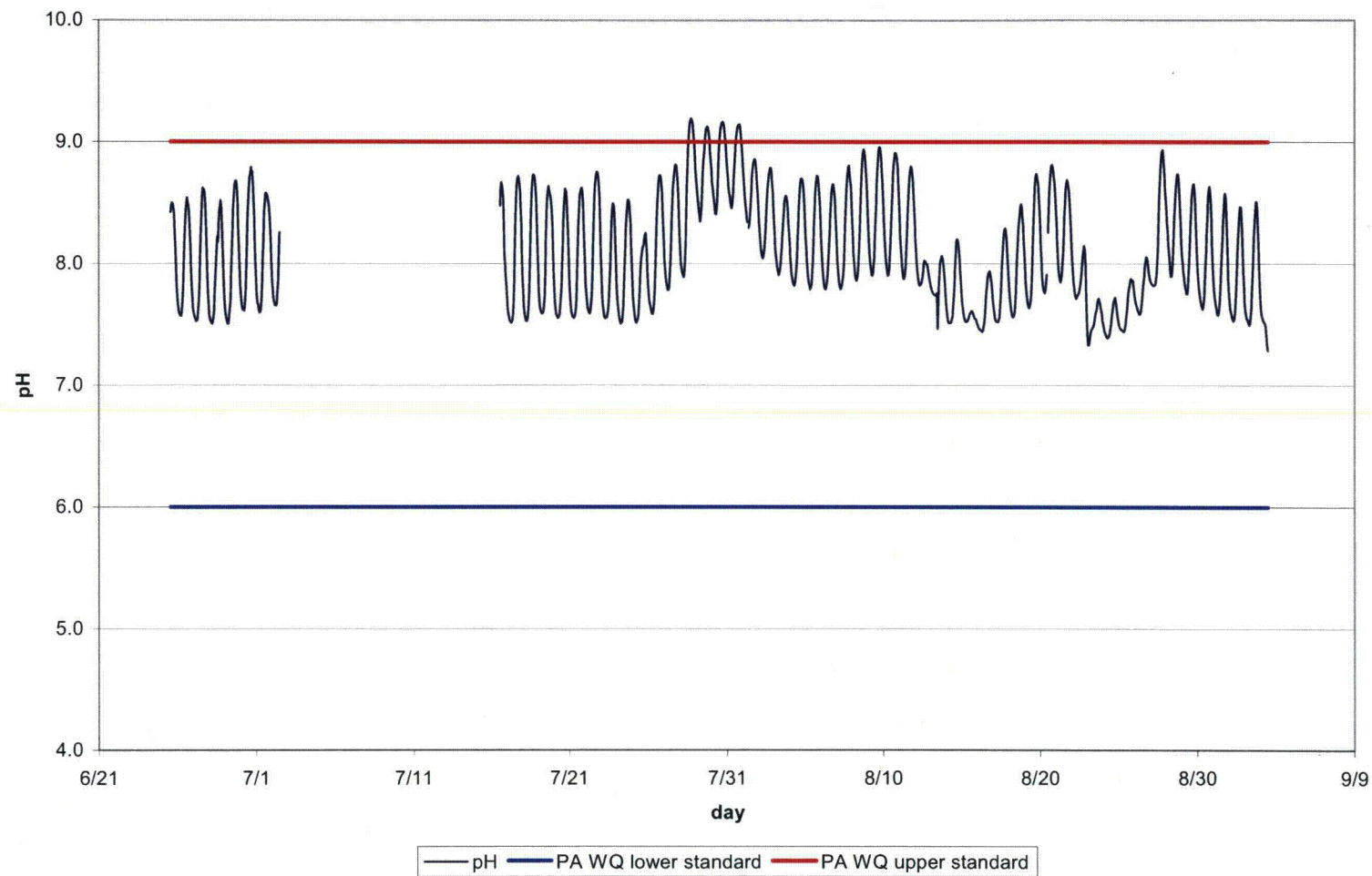


Figure 5-31 Sonde 5 (Downstream from Test Track, main channel) pH

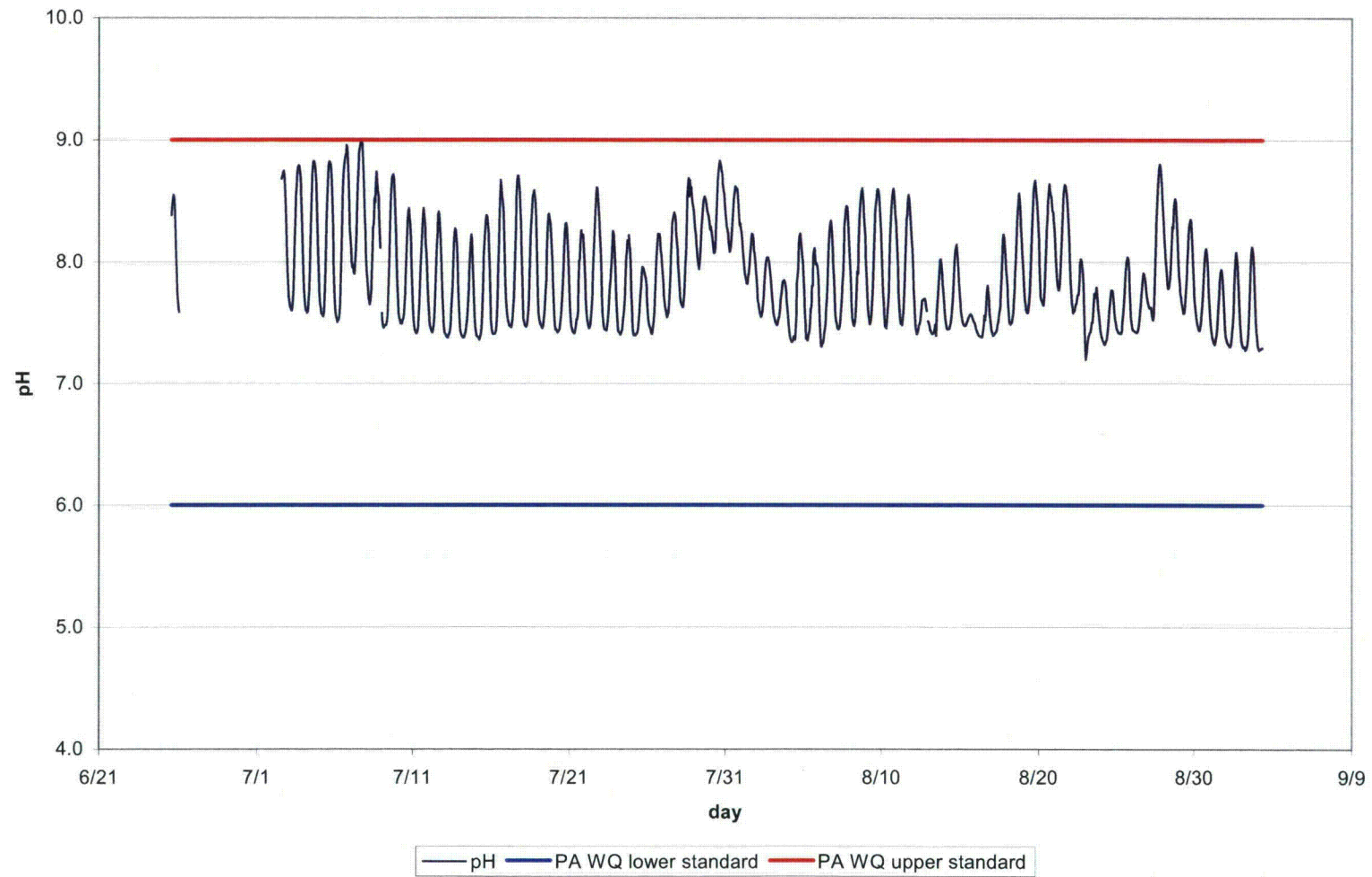


Figure 5-32 Sonde 6 (Downstream from Test Track, shallow) pH

#### **5.4.4. OBSERVATIONS ON SMB SPAWNING, REARING, AND NURSERY AREAS**

Ten surveys of SMB spawning activity, fry behavior, and subsequent survival were conducted from May through July 2010. A narrative of survey activities is provided in Appendix 5A. Most observations were made in the upriver section of the study area which afforded the most spawning sites. A motorized kayak was used to gain easy access to the shoreline in shallow water.

Most spawning, fry emergence, and YOY SMB were observed at Rocky Island, Goose Island, Environmental Lab boat ramp, and upriver of the mouth of Little Wapwallopen Creek. Spawning occurred in shallow areas (<2 ft deep) with little or no current, mostly on gravel substrate. Fry and juveniles utilized near-shore shallow (<1 ft deep) and low velocity areas. Occasionally in July and more often in August, naturally occurring water temperature exceeded 87°F (PA state standard for temperature in WWF stream from 1 July to 30 August) in SMB nursery areas but field observations noted that juveniles vacated those locales prior to the occurrence of temperatures.

YOY SMB, apparently infected by the bacterium *Flavobacterium columnare*, were observed in July; these infected juvenile bass appeared vulnerable to Blue Heron predation. These fish appeared stressed to the extent that they could be hand-dipped. A detailed description of observations is included in Appendix 5A.

#### **5.5. IMPACT ANALYSIS**

The 2010 sonde data cover a period from late June through 3 September. These data partially overlap the 1 May through 31 July SMB fry period of interest, as well as the potential juvenile SMB activity period through August. Three of the sondes were set in shallow areas that provide habitat to fry and juvenile SMB. To assess the potential effects of the 43 cfs withdrawal on the quality of these representative backwater habitats, the number of hours was calculated that the water temperature was equal to or greater than 1) the possible biological threshold of 84°F and 2) was equal to or greater than the PA WQ Standard of 87°F in July and August and 84°F in June. As discussed in Section 5.1, 84°F is considered a “possible biological threshold” temperature condition that prior studies suggest may be associated with increased *Flavobacterium columnare* virulence in fish fry.

For the impact assessment, the change in temperature due to the maximum expected reduction in depth of 0.5 inch was estimated with a thermal response calculation that uses meteorological data to assess heat transfer rates. The estimated changes in temperature were then applied to the sonde temperatures to obtain a modified sonde record. The observed sonde temperatures and the modified sonde temperatures were compared to both the PA WQ standard and the “possible biological threshold” to determine how often the number of exceedances increased for the reduced depth case.

#### **5.5.1. THERMAL RESPONSE ANALYSIS**

Changes in water temperature due to changes in water depth can be estimated by calculating the response temperature<sup>4,5</sup>. Response temperature is defined as the temperature a column of fully-mixed water would have if surface heat exchange were the only active heat transfer process (i.e., the water temperature “responds” only to surface heat exchange). This calculation is useful because it isolates temperature changes due to depth variations, which is the intent of the impact assessment. The calculation does not consider temperature changes in shallow areas due to overtopping during high flows or replenishment due to inflow and outflows through sands and gravels. These two processes would mitigate increases in temperature due to depth reduction.

The rate of change of response temperature can be written in terms of the net rate of surface heat exchange as

$$D \frac{dT}{dt} = \frac{R_n}{\rho c_p}$$

where

D = mean depth of the water column, m

dT = change water column temperature, °C

dt = change in time, s

R<sub>n</sub> = net rate of surface heat exchange, W/m<sup>2</sup>

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<sup>4</sup> Edinger, J. E., D. K. Brady and J. C. Geyer. 1974. Heat Exchange and Transport in the Environment. Cooling Water Studies for the Electric Power Research Institute, Research Project RP-49, Report 14. Palo Alto, California. EPRI Publication Number 74-049-00-3. November.

<sup>5</sup> Chapra, S.C. and Pelletier, G.J. 2003. QUAL2K: A Modeling Framework for Simulating River and Stream Water Quality: Documentation and Users Manual. Civil and Environmental Engineering Dept., Tufts University, Medford, MA.

$\rho$  = density of water, 1000 kg/m<sup>3</sup>

$c_p$  = specific heat of water, 4186 J /kg/°C

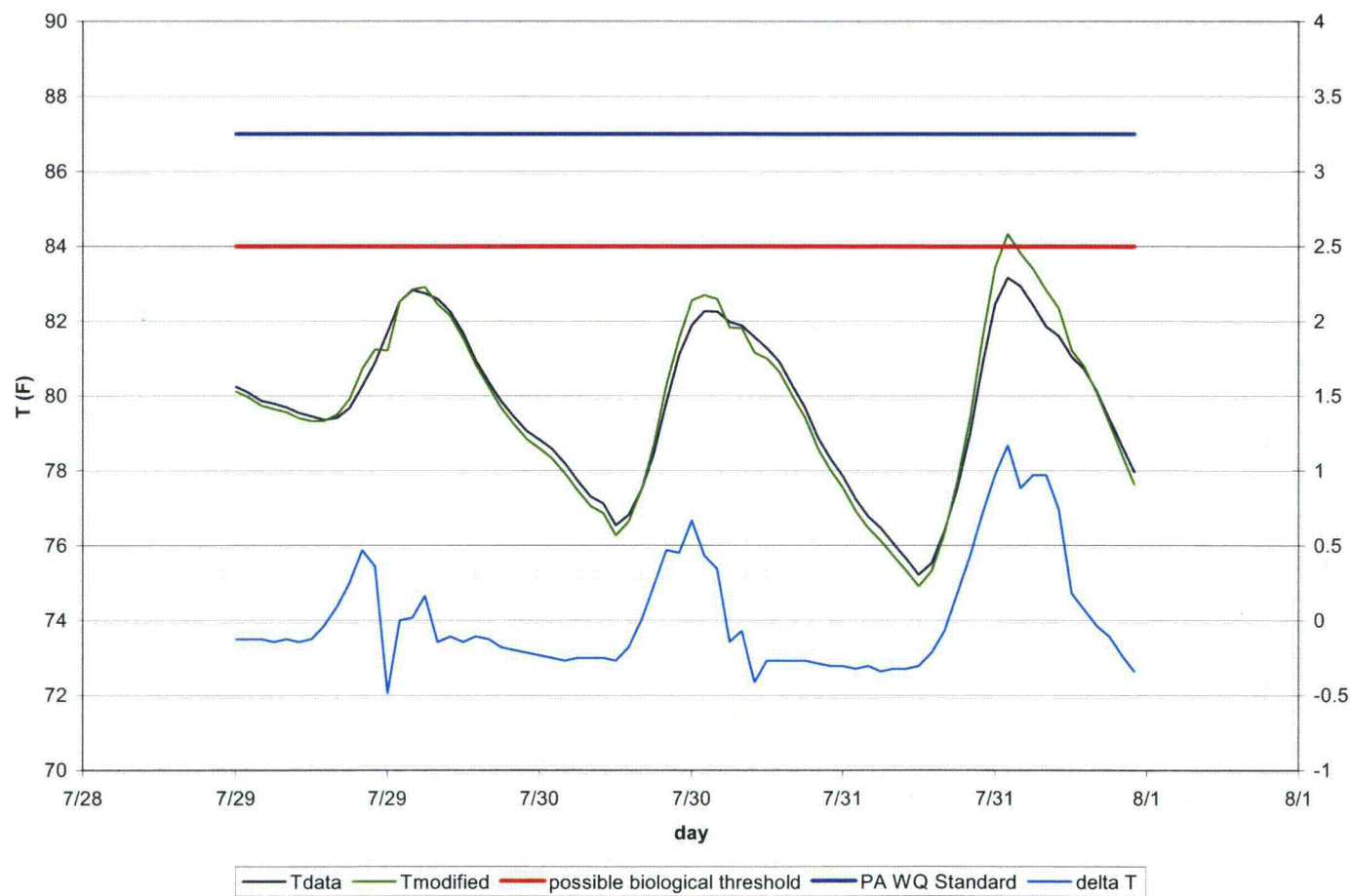
The rate of surface heat exchange can be computed from air and dew point temperature, windspeed, cloud cover, solar radiation, and atmospheric pressure. These meteorological variables are used to compute the seven individual terms that make up the net rate of surface heat exchange. These terms include shortwave solar radiation; reflected shortwave solar radiation; longwave atmospheric radiation; reflected longwave atmospheric radiation; back radiation; evaporative heat loss; and conduction.

For the present calculation, hourly meteorological data from the NOAA station at Avoca, PA (WBAN 14777), six miles southwest of Scranton and 27 miles northeast of the site, were used to calculate the hourly response temperature for the sonde data period. Solar radiation is not observed at Avoca and was instead calculated using cloud cover observations. However, to emphasize maximum water temperature changes for this assessment and to show more warming than actually would have occurred, clear sky solar radiation rates were used instead of the reduced values due to cloud cover.

When hourly or more frequent meteorological data are used to compute the response temperature, the characteristic diurnal pattern of warm afternoon temperatures and cool overnight temperatures emerges. Daytime heating is due primarily to incident solar radiation; nighttime cooling is due primarily to nighttime longwave back radiation. Furthermore, the diurnal pattern is more pronounced for waterbodies with shallow depths than for very deep waterbodies. Damping of the diurnal amplitude as depths increase is due to the increased mass of water on which the heating and cooling processes operate.

As noted, observed meteorological data were used for this impact assessment, except that clear sky solar radiation was used instead of a reduced value due to cloud cover. Use of observed meteorological data resulted in a variable pattern of heating and cooling from day to day as various processes become more or less important to the heat balance. For example, evaporation is an important heat loss process which increases with wind speed. Inclusion of observed meteorological data results in an irregular diurnal temperature pattern, as shown in Figure 5-33.





**Figure 5-33** Sample sonde observed and modified temperatures series and computed change in temperature from depth effect ( $\Delta T$ ) shown in light blue below on right hand y-axis (Sonde 3 Environmental Lab July 29 – 31 2010)

The calculation was run for six cases: once for each of the three shallow sondes (1, 3 and 6) at their nominal depths and once for these sondes at their nominal depth minus 0.5 inches. The hourly change in temperature ( $\Delta T$ ) was then applied to the hourly sonde observations to create a reduced-depth temperature record, referred to as the “modified record.”

#### 5.5.2. **RESULTS**

The computed response temperatures show the expected daytime heating and nighttime cooling cycle. When the predicted 0.5 inch maximum depth reduction associated with the 43 cfs is applied, the daytime maximum temperature is increased and the nighttime minimum temperature is decreased.

Figures 5-34 through 5-36 show the diurnal hourly change in temperature ( $\Delta T$ ), averaged over the sonde data period for Sondes 1, 3, and 6, respectively. The average shown in these figures summarizes the overall effects of the 0.5 inch temperature reduction: small increases in afternoon temperature and small decreases in nighttime temperature. This result is expected given the decreased water mass undergoing the same amount of daytime heating and nighttime cooling. The maximum and minimums in the figures illustrate the largest and smallest changes over the period of analysis. These values represent the single largest and smallest change for each hour of the day.

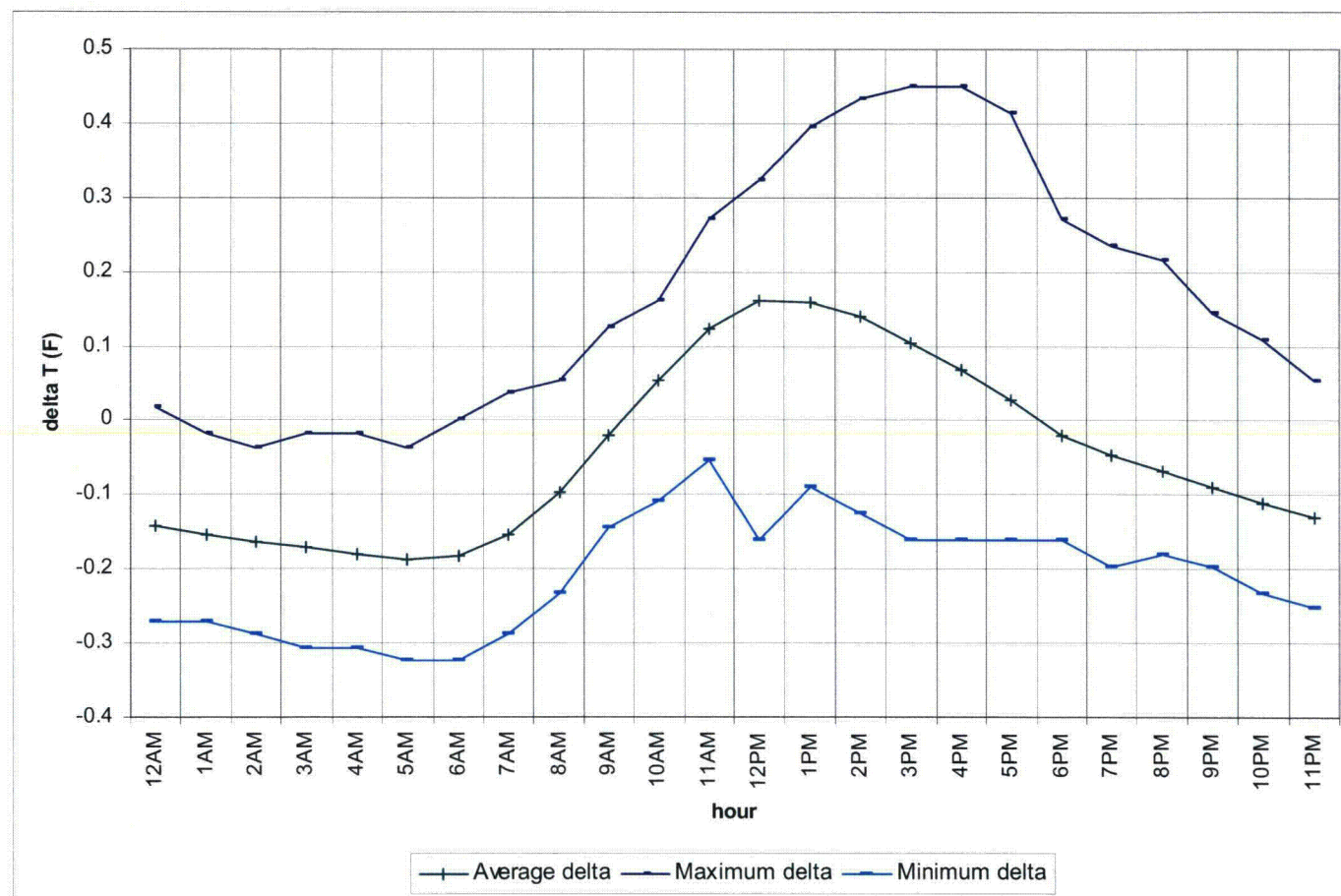
The calculated hourly changes in temperature were applied to the sonde data hour-by-hour. Figures 5-37 through 5-39 show the sonde temperature record as observed and as modified for Sondes 1, 3 and 6, respectively. Also shown is the hourly change in temperature ( $\Delta T$ ). The changes in temperature due to the anticipated reduction in depth of 0.5 inch are so slight as to make the observed and modified temperature curves overlay closely and show no appreciable difference. However an analysis of the observed and modified record presented in both tabular and graphic format (Appendix 5B and 5C) shows that there are occasions when the daytime temperature increases cause the temperature to exceed the 84°F possible biological threshold and to exceed the PA WQ standard.

Table 5-5 provides a summary of the threshold analysis that shows the duration and frequency of exceedance of the PA WQ standard and the 84°F for the observed and modified sonde record.

Quantifying frequency and duration consists of counting the number of hours exceeding these values for the observed and the modified sonde temperature records. Two metrics can be derived from this procedure: the number of additional hours exceeded and the number of additional events. An event is a set of consecutive exceedances, that is, the duration of the exceedance. An event therefore is representative of potential recurring stress. It is important to note with regard to recurring (or cyclic) stress that Chaplin *et al.* (2009) indicated that the effect is poorly understood and that little is known about it over a period of days or weeks in YOY SMB microhabitats. Since additional recurring stress

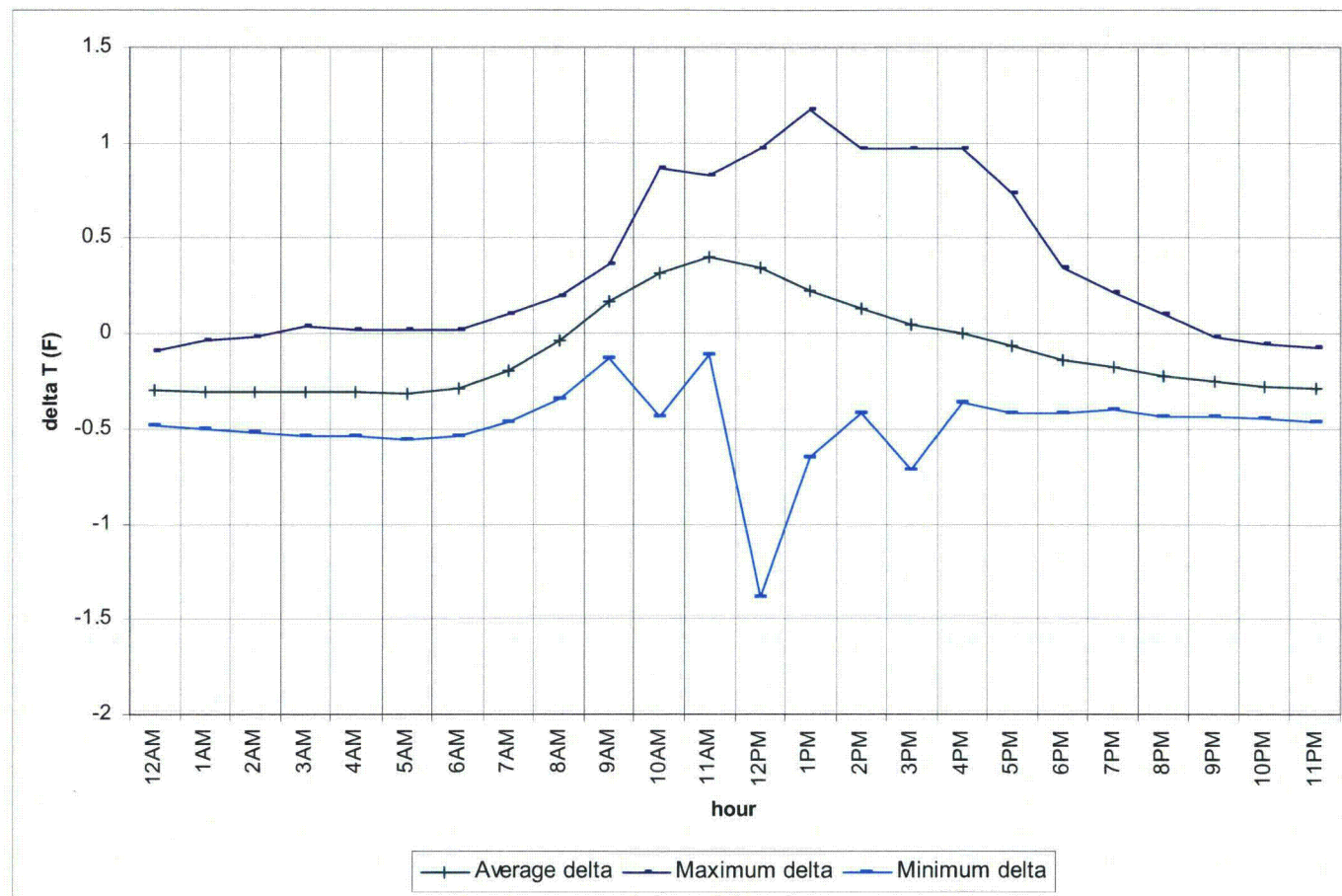
events associated with consumptive use as identified by the analysis in this report are extremely infrequent and are certainly not on the order of either days or weeks, no adverse effect is considered for this particular trend.

Because the temperature changes are small with increases confined to the afternoon, Table 5-5 shows that the 0.5 inch reduction in depth has no appreciable effect on the magnitude, the duration or the frequency of events greater than the possible biological threshold of 84°F. Similarly, the table shows that the reduction in depth due to consumptive use has no appreciable effect on the magnitude, the duration or the frequency of events greater than the PA WQ Standard.



**Figure 5-34 Overall change in temperature from reduced depth for Sonde 1 (Goose Island, shallow)**

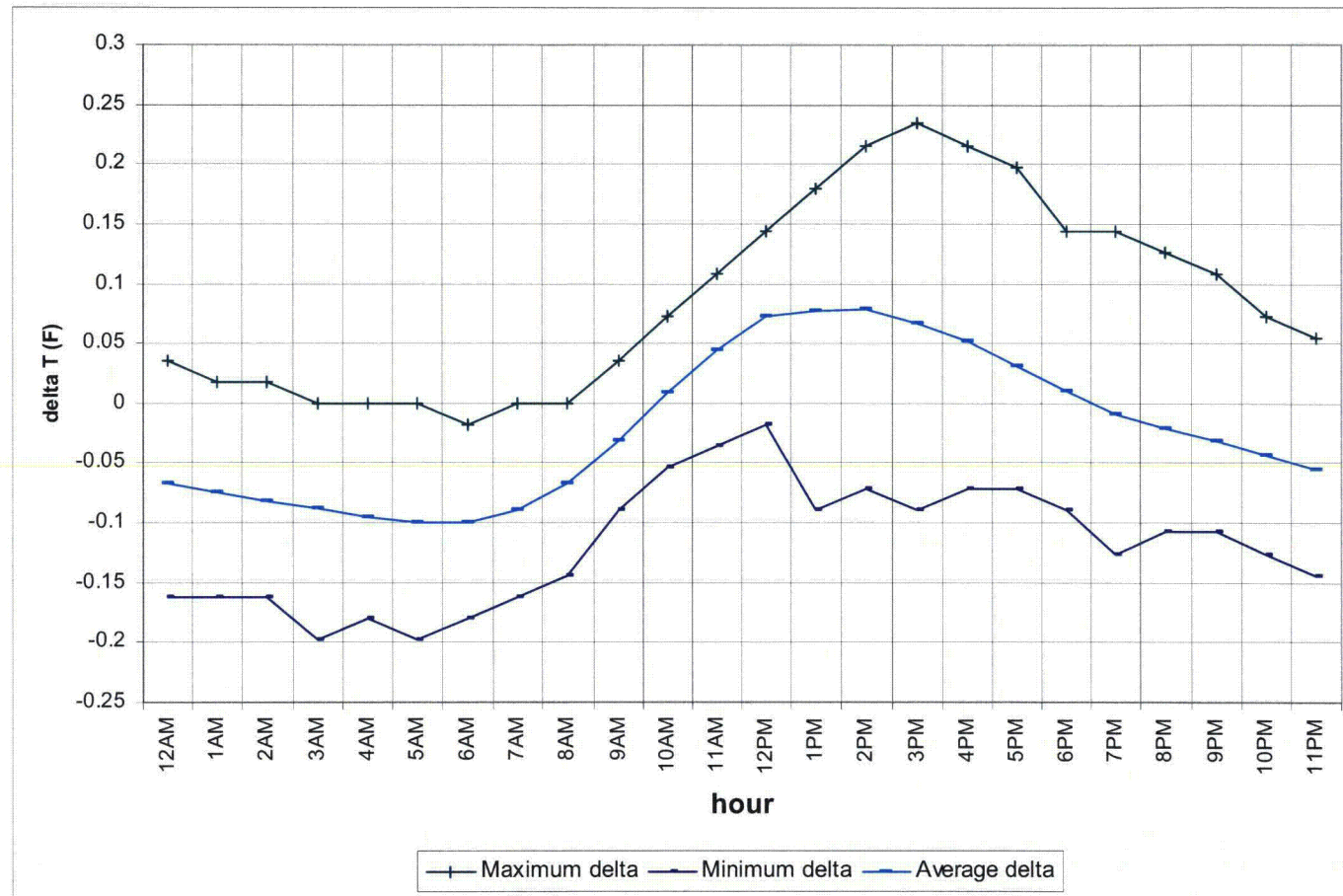
The  $\Delta T$  is positive for increases and negative for decreases when applied to sonde data; nominal depth for Sonde 1 is 15 in.



**Figure 5-35 Overall change in temperature from reduced depth for Sonde 3 (Environmental lab, shallow)**

The  $\Delta T$  is positive for increases and negative for decreases when applied to sonde data; nominal depth for Sonde 3 is 9 in.

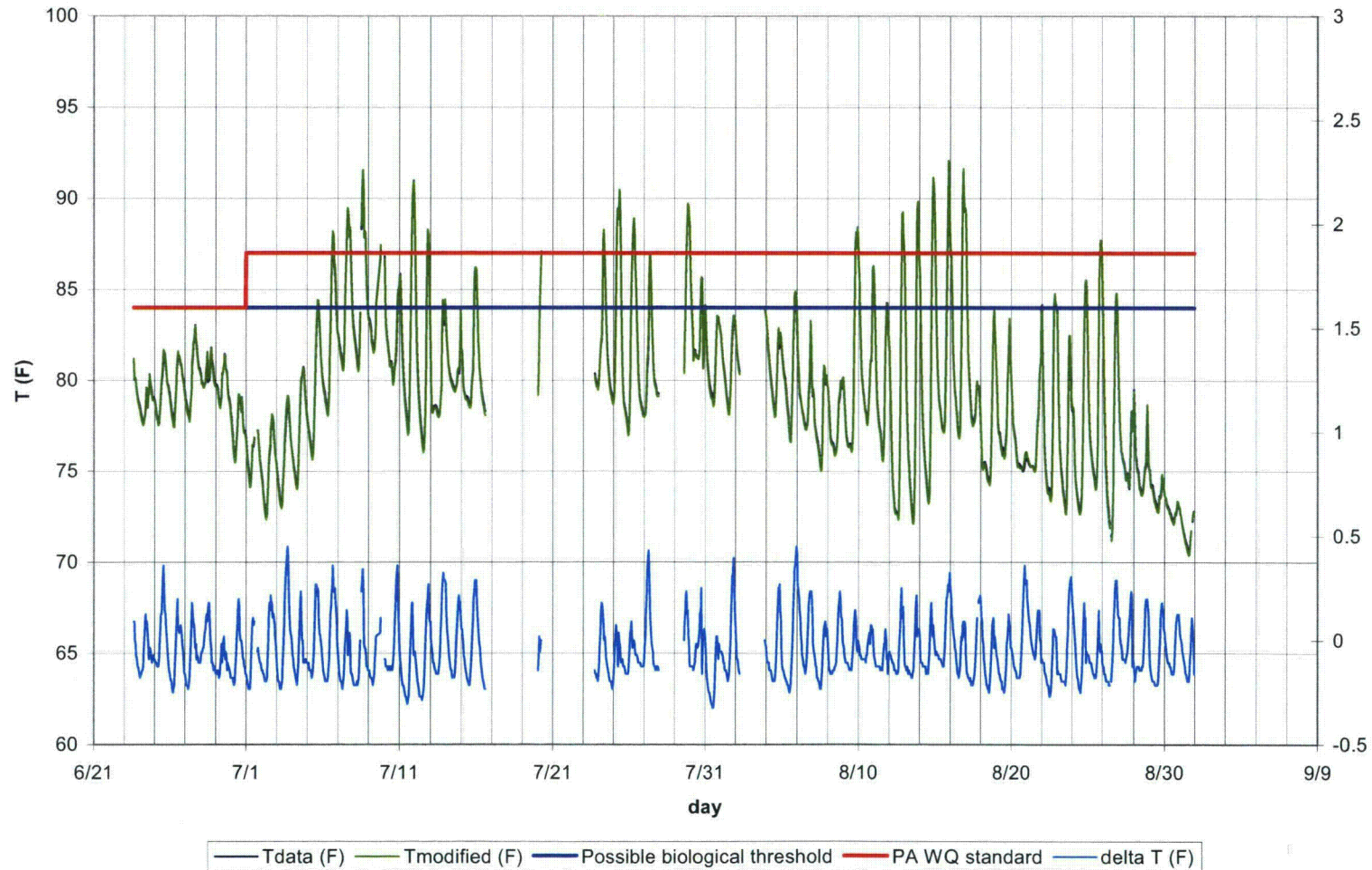




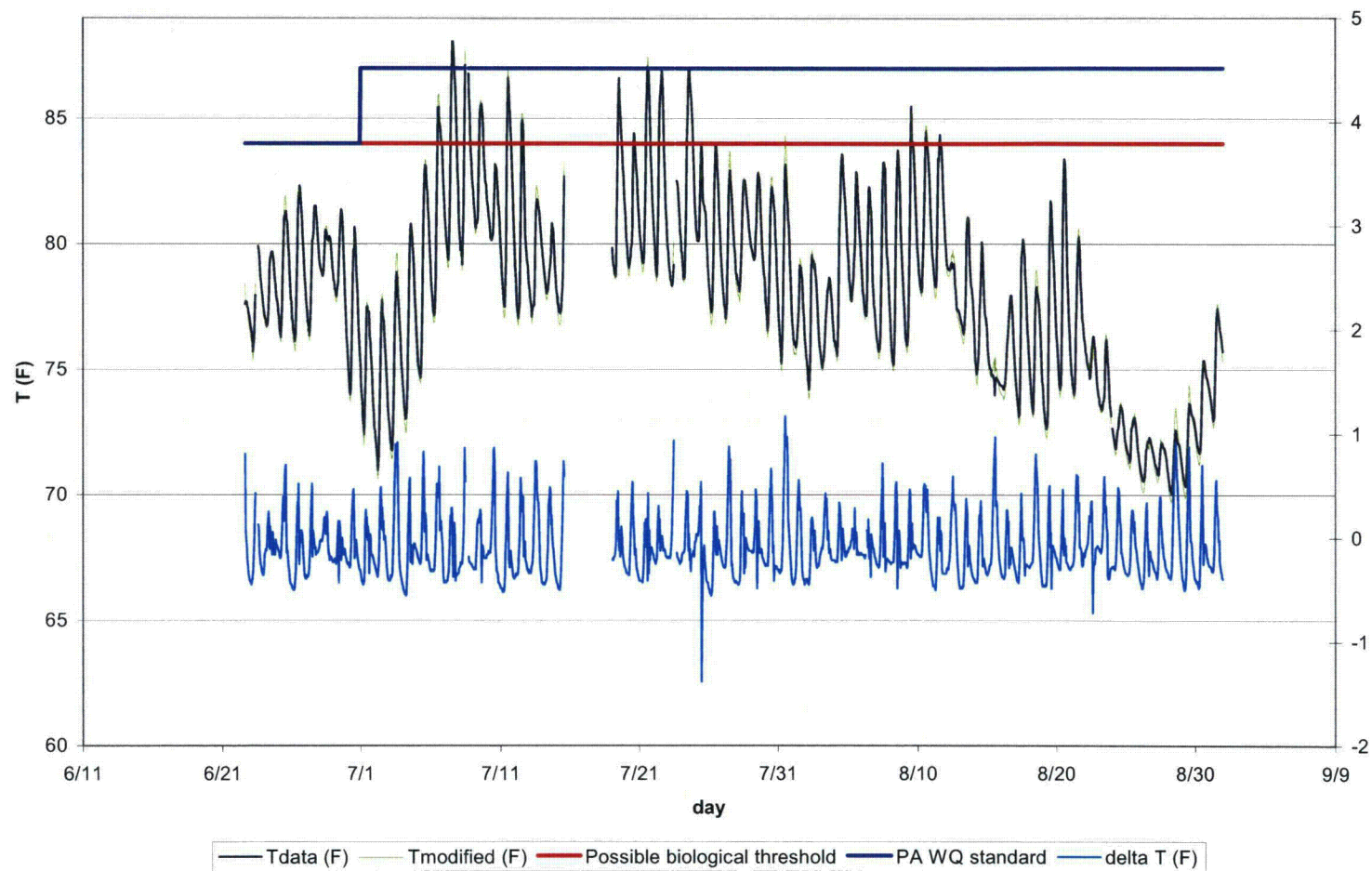
**Figure 5-36 Overall change in temperature from reduced depth for Sonde 6 (downstream from Test Track, shallow)**

The  $\Delta T$  is positive for increases and negative for decreases when applied to sonde data; nominal depth for Sonde 6 is 21 in.

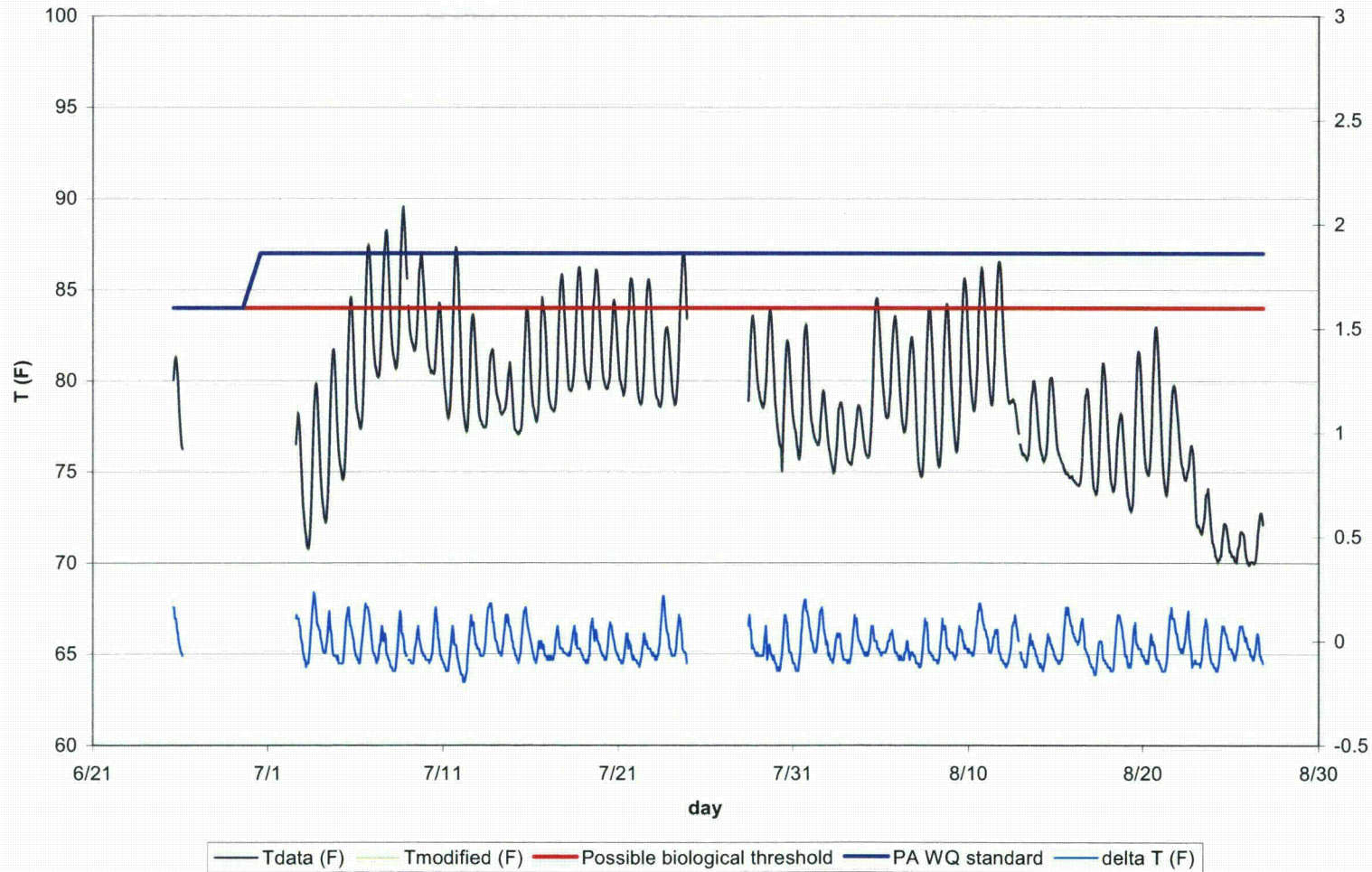




**Figure 5-37 Sonde 1 (Goose Island, shallow) observed and modified temperatures series and computed change in temperature from depth effect ( $\Delta T$ ) shown in light blue below on right hand y-axis**



**Figure 5-38 Sonde 3 (Environmental lab, shallow) observed and modified temperatures series and computed change in temperature from depth effect ( $\Delta T$ ) shown in light blue below on right hand y-axis**



**Figure 5-39 Sonde 6 (Downstream of Test Track, shallow) observed and modified temperatures series and computed change in temperature from depth effect ( $\Delta T$ ) shown in light blue below on right hand y-axis**



**Table 5-5 Thermal analysis summary**

	Sonde 1 (Goose Island)	Sonde 3 (Environmental lab)	Sonde 6 (Test Track)
Sonde data period (2010)	23 June – 3 September	22 June – 3 September	25 June – 3 September
Depth used for thermal response calculation (inches)	15	9	21
<b>Comparison to PA WQ Standard</b>			
2010 data: hours above PA WQ standard	81	7	19
With $\Delta T$ applied: hours above PA WQ standard	81	8	19
Added hours	0	1	0
2010 data: number of events above PA WQ standard	18	3	6
With $\Delta T$ applied: number of events above PA WQ standard	18	4	6
New events	0	1	0
2010 data: average event duration (hours)	4.50	2.33	3.17
With $\Delta T$ applied: average event duration (hours)	4.50	2.33	4.25
<b>Comparison to possible biological threshold</b>			
2010 data: hours above 84°F	185	85	133
With $\Delta T$ applied: hours above 84°F	185	90	133
Added hours	0	5	0
2010 data: number of events above 84°F	34	16	22
With $\Delta T$ applied: number of events above 84°F	34	17	22
New events	0	1	0
2010 data: average event duration (hours)	5.44	5.31	6.05
With $\Delta T$ applied: average event duration (hours)	5.44	5.31	6.05

## 5.6. CONCLUSIONS

Based on field observations, SMB successfully spawned throughout the study area in late May and early June 2010. As the fry developed throughout June, they tended to disperse from the schools, but remained along the shoreline in aquatic vegetation at the river banks and the islands. However, by the time water temperature consistently exceeded 84-85° F these fry had grown to juvenile size and migrated from the shoreline habitat into deeper river water. In early July, shoreline water temperatures were approaching 90° F. At this time, YOY SMB were not observed in these areas.

Based on field observations and during naturally occurring flow events, some smallmouth bass juveniles appeared to suffer in 2010 from the same bacterial disease (*Flavobacterium*) experienced in 2005.



Collected water quality data indicates that during the summer low flow months there are natural occurrences of water quality not meeting the Pennsylvania State criteria for warm water fisheries, primarily for water temperature and DO and to a much lesser extent pH. These naturally occurring variations from the Pennsylvania Water Quality Criteria in water temperature and dissolved oxygen, independent of consumptive use, were of short duration and were limited to the shallow, inshore areas both upstream and downstream of the proposed BBNP discharge location.

The thermal response analysis shows that the 0.5 inch reduction in depth has no appreciable effect on the magnitude, the duration or the frequency of events greater than or equal to a possible biological threshold of 84°F nor on the magnitude, the duration or the frequency of events greater than the PA WQ Standard.

Therefore, we conclude that the proposed consumptive use of the Bell Bend Project will have no appreciable effect on the condition for SMB spawning, fry emergence, rearing, and nursery.

***APPENDIX 5A***

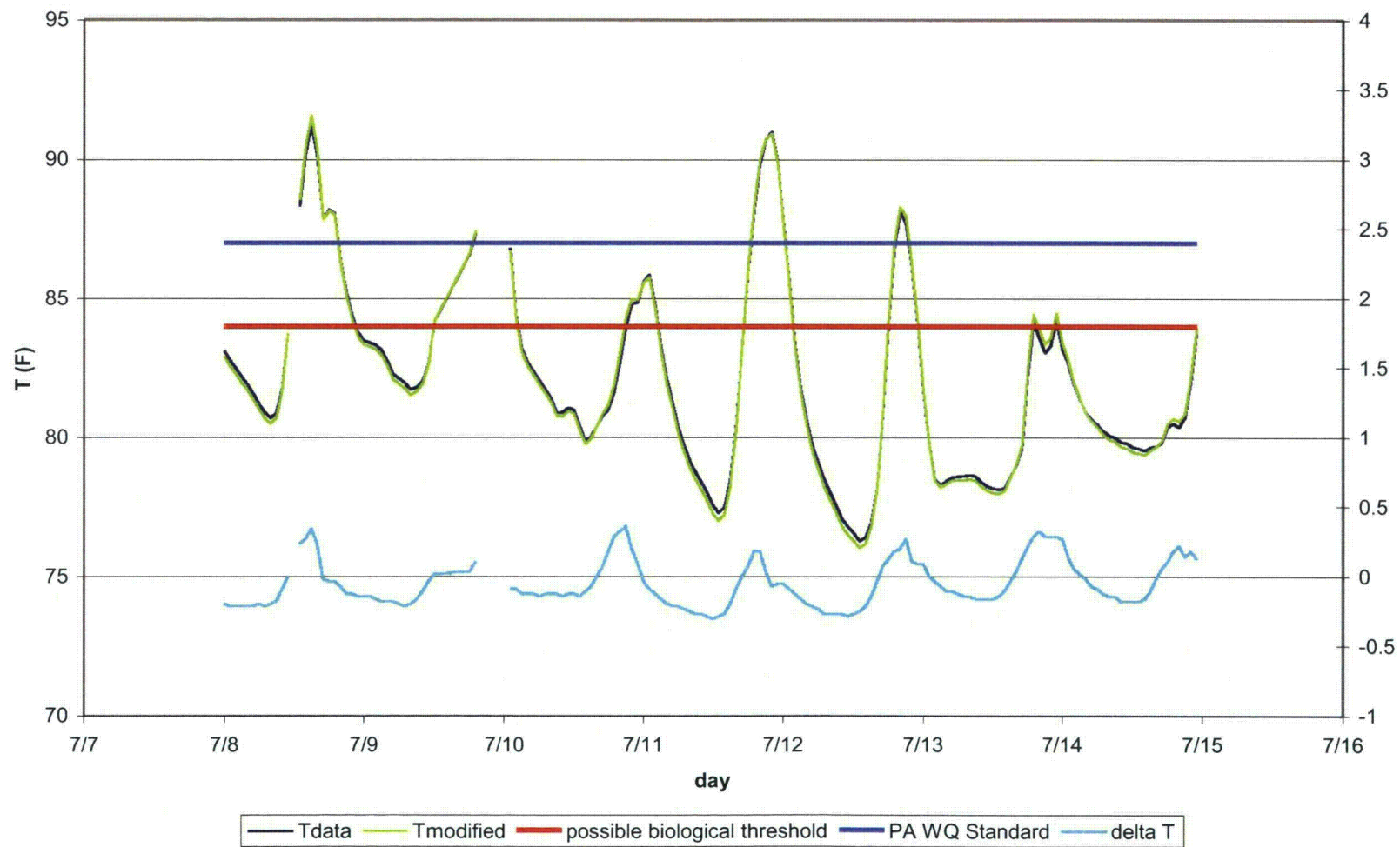
***APPENDIX 5B***

***APPENDIX 5C***

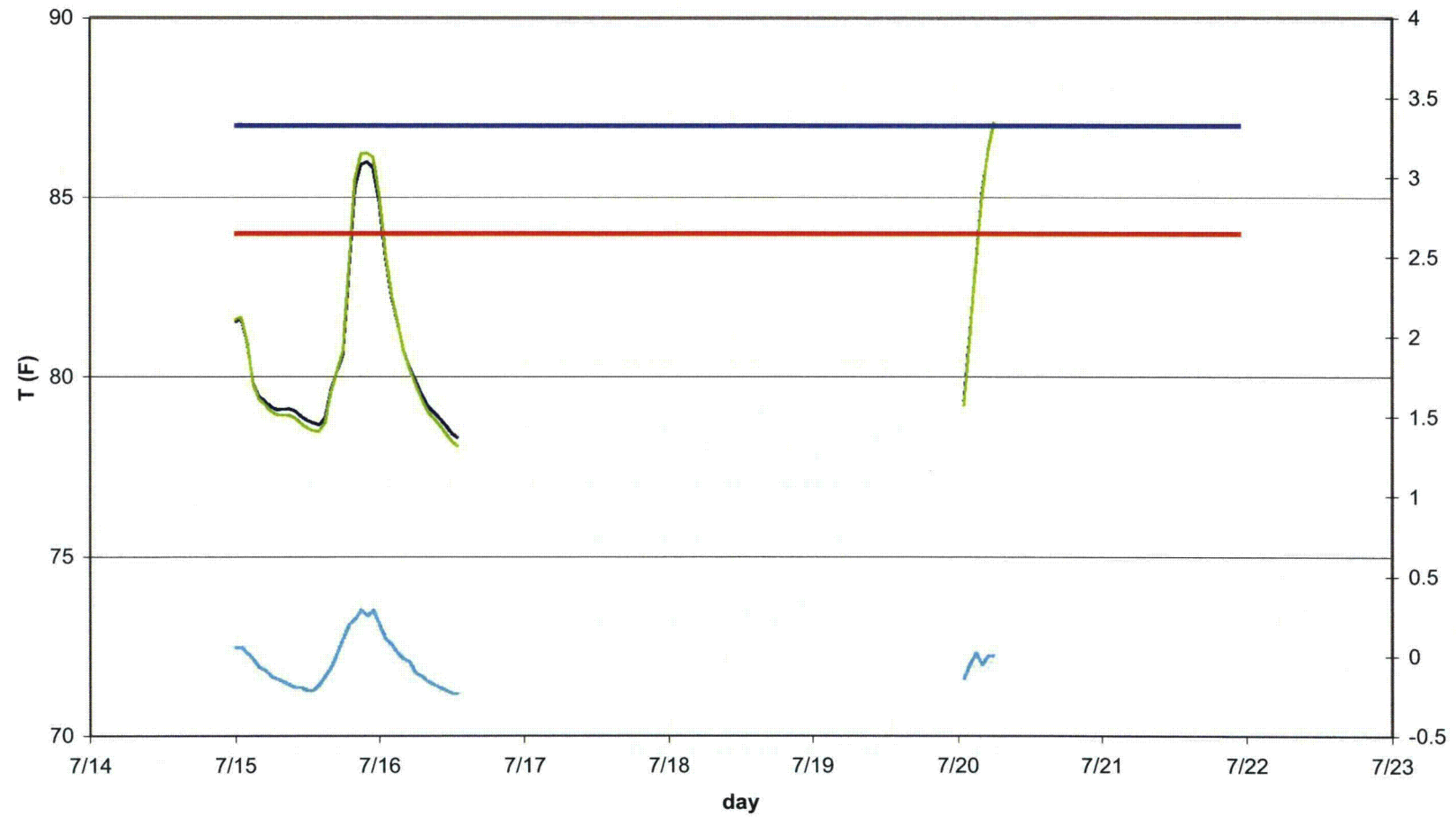
***APPENDIX 5C. THERMAL RESPONSE DATA - GRAPHIC***



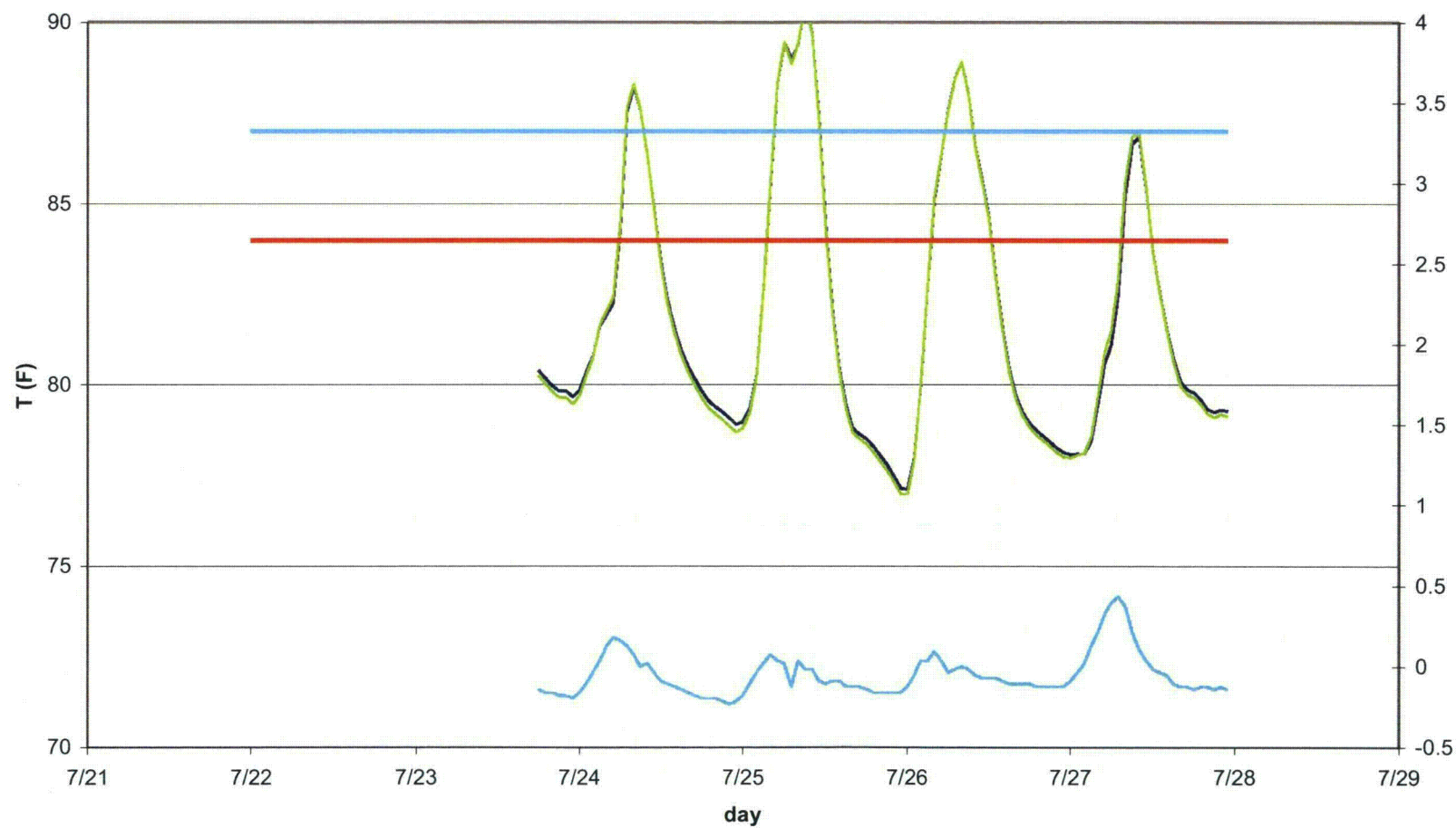
### Sonde 1 Goose Island (shallow)



### Sonde 1 Goose Island (shallow)

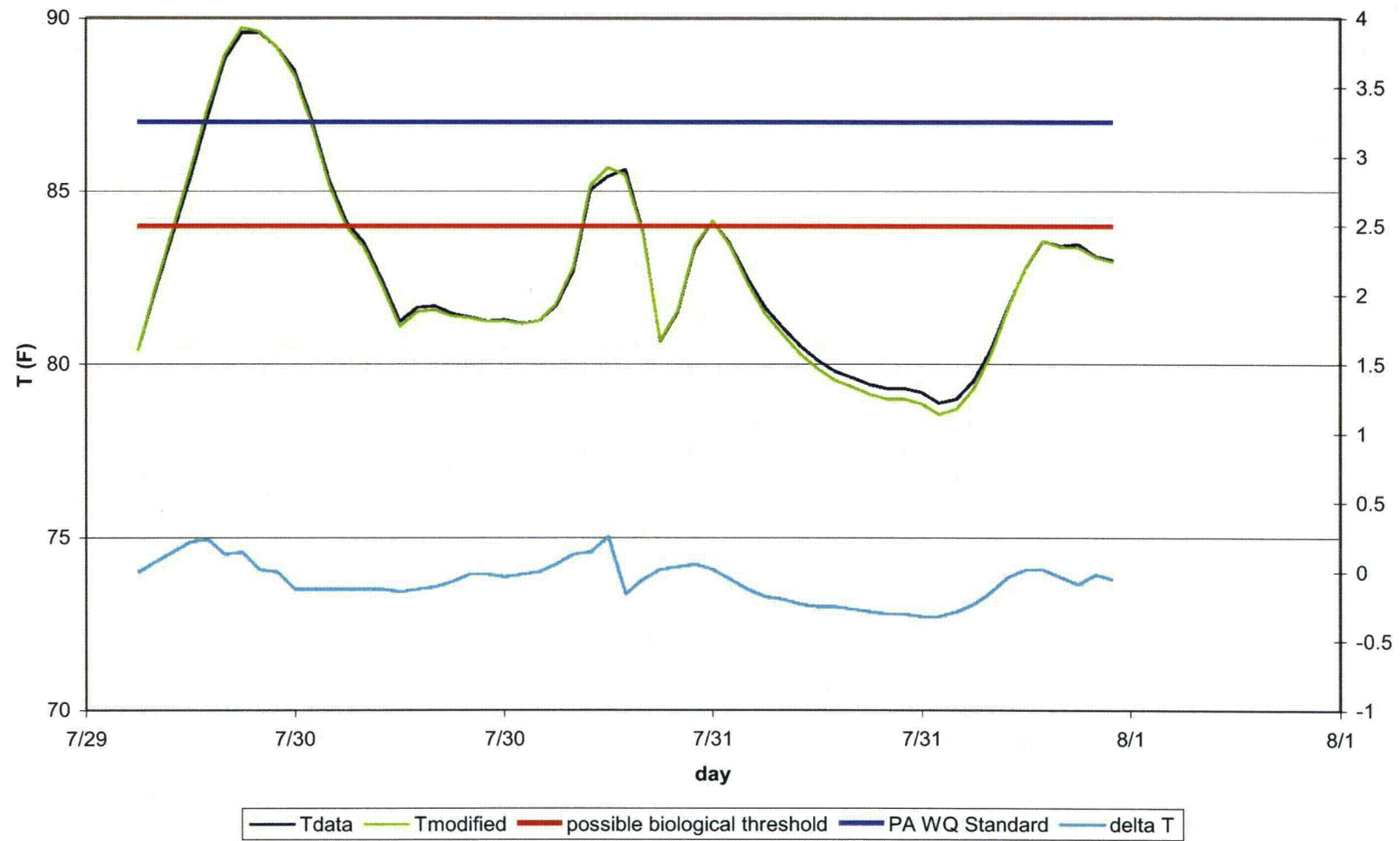


### Sonde 1 Goose Island (shallow)

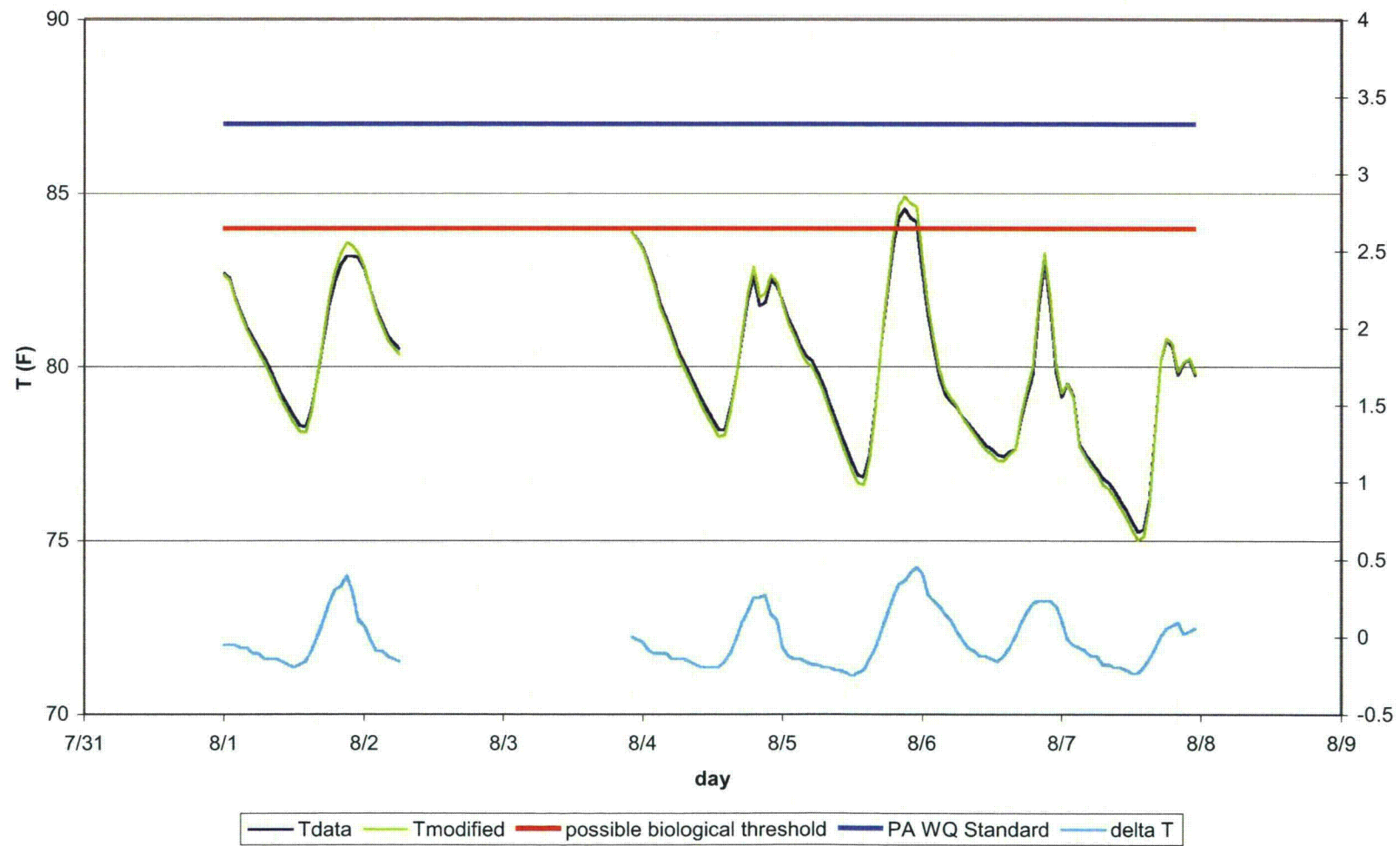


— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

### Sonde 1 Goose Island (shallow)

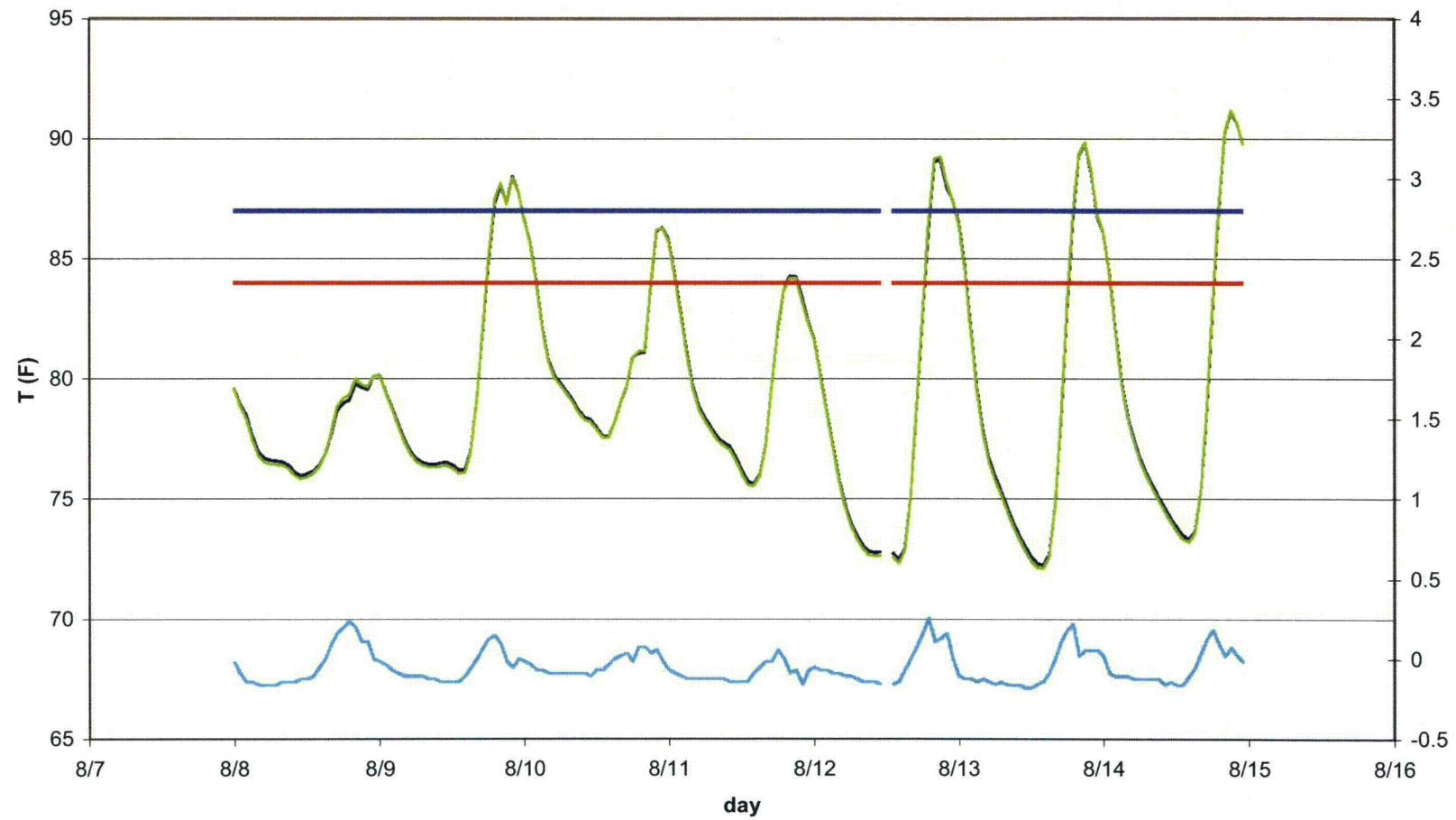


### Sonde 1 Goose Island (shallow)



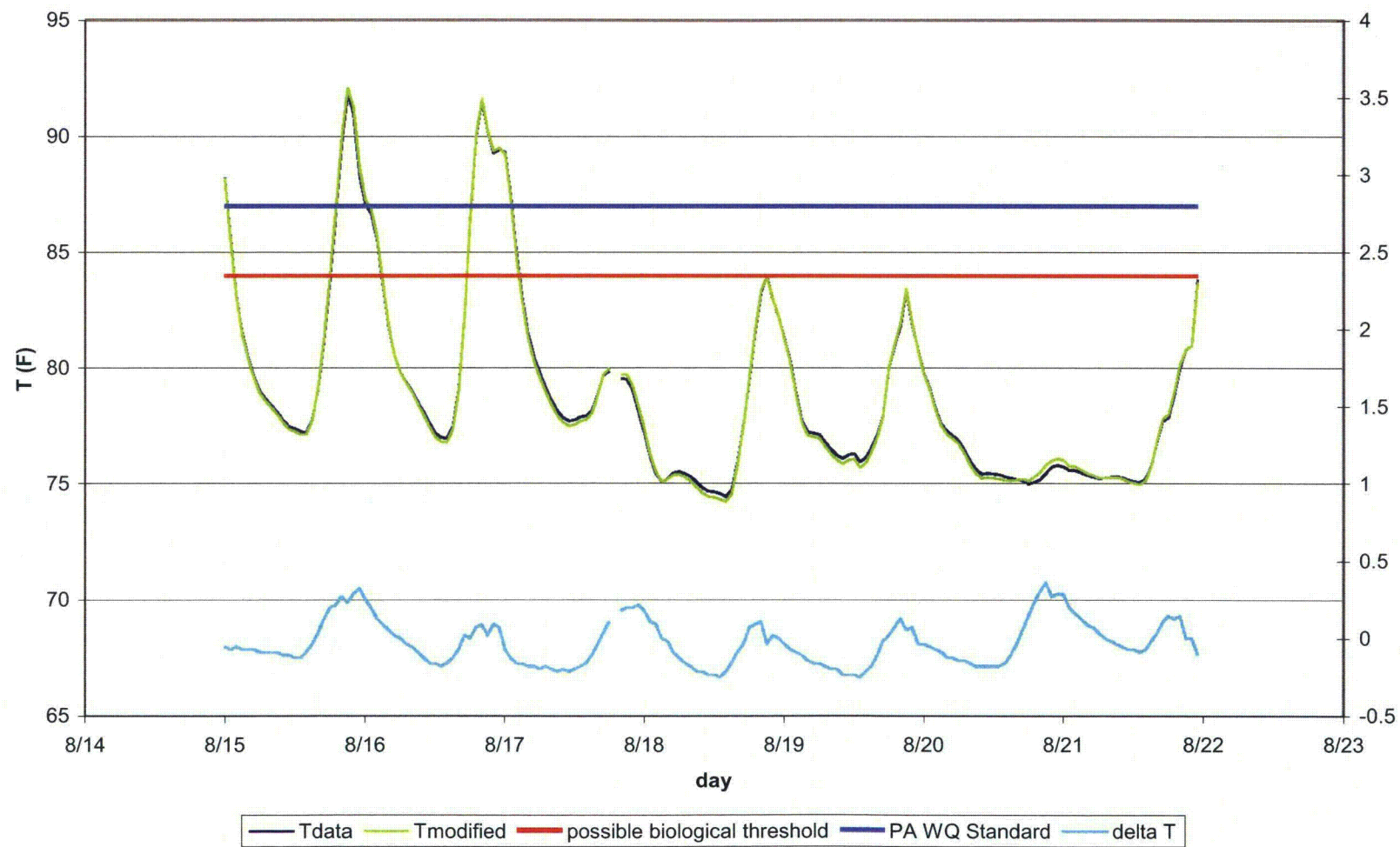


### Sonde 1 Goose Island (shallow)

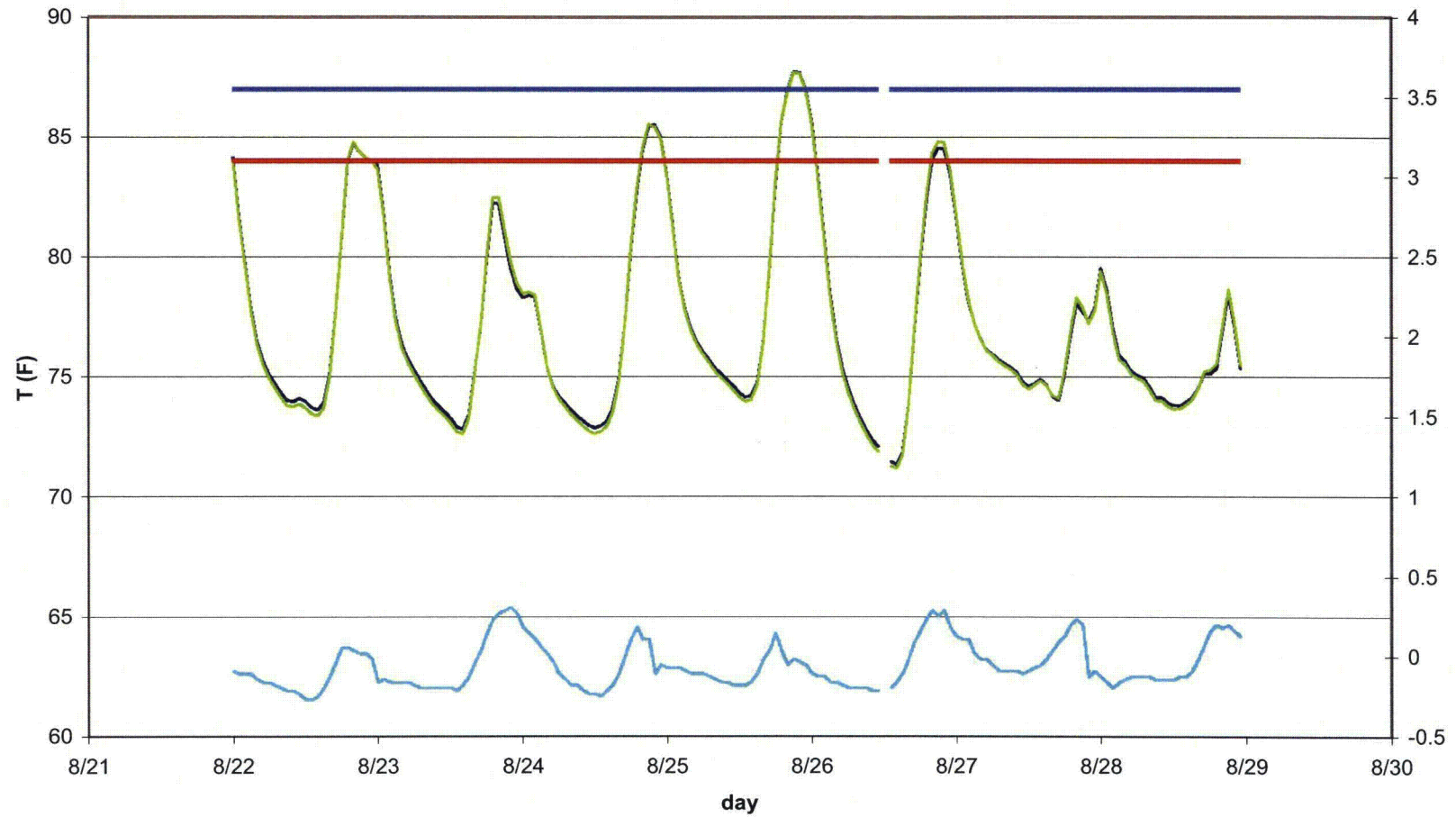


— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

### Sonde 1 Goose Island (shallow)

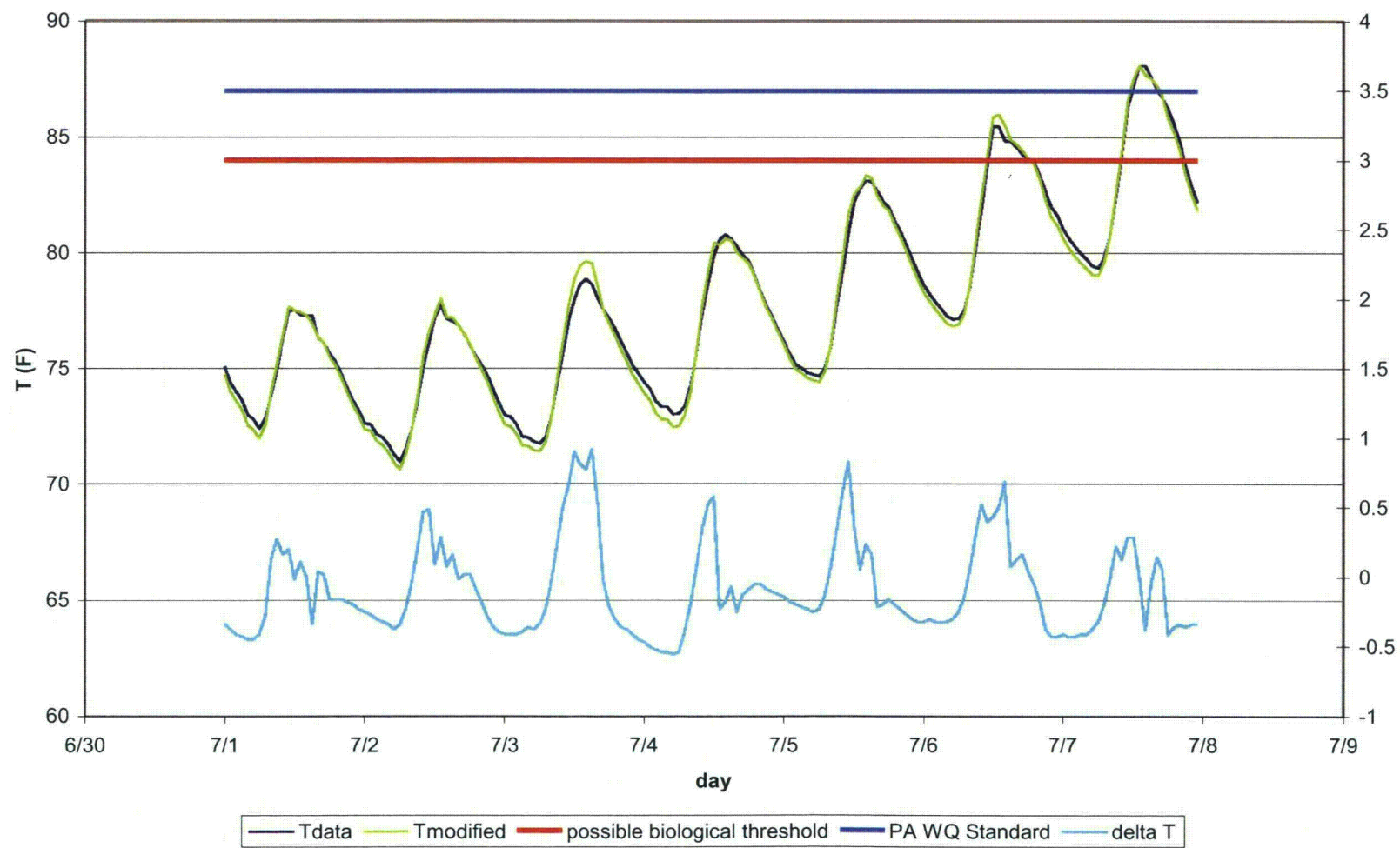


### Sonde 1 Goose Island (shallow)

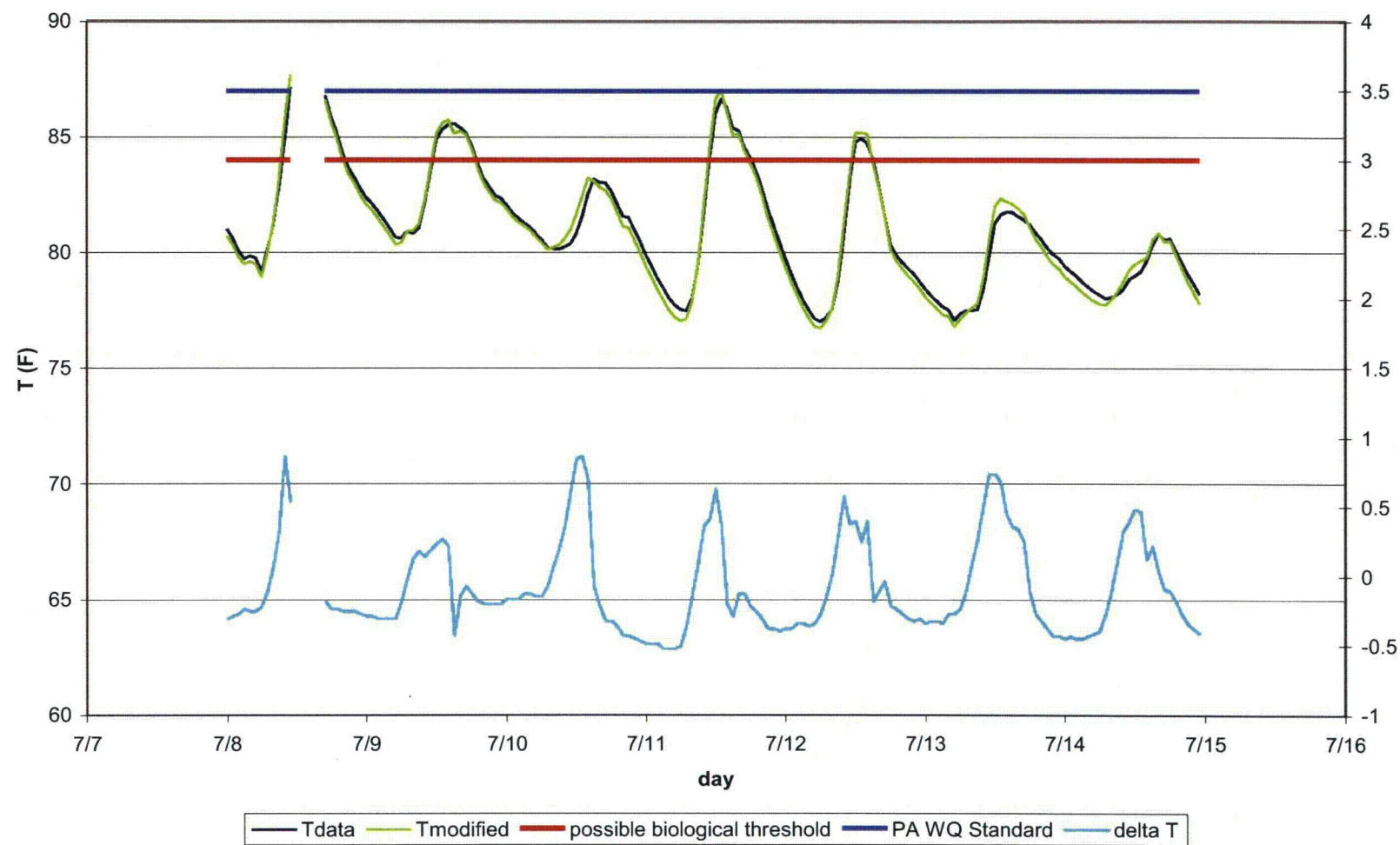


— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

### Sonde 3 Environmental lab (shallow)

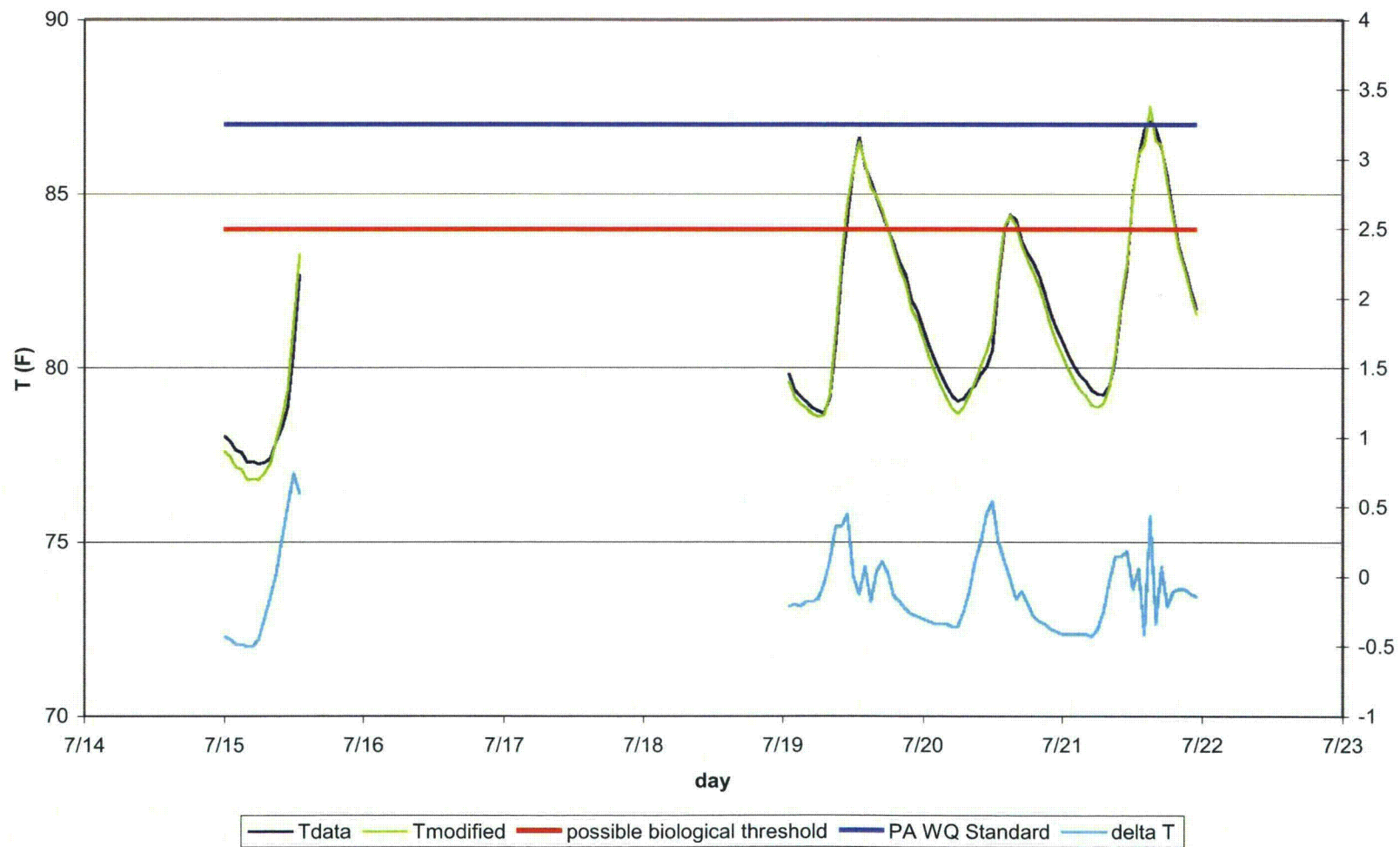


### Sonde 3 Environmental lab (shallow)



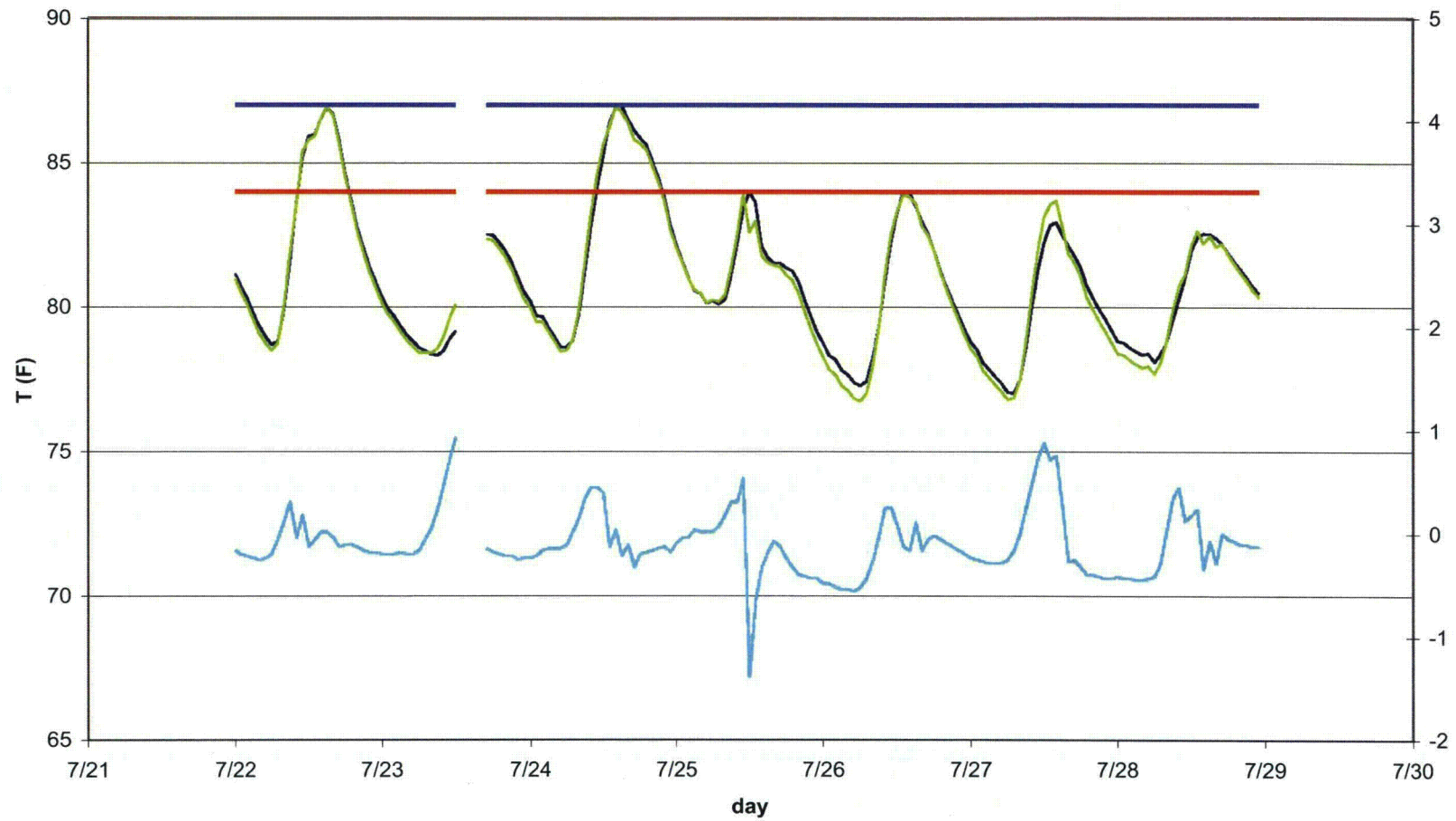


### Sonde 3 Environmental lab (shallow)



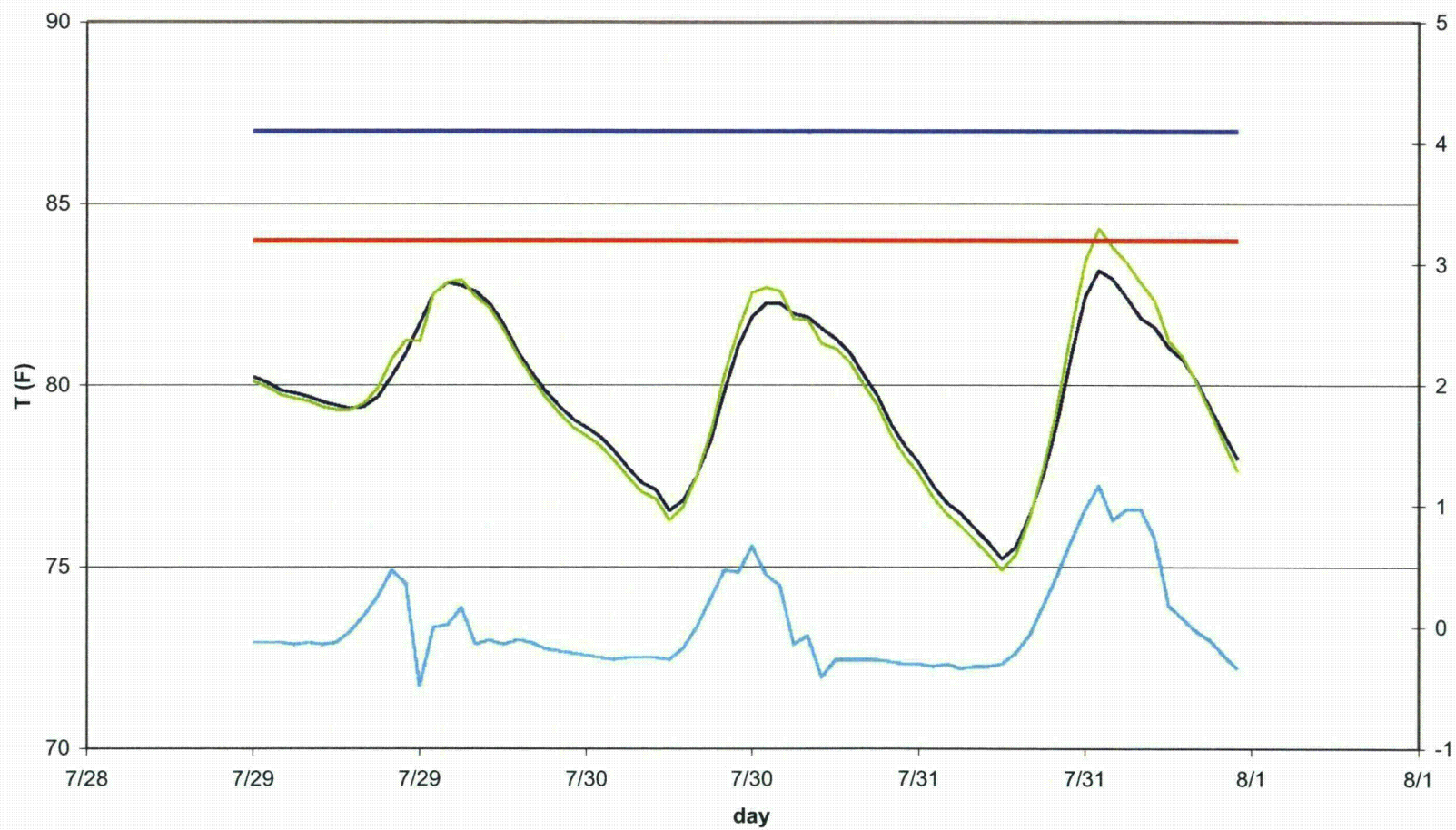


### Sonde 3 Environmental lab (shallow)



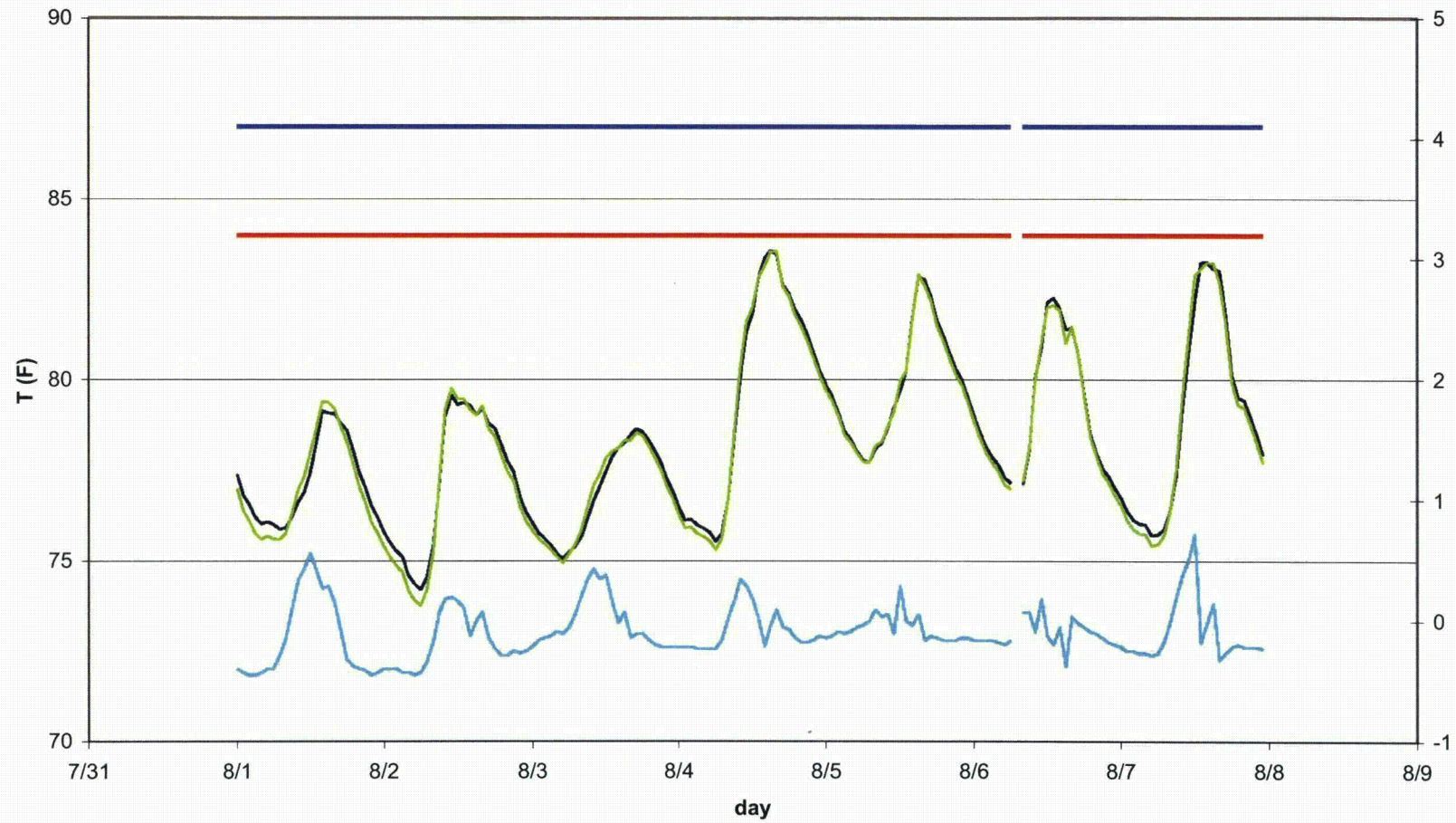
— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

### Sonde 3 Environmental lab (shallow)

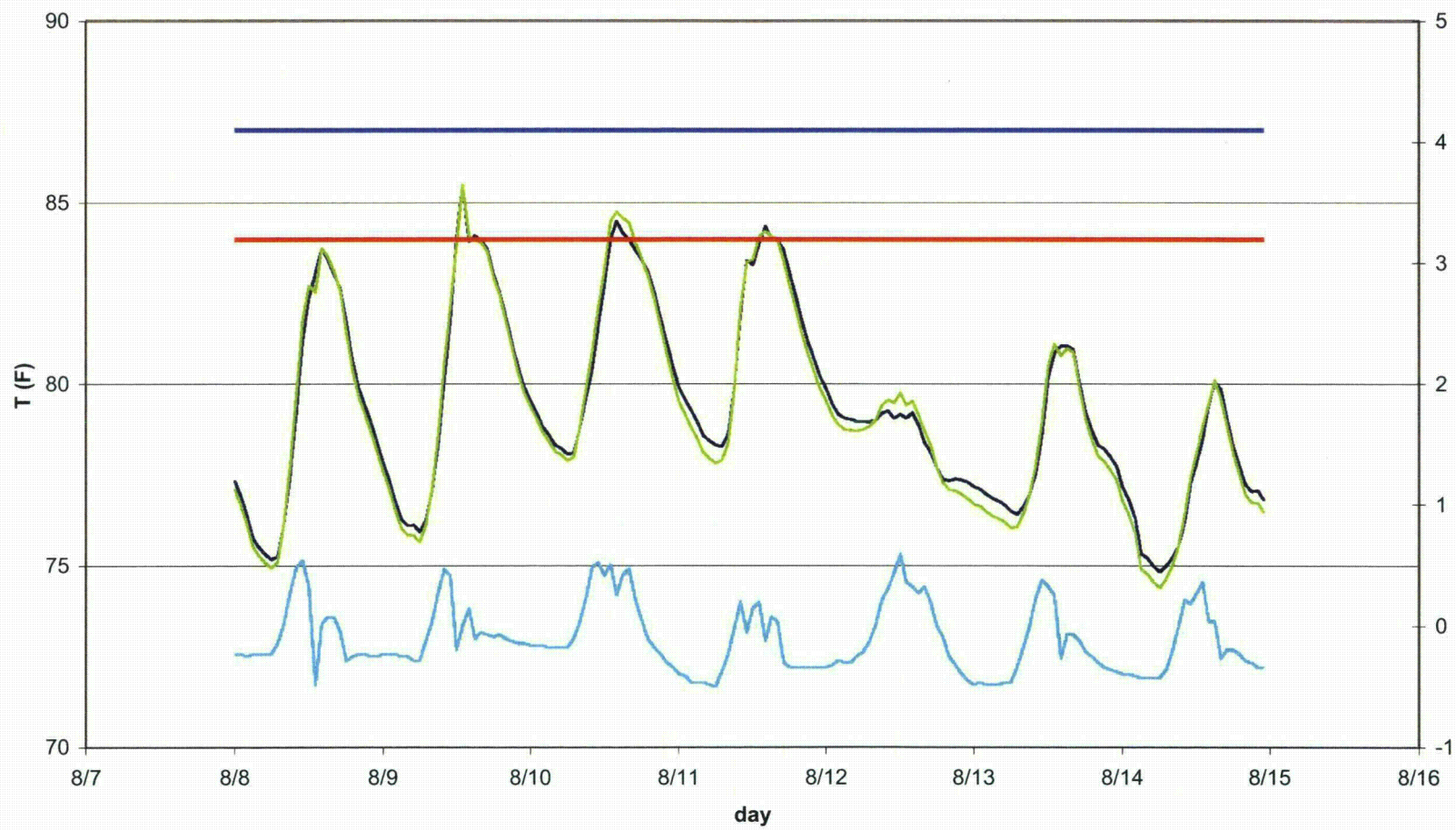


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### Sonde 3 Environmental lab (shallow)



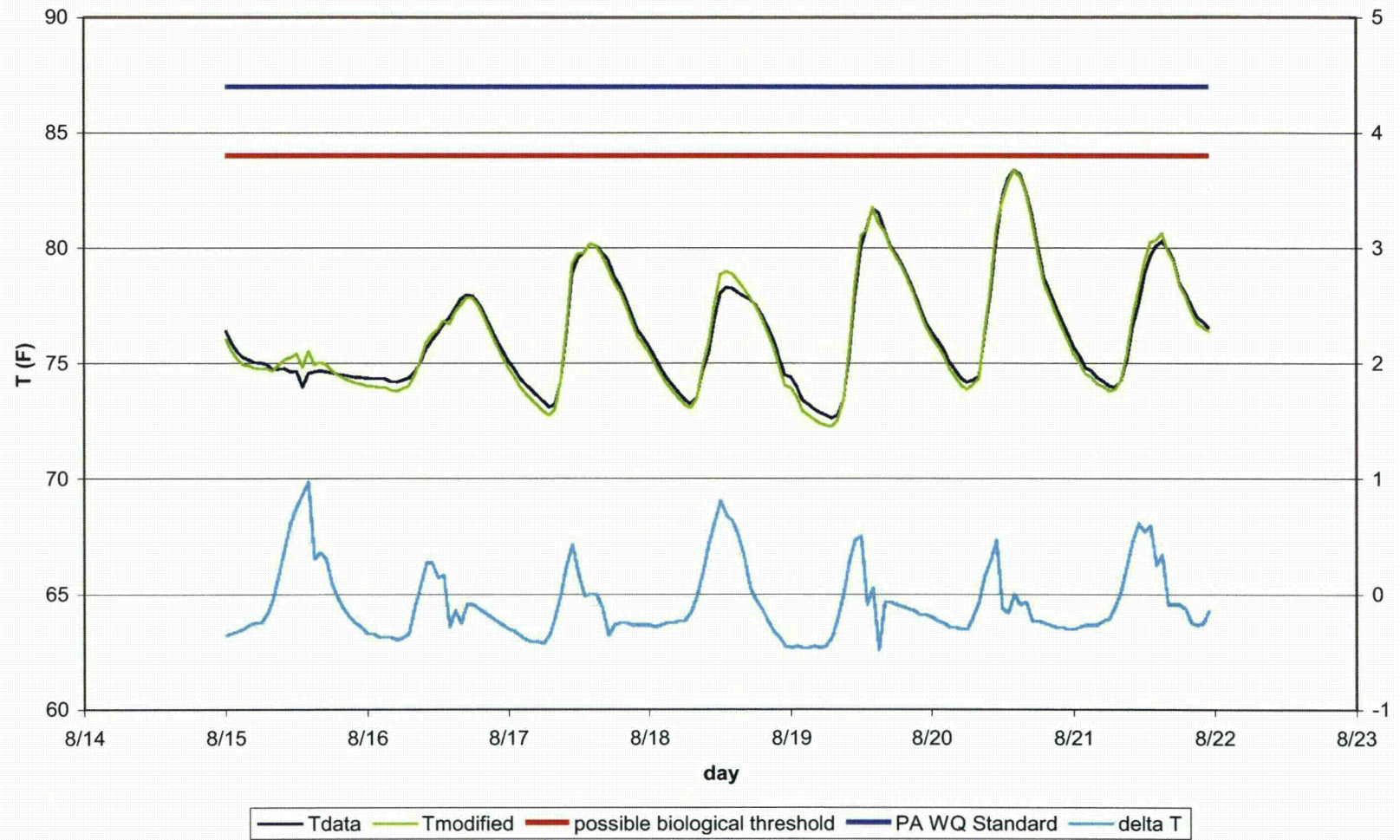
### Sonde 3 Environmental lab (shallow)



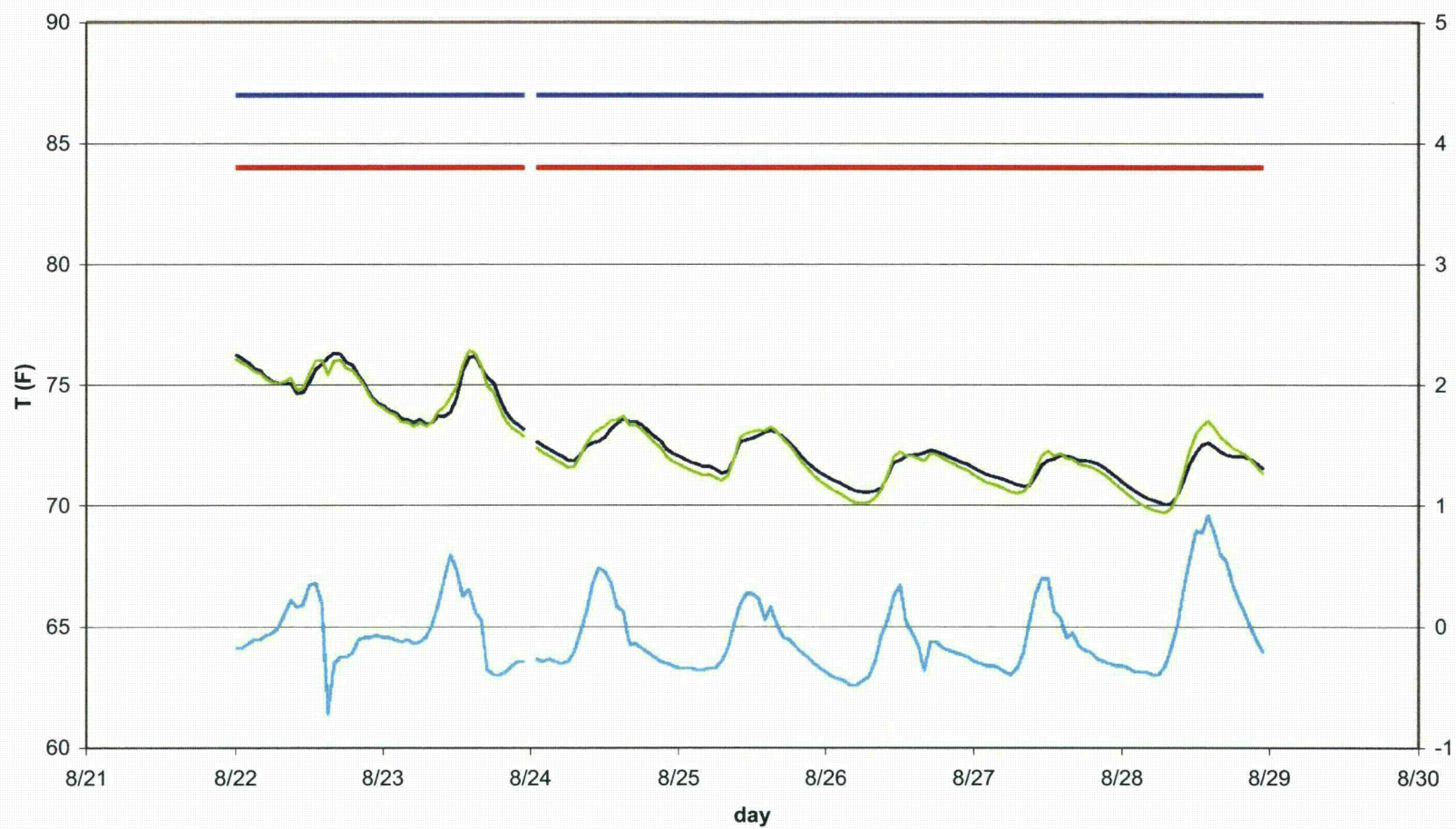
— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T



### Sonde 3 Environmental lab (shallow)



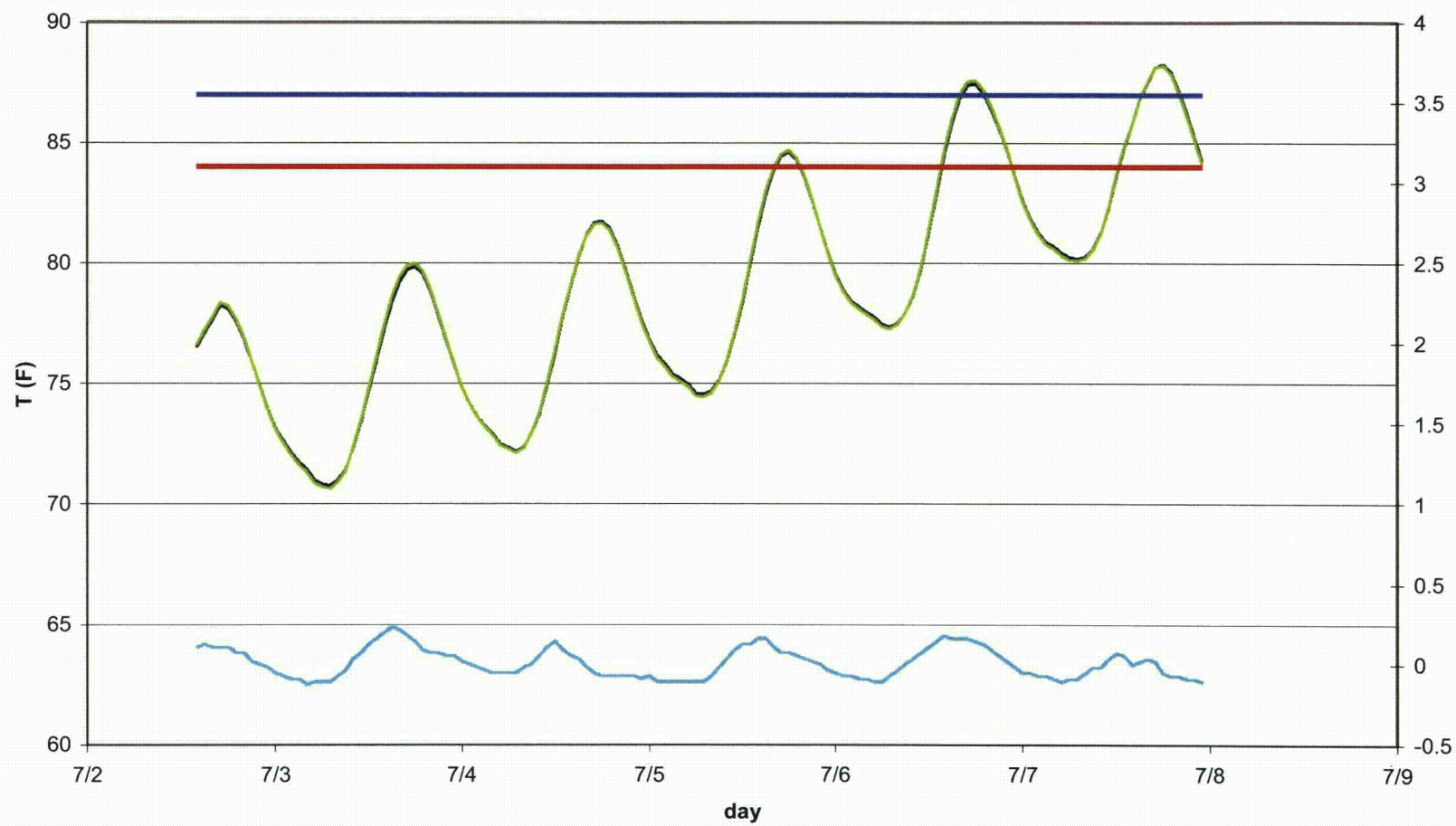
### Sonde 3 Environmental lab (shallow)



— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

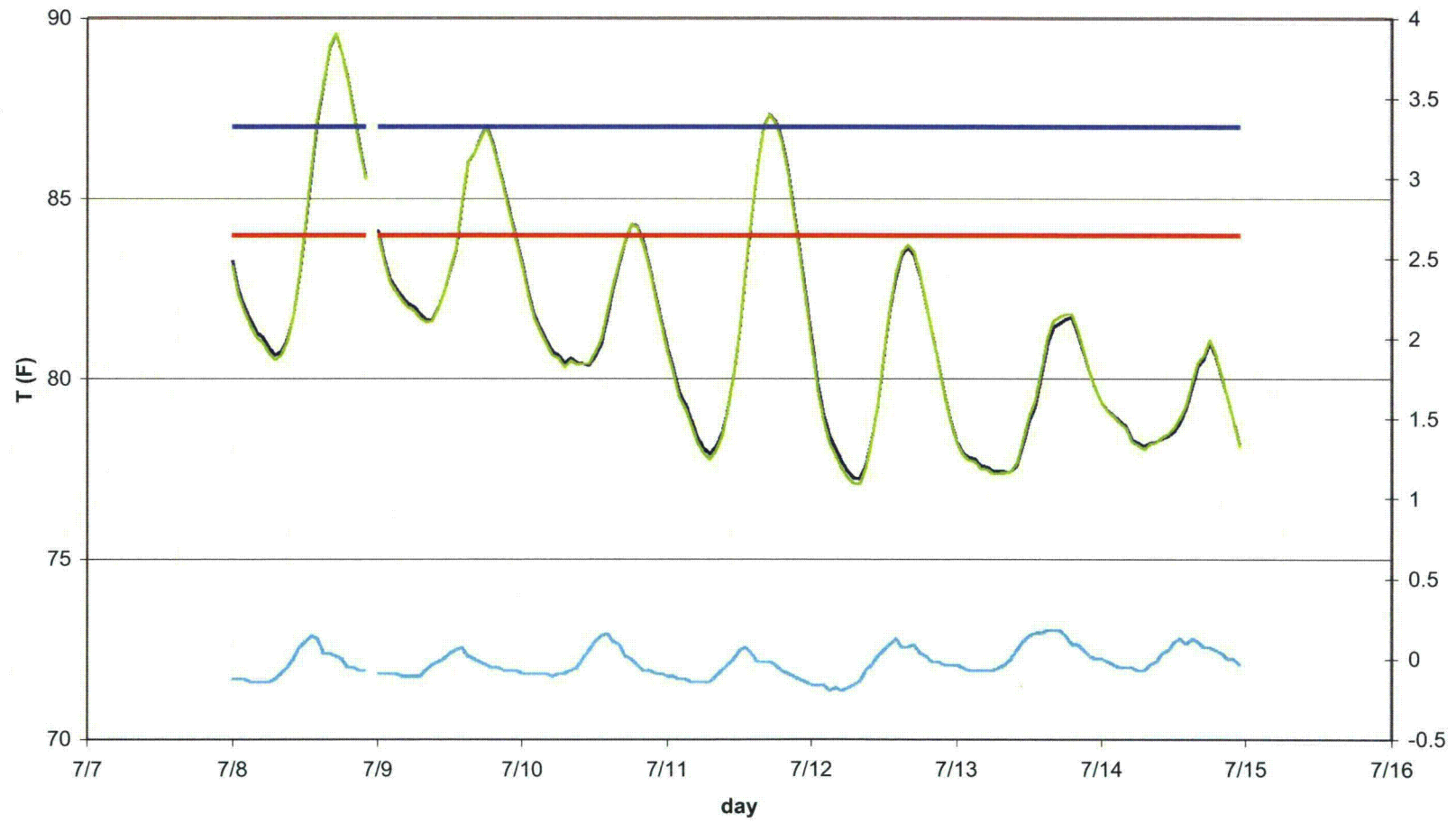


Sonde 6 Test Track (shallow)



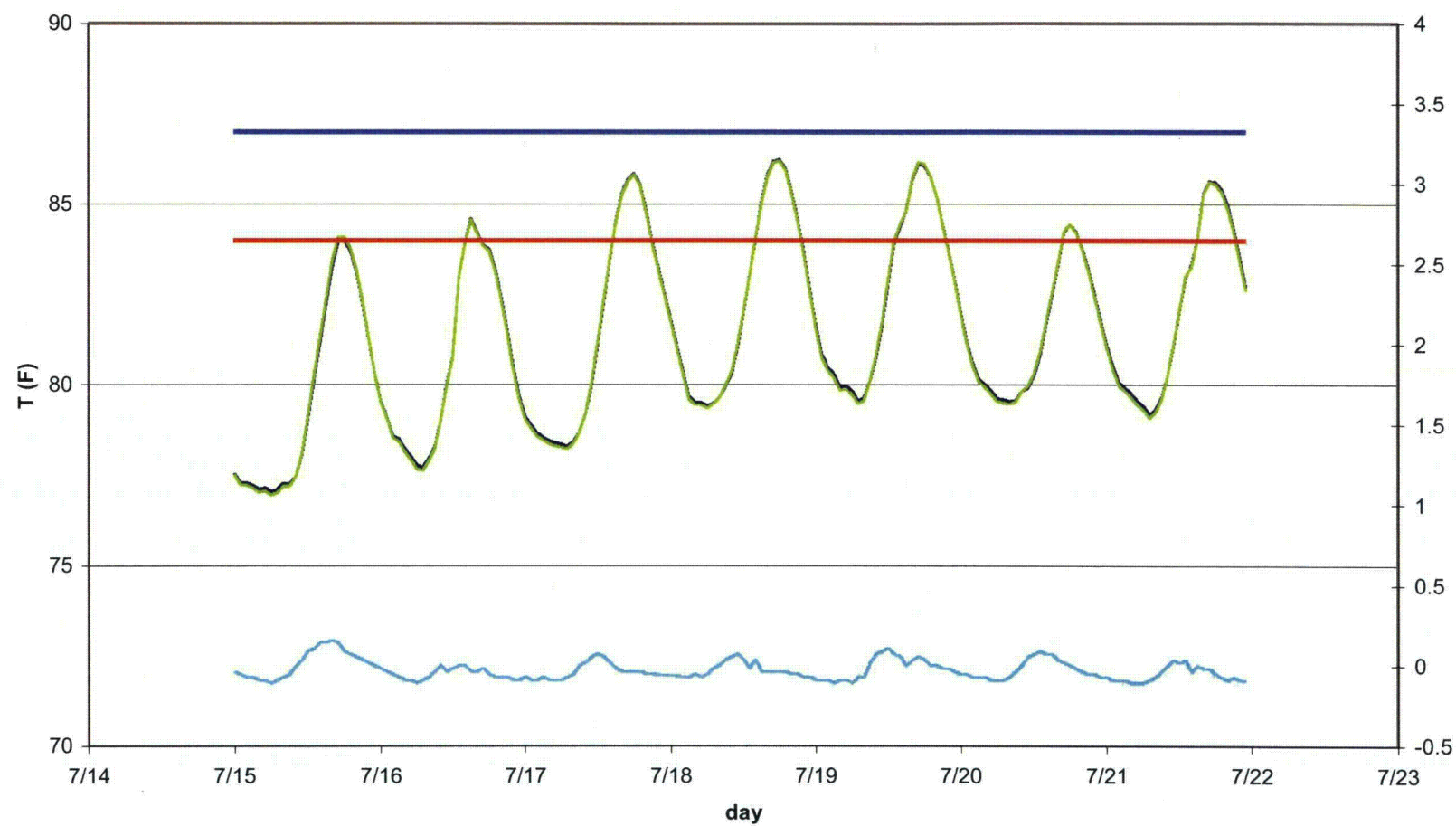
— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

Sonde 6 Test Track (shallow)



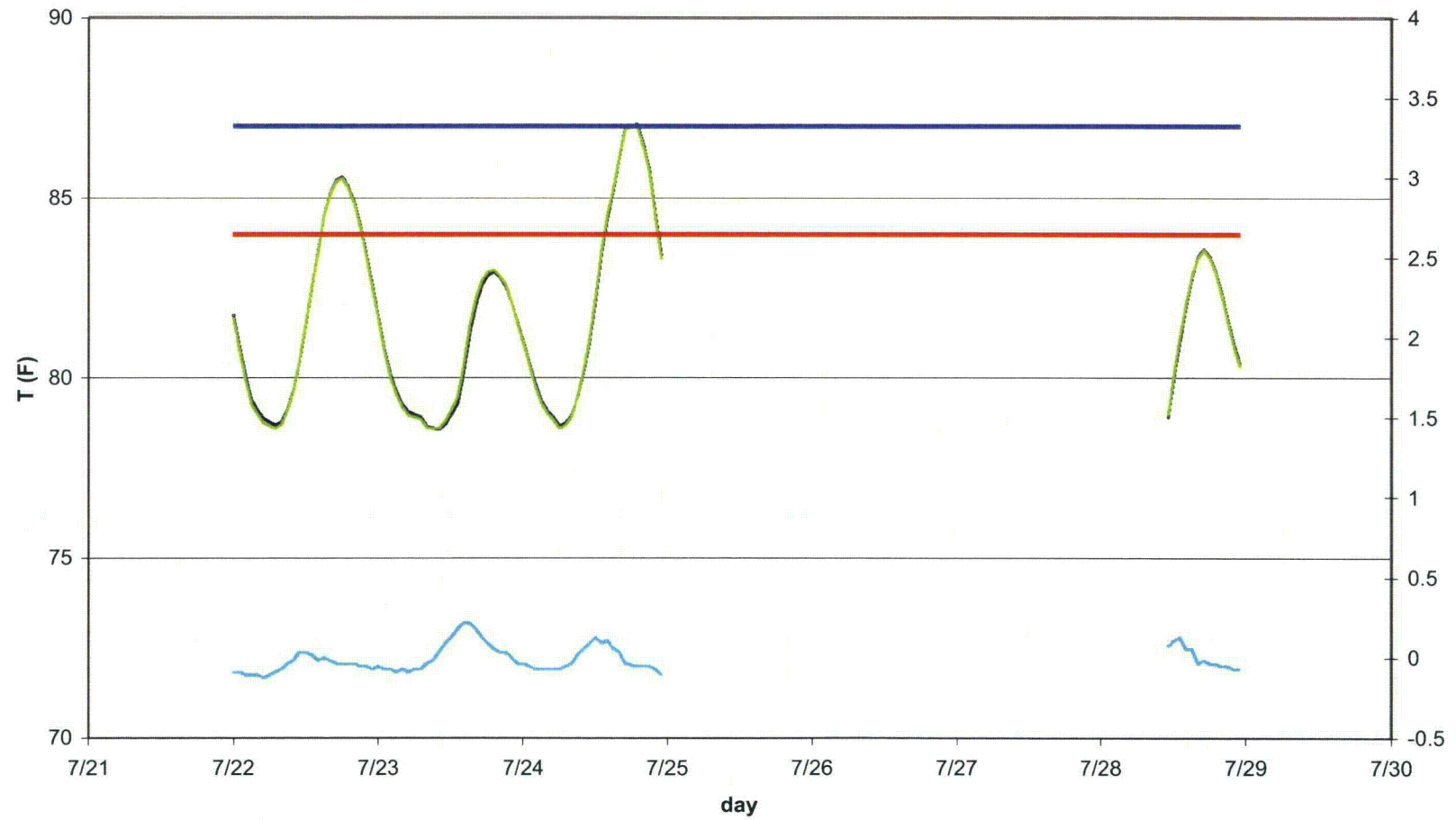
Tdata Tmodified possible biological threshold PA WQ Standard delta T

Sonde 6 Test Track (shallow)

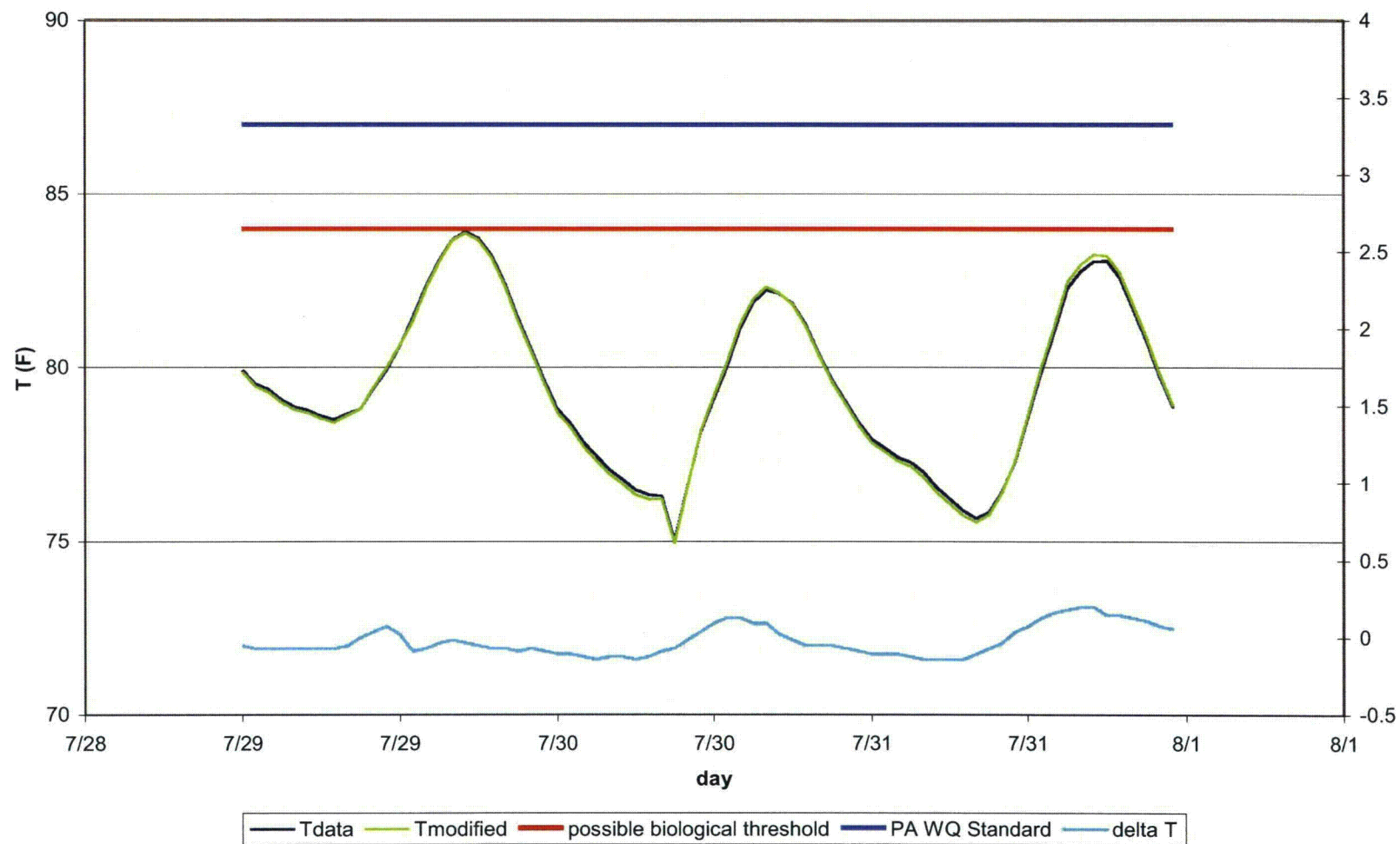


— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

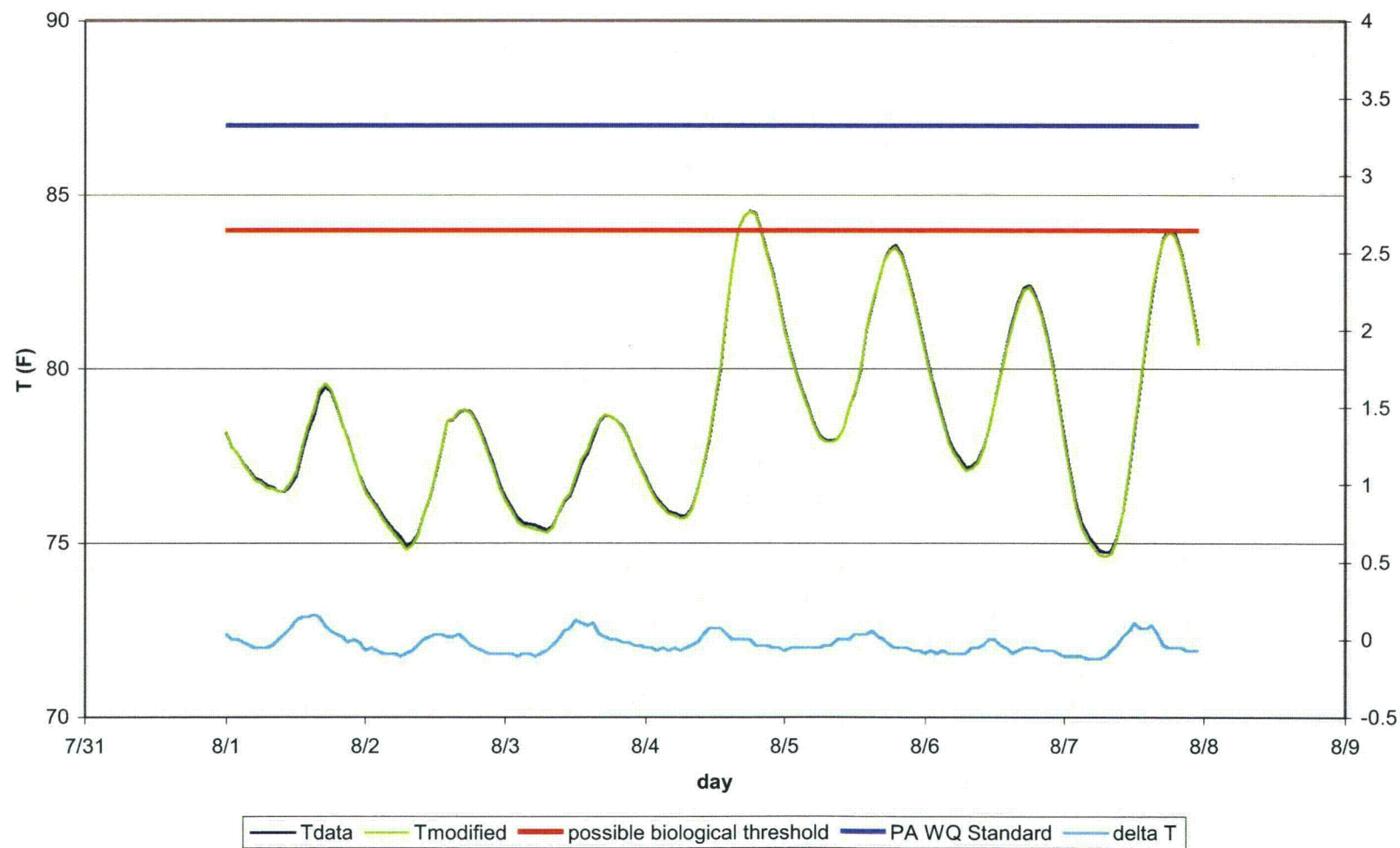
Sonde 6 Test Track (shallow)



Sonde 6 Test Track (shallow)

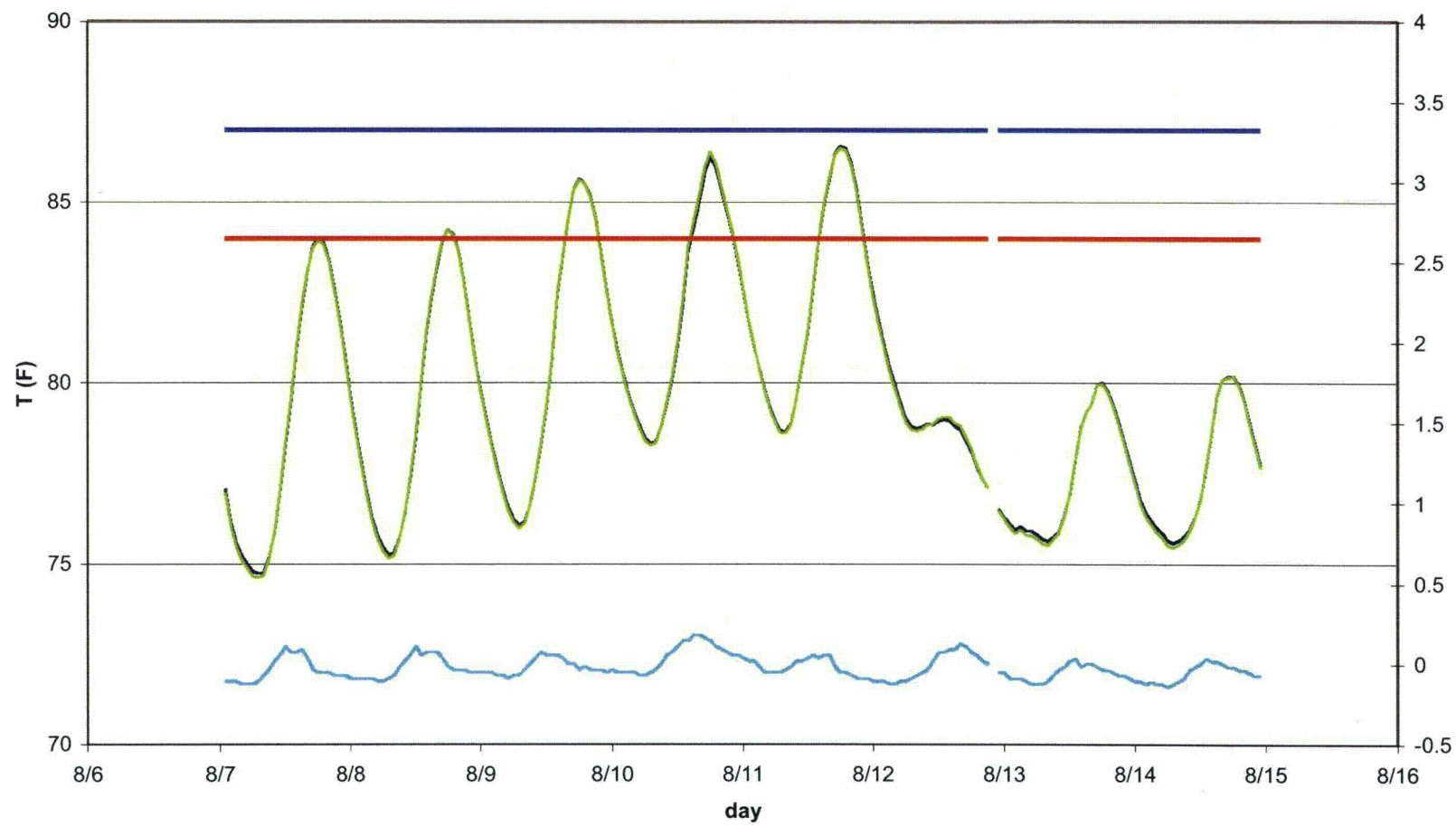


### Sonde 6 Test Track (shallow)



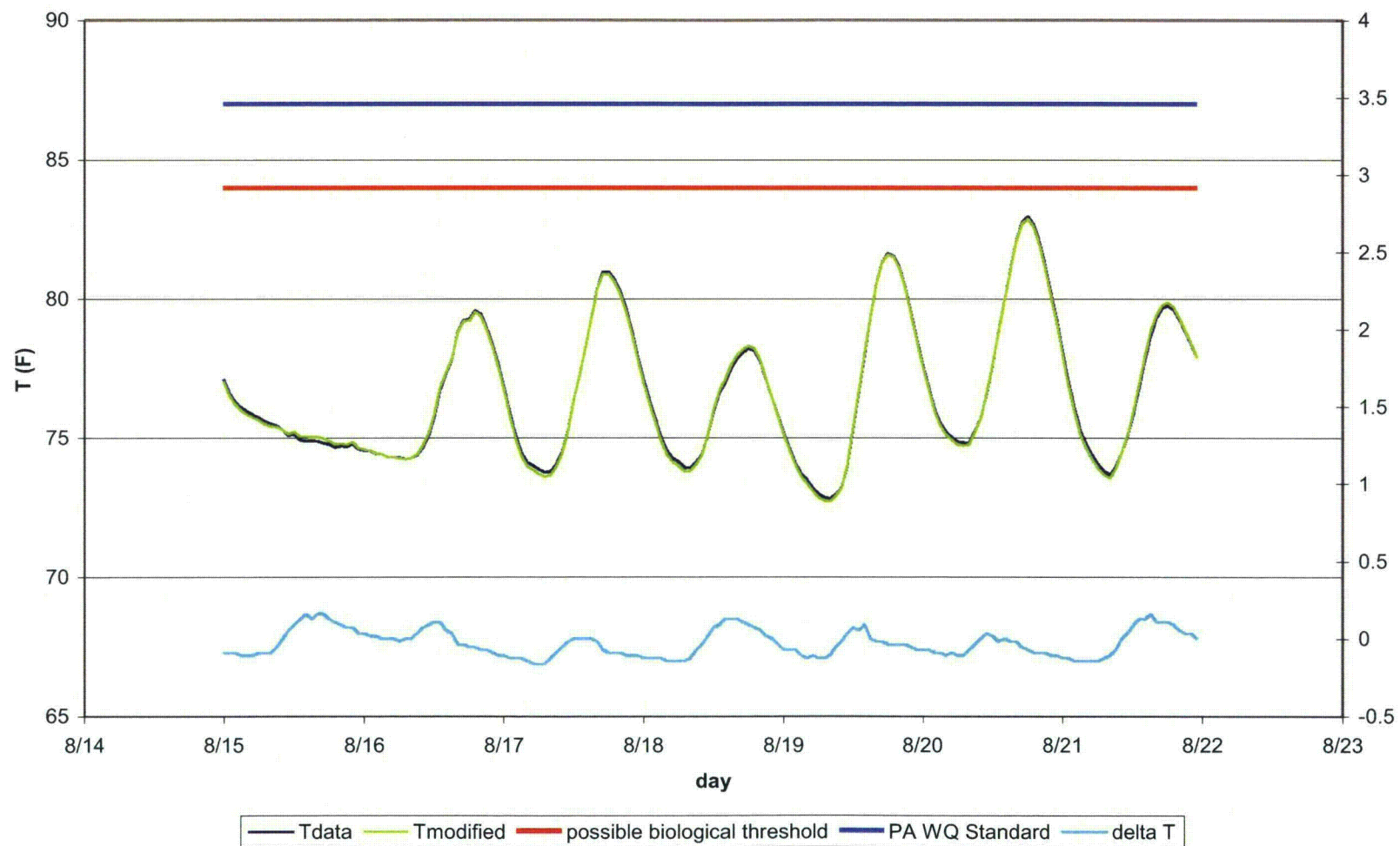


### Sonde 6 Test Track (shallow)

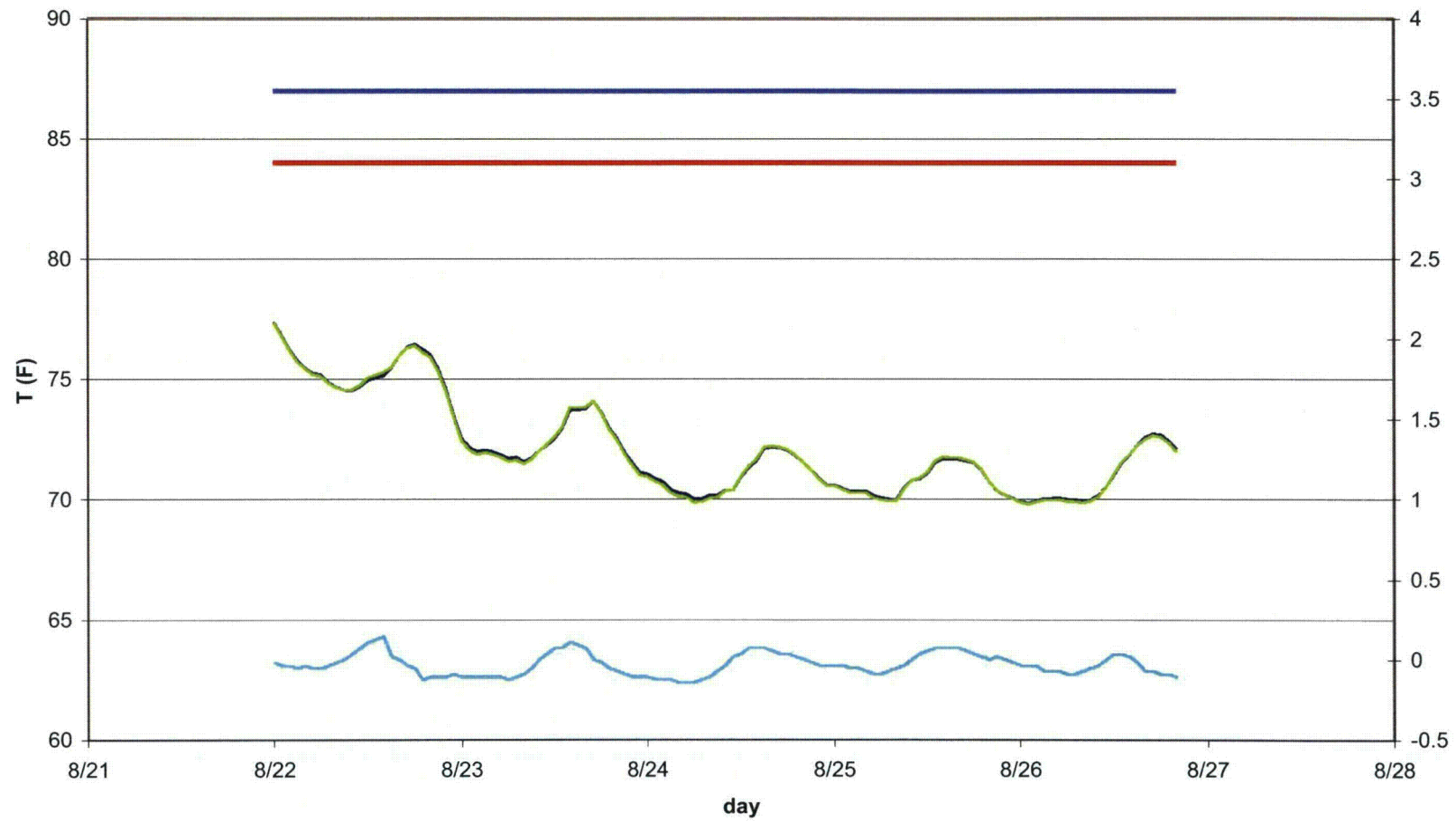


— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

### Sonde 6 Test Track (shallow)



### Sonde 6 Test Track (shallow)



— Tdata — Tmodified — possible biological threshold — PA WQ Standard — delta T

***APPENDIX 5B. THERMAL RESPONSE DATA - TABULAR***

**Sonde 1 Goose Island (shallow)**

Day	Tdata (F)	Tmodified (F)	delta T (F)
6/23/10 15:00	81.10	81.19	0.09
6/23/10 16:00	80.04	80.13	0.09
6/23/10 17:00	80.17	80.17	0
6/23/10 18:00	80.08	80.06	-0.018
6/23/10 19:00	79.72	79.65	-0.072
6/23/10 20:00	79.36	79.27	-0.09
6/23/10 21:00	79.11	78.98	-0.126
6/23/10 22:00	78.91	78.78	-0.126
6/23/10 23:00	78.80	78.66	-0.144
6/24/10 0:00	78.66	78.49	-0.162
6/24/10 1:00	78.49	78.31	-0.18
6/24/10 2:00	78.22	78.06	-0.162
6/24/10 3:00	78.08	77.92	-0.162
6/24/10 4:00	77.90	77.76	-0.144
6/24/10 5:00	77.76	77.61	-0.144
6/24/10 6:00	77.65	77.52	-0.126
6/24/10 7:00	77.65	77.59	-0.054
6/24/10 8:00	77.90	77.92	0.018
6/24/10 9:00	78.12	78.22	0.108
6/24/10 10:00	78.58	78.71	0.126
6/24/10 11:00	79.56	79.61	0.054
6/24/10 12:00	79.16	79.25	0.09
6/24/10 13:00	78.51	78.55	0.036
6/24/10 14:00	79.18	79.16	-0.018
6/24/10 15:00	79.34	79.25	-0.09
6/24/10 16:00	80.35	80.29	-0.054
6/24/10 17:00	79.99	79.95	-0.036
6/24/10 18:00	79.74	79.68	-0.054
6/24/10 19:00	79.48	79.39	-0.09
6/24/10 20:00	79.21	79.11	-0.108
6/24/10 21:00	79.00	78.91	-0.09
6/24/10 22:00	79.07	79.00	-0.072
6/24/10 23:00	79.02	78.93	-0.09
6/25/10 0:00	78.93	78.84	-0.09
6/25/10 1:00	78.75	78.64	-0.108
6/25/10 2:00	78.48	78.37	-0.108
6/25/10 3:00	78.22	78.12	-0.108
6/25/10 4:00	77.99	77.86	-0.126
6/25/10 5:00	77.90	77.77	-0.126
6/25/10 6:00	77.65	77.52	-0.126
6/25/10 7:00	77.70	77.61	-0.09
6/25/10 8:00	78.06	78.04	-0.018
6/25/10 9:00	78.69	78.75	0.054
6/25/10 10:00	79.23	79.36	0.126
6/25/10 11:00	79.88	80.01	0.126

6/25/10 12:00	80.26	80.49	0.234
6/25/10 13:00	80.65	80.96	0.306
6/25/10 14:00	81.34	81.70	0.36
6/25/10 15:00	81.30	81.57	0.27
6/25/10 16:00	81.39	81.54	0.144
6/25/10 17:00	80.96	81.09	0.126
6/25/10 18:00	80.74	80.82	0.072
6/25/10 19:00	80.19	80.20	0.018
6/25/10 20:00	79.86	79.84	-0.018
6/25/10 21:00	79.77	79.70	-0.072
6/25/10 22:00	79.70	79.59	-0.108
6/25/10 23:00	79.43	79.29	-0.144
6/26/10 0:00	79.21	79.05	-0.162
6/26/10 1:00	78.91	78.73	-0.18
6/26/10 2:00	78.62	78.42	-0.198
6/26/10 3:00	78.37	78.17	-0.198
6/26/10 4:00	78.13	77.90	-0.234
6/26/10 5:00	77.92	77.67	-0.252
6/26/10 6:00	77.67	77.43	-0.234
6/26/10 7:00	77.65	77.43	-0.216
6/26/10 8:00	78.19	78.04	-0.144
6/26/10 9:00	78.96	78.91	-0.054
6/26/10 10:00	79.68	79.72	0.036
6/26/10 11:00	80.51	80.60	0.09
6/26/10 12:00	81.09	81.28	0.198
6/26/10 13:00	81.55	81.61	0.054
6/26/10 14:00	81.21	81.27	0.054
6/26/10 15:00	81.32	81.36	0.036
6/26/10 16:00	81.12	81.18	0.054
6/26/10 17:00	80.82	80.89	0.072
6/26/10 18:00	80.87	80.92	0.054
6/26/10 19:00	80.51	80.53	0.018
6/26/10 20:00	80.26	80.24	-0.018
6/26/10 21:00	80.06	80.01	-0.054
6/26/10 22:00	79.86	79.75	-0.108
6/26/10 23:00	79.54	79.38	-0.162
6/27/10 0:00	79.32	79.16	-0.162
6/27/10 1:00	79.03	78.85	-0.18
6/27/10 2:00	78.80	78.58	-0.216
6/27/10 3:00	78.55	78.33	-0.216
6/27/10 4:00	78.37	78.15	-0.216
6/27/10 5:00	78.28	78.04	-0.234
6/27/10 6:00	78.21	77.99	-0.216
6/27/10 7:00	77.90	77.72	-0.18
6/27/10 8:00	78.22	78.10	-0.126
6/27/10 9:00	78.93	78.91	-0.018
6/27/10 10:00	79.30	79.39	0.09
6/27/10 11:00	80.83	81.01	0.18



6/27/10 12:00	81.32	81.45	0.126
6/27/10 13:00	81.99	82.08	0.09
6/27/10 14:00	82.17	82.24	0.072
6/27/10 15:00	82.76	82.78	0.018
6/27/10 16:00	83.05	83.01	-0.036
6/27/10 17:00	82.24	82.22	-0.018
6/27/10 18:00	81.95	81.86	-0.09
6/27/10 19:00	81.45	81.37	-0.072
6/27/10 20:00	81.09	81.00	-0.09
6/27/10 21:00	80.80	80.69	-0.108
6/27/10 22:00	80.67	80.56	-0.108
6/27/10 23:00	80.65	80.55	-0.108
6/28/10 0:00	80.42	80.31	-0.108
6/28/10 1:00	80.40	80.33	-0.072
6/28/10 2:00	79.86	79.81	-0.054
6/28/10 3:00	79.90	79.84	-0.054
6/28/10 4:00	79.74	79.70	-0.036
6/28/10 5:00	79.63	79.59	-0.036
6/28/10 6:00	79.61	79.61	0
6/28/10 7:00	79.77	79.81	0.036
6/28/10 8:00	79.86	79.92	0.054
6/28/10 9:00	80.47	80.58	0.108
6/28/10 10:00	80.73	80.85	0.126
6/28/10 11:00	81.48	81.57	0.09
6/28/10 12:00	79.92	80.06	0.144
6/28/10 13:00	80.53	80.71	0.18
6/28/10 14:00	80.01	80.19	0.18
6/28/10 15:00	80.47	80.55	0.072
6/28/10 16:00	81.39	81.39	0
6/28/10 17:00	81.81	81.77	-0.036
6/28/10 18:00	81.14	81.03	-0.108
6/28/10 19:00	80.94	80.83	-0.108
6/28/10 20:00	80.58	80.46	-0.126
6/28/10 21:00	80.15	80.01	-0.144
6/28/10 22:00	79.92	79.79	-0.126
6/28/10 23:00	79.84	79.70	-0.144
6/29/10 0:00	79.79	79.63	-0.162
6/29/10 1:00	79.75	79.59	-0.162
6/29/10 2:00	79.70	79.56	-0.144
6/29/10 3:00	79.56	79.41	-0.144
6/29/10 4:00	79.21	79.05	-0.162
6/29/10 5:00	78.94	78.76	-0.18
6/29/10 6:00	78.66	78.49	-0.162
6/29/10 7:00	78.60	78.48	-0.126
6/29/10 8:00	78.96	78.89	-0.072
6/29/10 9:00	79.03	79.02	-0.018
6/29/10 10:00	80.38	80.28	-0.108
6/29/10 11:00	80.33	80.31	-0.018

6/29/10 12:00	80.71	80.71	0
6/29/10 13:00	80.92	80.94	0.018
6/29/10 14:00	81.48	81.41	-0.072
6/29/10 15:00	81.37	81.28	-0.09
6/29/10 16:00	80.67	80.62	-0.054
6/29/10 17:00	80.58	80.51	-0.072
6/29/10 18:00	80.38	80.24	-0.144
6/29/10 19:00	79.68	79.57	-0.108
6/29/10 20:00	79.16	79.03	-0.126
6/29/10 21:00	79.11	78.98	-0.126
6/29/10 22:00	78.91	78.76	-0.144
6/29/10 23:00	78.60	78.44	-0.162
6/30/10 0:00	78.22	78.04	-0.18
6/30/10 1:00	77.86	77.68	-0.18
6/30/10 2:00	77.45	77.27	-0.18
6/30/10 3:00	76.95	76.77	-0.18
6/30/10 4:00	76.44	76.24	-0.198
6/30/10 5:00	76.01	75.79	-0.216
6/30/10 6:00	75.67	75.47	-0.198
6/30/10 7:00	75.61	75.47	-0.144
6/30/10 8:00	76.26	76.19	-0.072
6/30/10 9:00	76.68	76.66	-0.018
6/30/10 10:00	77.34	77.41	0.072
6/30/10 11:00	78.40	78.57	0.162
6/30/10 12:00	79.05	79.25	0.198
6/30/10 13:00	79.02	79.18	0.162
6/30/10 14:00	79.02	79.05	0.036
6/30/10 15:00	78.89	78.89	0
6/30/10 16:00	78.26	78.26	0
6/30/10 17:00	79.07	79.05	-0.018
6/30/10 18:00	78.48	78.42	-0.054
6/30/10 19:00	77.70	77.61	-0.09
6/30/10 20:00	77.31	77.22	-0.09
6/30/10 21:00	77.23	77.11	-0.126
6/30/10 22:00	77.23	77.11	-0.126
6/30/10 23:00	77.05	76.89	-0.162
7/1/10 0:00	76.82	76.66	-0.162
7/1/10 1:00	76.23	76.05	-0.18
7/1/10 2:00	75.76	75.56	-0.198
7/1/10 3:00	75.38	75.16	-0.216
7/1/10 4:00	75.06	74.82	-0.234
7/1/10 5:00	74.66	74.43	-0.234
7/1/10 6:00	74.35	74.12	-0.234
7/1/10 7:00	74.35	74.16	-0.198
7/1/10 8:00	74.68	74.61	-0.072
7/1/10 9:00	75.40	75.42	0.018
7/1/10 10:00	76.37	76.46	0.09
7/1/10 11:00	76.33	76.44	0.108

7/1/10 12:00	76.42	76.50	0.072
7/1/10 13:00	76.77	76.86	0.09
7/1/10 16:00			
7/1/10 17:00			
7/1/10 18:00	77.25	77.20	-0.054
7/1/10 19:00	77.24	77.21	-0.036
7/1/10 20:00	76.61	76.54	-0.072
7/1/10 21:00	76.14	76.05	-0.09
7/1/10 22:00	75.62	75.52	-0.108
7/1/10 23:00	75.34	75.23	-0.108
7/2/10 0:00	75.08	74.96	-0.126
7/2/10 1:00	74.77	74.62	-0.144
7/2/10 2:00	74.38	74.23	-0.144
7/2/10 3:00	73.97	73.81	-0.162
7/2/10 4:00	73.56	73.40	-0.162
7/2/10 5:00	73.22	73.04	-0.18
7/2/10 6:00	72.94	72.74	-0.198
7/2/10 7:00	72.69	72.50	-0.198
7/2/10 8:00	72.54	72.34	-0.198
7/2/10 9:00	72.82	72.64	-0.18
7/2/10 10:00	73.48	73.37	-0.108
7/2/10 11:00	74.40	74.38	-0.018
7/2/10 12:00	75.34	75.45	0.108
7/2/10 13:00	75.88	76.06	0.18
7/2/10 14:00	76.32	76.46	0.144
7/2/10 15:00	77.13	77.35	0.216
7/2/10 16:00	77.69	77.85	0.162
7/2/10 17:00	77.97	78.15	0.18
7/2/10 18:00	77.90	78.01	0.108
7/2/10 19:00	77.59	77.72	0.126
7/2/10 20:00	76.99	77.09	0.108
7/2/10 21:00	76.39	76.46	0.072
7/2/10 22:00	75.99	76.01	0.018
7/2/10 23:00	75.66	75.65	-0.018
7/3/10 0:00	75.40	75.31	-0.09
7/3/10 1:00	75.09	74.96	-0.126
7/3/10 2:00	74.73	74.55	-0.18
7/3/10 3:00	74.39	74.19	-0.198
7/3/10 4:00	74.05	73.85	-0.198
7/3/10 5:00	73.75	73.54	-0.216
7/3/10 6:00	73.49	73.25	-0.234
7/3/10 7:00	73.28	73.05	-0.234
7/3/10 8:00	73.17	72.95	-0.216
7/3/10 9:00	73.38	73.18	-0.198
7/3/10 10:00	74.10	73.99	-0.108
7/3/10 11:00	74.99	74.97	-0.018
7/3/10 12:00	75.76	75.85	0.09
7/3/10 13:00	76.61	76.81	0.198

7/3/10 14:00	77.36	77.66	0.306
7/3/10 15:00	77.95	78.29	0.342
7/3/10 16:00	78.42	78.82	0.396
7/3/10 17:00	78.70	79.15	0.45
7/3/10 18:00	78.75	79.14	0.396
7/3/10 19:00	78.47	78.70	0.234
7/3/10 20:00	77.97	78.12	0.144
7/3/10 21:00	77.39	77.44	0.054
7/3/10 22:00	76.87	76.91	0.036
7/3/10 23:00	76.44	76.46	0.018
7/4/10 0:00	76.14	76.12	-0.018
7/4/10 1:00	75.84	75.77	-0.072
7/4/10 2:00	75.61	75.52	-0.09
7/4/10 3:00	75.34	75.21	-0.126
7/4/10 4:00	75.04	74.89	-0.144
7/4/10 5:00	74.75	74.59	-0.162
7/4/10 6:00	74.53	74.35	-0.18
7/4/10 7:00	74.33	74.13	-0.198
7/4/10 8:00	74.21	73.99	-0.216
7/4/10 9:00	74.50	74.34	-0.162
7/4/10 10:00	75.44	75.34	-0.108
7/4/10 11:00	76.60	76.58	-0.018
7/4/10 12:00	77.75	77.82	0.072
7/4/10 13:00	78.84	79.02	0.18
7/4/10 14:00	79.72	79.96	0.234
7/4/10 15:00	80.12	80.21	0.09
7/4/10 16:00	80.33	80.33	0
7/4/10 17:00	80.66	80.66	0
7/4/10 18:00	80.76	80.65	-0.108
7/4/10 19:00	80.43	80.33	-0.108
7/4/10 20:00	79.84	79.73	-0.108
7/4/10 21:00	79.12	79.03	-0.09
7/4/10 22:00	78.64	78.55	-0.09
7/4/10 23:00	78.23	78.13	-0.108
7/5/10 0:00	77.90	77.79	-0.108
7/5/10 1:00	77.61	77.50	-0.108
7/5/10 2:00	77.32	77.22	-0.108
7/5/10 3:00	77.09	76.94	-0.144
7/5/10 4:00	76.81	76.66	-0.144
7/5/10 5:00	76.53	76.38	-0.144
7/5/10 6:00	76.24	76.10	-0.144
7/5/10 7:00	75.96	75.78	-0.18
7/5/10 8:00	75.79	75.63	-0.162
7/5/10 9:00	76.10	75.98	-0.126
7/5/10 10:00	77.18	77.13	-0.054
7/5/10 11:00	78.49	78.53	0.036
7/5/10 12:00	79.81	79.97	0.162
7/5/10 13:00	81.34	81.61	0.27

7/5/10 14:00	82.72	82.99	0.27
7/5/10 15:00	83.74	83.95	0.216
7/5/10 16:00	84.17	84.43	0.252
7/5/10 17:00	84.18	84.41	0.234
7/5/10 18:00	83.87	83.96	0.09
7/5/10 19:00	83.12	83.15	0.036
7/5/10 20:00	82.00	82.02	0.018
7/5/10 21:00	81.31	81.31	0
7/5/10 22:00	80.75	80.72	-0.036
7/5/10 23:00	80.34	80.27	-0.072
7/6/10 0:00	80.01	79.90	-0.108
7/6/10 1:00	79.79	79.64	-0.144
7/6/10 2:00	79.55	79.39	-0.162
7/6/10 3:00	79.32	79.14	-0.18
7/6/10 4:00	79.07	78.87	-0.198
7/6/10 5:00	78.83	78.63	-0.198
7/6/10 6:00	78.62	78.43	-0.198
7/6/10 7:00	78.40	78.20	-0.198
7/6/10 8:00	78.24	78.06	-0.18
7/6/10 9:00	78.55	78.41	-0.144
7/6/10 10:00	79.46	79.37	-0.09
7/6/10 11:00	81.16	81.16	0
7/6/10 12:00	82.94	83.07	0.126
7/6/10 13:00	84.73	84.89	0.162
7/6/10 14:00	86.20	86.42	0.216
7/6/10 15:00	87.42	87.69	0.27
7/6/10 16:00	87.85	88.21	0.36
7/6/10 17:00	87.68	87.92	0.234
7/6/10 18:00	86.37	86.61	0.234
7/6/10 19:00	86.01	86.26	0.252
7/6/10 20:00	85.23	85.41	0.18
7/6/10 21:00	84.22	84.38	0.162
7/6/10 22:00	83.31	83.40	0.09
7/6/10 23:00	82.72	82.70	-0.018
7/7/10 0:00	82.53	82.46	-0.072
7/7/10 1:00	82.30	82.17	-0.126
7/7/10 2:00	82.03	81.87	-0.162
7/7/10 3:00	81.82	81.64	-0.18
7/7/10 4:00	81.62	81.42	-0.198
7/7/10 5:00	81.38	81.18	-0.198
7/7/10 6:00	81.13	80.92	-0.216
7/7/10 7:00	80.88	80.65	-0.234
7/7/10 8:00	80.74	80.55	-0.198
7/7/10 9:00	81.03	80.85	-0.18
7/7/10 10:00	82.05	81.94	-0.108
7/7/10 11:00	83.88	83.84	-0.036
7/7/10 12:00	85.64	85.66	0.018
7/7/10 13:00	86.95	87.04	0.09

7/7/10 14:00	88.20	88.34	0.144
7/7/10 15:00	89.40	89.49	0.09
7/7/10 16:00	89.39	89.32	-0.072
7/7/10 17:00	88.83	88.81	-0.018
7/7/10 18:00	87.89	87.93	0.036
7/7/10 19:00	88.41	88.43	0.018
7/7/10 20:00	87.08	86.94	-0.144
7/7/10 21:00	85.82	85.65	-0.162
7/7/10 22:00	84.61	84.44	-0.162
7/7/10 23:00	83.66	83.48	-0.18
7/8/10 0:00	83.11	82.91	-0.198
7/8/10 1:00	82.77	82.55	-0.216
7/8/10 2:00	82.49	82.27	-0.216
7/8/10 3:00	82.19	81.97	-0.216
7/8/10 4:00	81.92	81.70	-0.216
7/8/10 5:00	81.59	81.37	-0.216
7/8/10 6:00	81.20	81.01	-0.198
7/8/10 7:00	80.91	80.69	-0.216
7/8/10 8:00	80.69	80.50	-0.198
7/8/10 9:00	80.87	80.69	-0.18
7/8/10 10:00	81.79	81.70	-0.09
7/8/10 11:00	83.74	83.74	0
7/8/10 12:00			
7/8/10 13:00	88.31	88.55	0.234
7/8/10 14:00	90.21	90.48	0.27
7/8/10 15:00	91.23	91.58	0.342
7/8/10 16:00	90.10	90.34	0.234
7/8/10 17:00	87.86	87.85	-0.018
7/8/10 18:00	88.19	88.16	-0.036
7/8/10 19:00	88.06	88.02	-0.036
7/8/10 20:00	86.35	86.27	-0.072
7/8/10 21:00	85.20	85.07	-0.126
7/8/10 22:00	84.37	84.24	-0.126
7/8/10 23:00	83.76	83.62	-0.144
7/9/10 0:00	83.48	83.34	-0.144
7/9/10 1:00	83.41	83.26	-0.144
7/9/10 2:00	83.33	83.17	-0.162
7/9/10 3:00	83.15	82.97	-0.18
7/9/10 4:00	82.76	82.58	-0.18
7/9/10 5:00	82.27	82.09	-0.18
7/9/10 6:00	82.12	81.92	-0.198
7/9/10 7:00	81.97	81.75	-0.216
7/9/10 8:00	81.72	81.52	-0.198
7/9/10 9:00	81.82	81.65	-0.162
7/9/10 10:00	82.04	81.93	-0.108
7/9/10 11:00	82.64	82.60	-0.036
7/9/10 12:00	84.17	84.19	0.018
7/9/10 18:00	86.63	86.67	0.036



7/9/10 19:00	87.34	87.45	0.108
7/9/10 20:00			
7/9/10 21:00			
7/9/10 22:00			
7/9/10 23:00			
7/10/10 0:00			
7/10/10 1:00	86.81	86.72	-0.09
7/10/10 2:00	84.40	84.31	-0.09
7/10/10 3:00	83.20	83.07	-0.126
7/10/10 4:00	82.69	82.56	-0.126
7/10/10 5:00	82.35	82.22	-0.126
7/10/10 6:00	82.04	81.90	-0.144
7/10/10 7:00	81.72	81.59	-0.126
7/10/10 8:00	81.38	81.25	-0.126
7/10/10 9:00	80.88	80.76	-0.126
7/10/10 10:00	80.91	80.76	-0.144
7/10/10 11:00	81.07	80.95	-0.126
7/10/10 12:00	80.97	80.85	-0.126
7/10/10 13:00	80.41	80.26	-0.144
7/10/10 14:00	79.86	79.75	-0.108
7/10/10 15:00	80.02	79.95	-0.072
7/10/10 16:00	80.40	80.40	0
7/10/10 17:00	80.77	80.84	0.072
7/10/10 18:00	81.01	81.19	0.18
7/10/10 19:00	81.63	81.92	0.288
7/10/10 20:00	82.73	83.06	0.324
7/10/10 21:00	83.93	84.29	0.36
7/10/10 22:00	84.80	85.00	0.198
7/10/10 23:00	84.86	84.95	0.09
7/11/10 0:00	85.60	85.56	-0.036
7/11/10 1:00	85.85	85.76	-0.09
7/11/10 2:00	84.75	84.62	-0.126
7/11/10 3:00	83.28	83.12	-0.162
7/11/10 4:00	82.09	81.89	-0.198
7/11/10 5:00	81.23	81.01	-0.216
7/11/10 6:00	80.34	80.13	-0.216
7/11/10 7:00	79.70	79.47	-0.234
7/11/10 8:00	79.14	78.89	-0.252
7/11/10 9:00	78.73	78.46	-0.27
7/11/10 10:00	78.38	78.11	-0.27
7/11/10 11:00	77.99	77.71	-0.288
7/11/10 12:00	77.56	77.25	-0.306
7/11/10 13:00	77.28	77.00	-0.288
7/11/10 14:00	77.48	77.21	-0.27
7/11/10 15:00	78.43	78.23	-0.198
7/11/10 16:00	80.40	80.31	-0.09
7/11/10 17:00	83.23	83.23	0
7/11/10 18:00	86.01	86.08	0.072

7/11/10 19:00	88.14	88.32	0.18
7/11/10 20:00	89.83	90.01	0.18
7/11/10 21:00	90.70	90.74	0.036
7/11/10 22:00	90.99	90.92	-0.072
7/11/10 23:00	89.96	89.91	-0.054
7/12/10 0:00	87.77	87.72	-0.054
7/12/10 1:00	85.71	85.62	-0.09
7/12/10 2:00	83.37	83.24	-0.126
7/12/10 3:00	81.76	81.60	-0.162
7/12/10 4:00	80.66	80.47	-0.198
7/12/10 5:00	79.72	79.50	-0.216
7/12/10 6:00	79.10	78.86	-0.234
7/12/10 7:00	78.50	78.23	-0.27
7/12/10 8:00	78.03	77.76	-0.27
7/12/10 9:00	77.58	77.31	-0.27
7/12/10 10:00	77.08	76.81	-0.27
7/12/10 11:00	76.79	76.50	-0.288
7/12/10 12:00	76.55	76.28	-0.27
7/12/10 13:00	76.28	76.03	-0.252
7/12/10 14:00	76.39	76.17	-0.216
7/12/10 15:00	76.94	76.80	-0.144
7/12/10 16:00	78.17	78.13	-0.036
7/12/10 17:00	80.75	80.83	0.072
7/12/10 18:00	84.08	84.21	0.126
7/12/10 19:00	86.80	86.98	0.18
7/12/10 20:00	88.10	88.30	0.198
7/12/10 21:00	87.71	87.98	0.27
7/12/10 22:00	86.20	86.31	0.108
7/12/10 23:00	84.12	84.21	0.09
7/13/10 0:00	81.68	81.77	0.09
7/13/10 1:00	79.77	79.77	0
7/13/10 2:00	78.47	78.43	-0.036
7/13/10 3:00	78.28	78.21	-0.072
7/13/10 4:00	78.43	78.32	-0.108
7/13/10 5:00	78.56	78.45	-0.108
7/13/10 6:00	78.60	78.47	-0.126
7/13/10 7:00	78.61	78.46	-0.144
7/13/10 8:00	78.64	78.49	-0.144
7/13/10 9:00	78.60	78.44	-0.162
7/13/10 10:00	78.39	78.23	-0.162
7/13/10 11:00	78.24	78.08	-0.162
7/13/10 12:00	78.16	77.99	-0.162
7/13/10 13:00	78.12	77.98	-0.144
7/13/10 14:00	78.17	78.06	-0.108
7/13/10 15:00	78.58	78.54	-0.036
7/13/10 16:00	78.98	79.01	0.036
7/13/10 17:00	79.59	79.71	0.126
7/13/10 18:00	82.24	82.45	0.216

7/13/10 19:00	84.15	84.43	0.288
7/13/10 20:00	83.57	83.90	0.324
7/13/10 21:00	83.04	83.33	0.288
7/13/10 22:00	83.30	83.59	0.288
7/13/10 23:00	84.17	84.46	0.288
7/14/10 0:00	83.15	83.42	0.27
7/14/10 1:00	82.70	82.84	0.144
7/14/10 2:00	81.92	81.97	0.054
7/14/10 3:00	81.38	81.40	0.018
7/14/10 4:00	80.90	80.88	-0.018
7/14/10 5:00	80.65	80.58	-0.072
7/14/10 6:00	80.45	80.36	-0.09
7/14/10 7:00	80.23	80.11	-0.126
7/14/10 8:00	80.07	79.93	-0.144
7/14/10 9:00	80.00	79.85	-0.144
7/14/10 10:00	79.84	79.66	-0.18
7/14/10 11:00	79.79	79.61	-0.18
7/14/10 12:00	79.65	79.47	-0.18
7/14/10 13:00	79.61	79.43	-0.18
7/14/10 14:00	79.53	79.37	-0.162
7/14/10 15:00	79.64	79.53	-0.108
7/14/10 16:00	79.67	79.66	-0.018
7/14/10 17:00	79.80	79.86	0.054
7/14/10 18:00	80.38	80.49	0.108
7/14/10 19:00	80.49	80.67	0.18
7/14/10 20:00	80.37	80.59	0.216
7/14/10 21:00	80.71	80.86	0.144
7/14/10 22:00	81.99	82.17	0.18
7/14/10 23:00	83.81	83.93	0.126
7/15/10 0:00	81.54	81.59	0.054
7/15/10 1:00	81.61	81.66	0.054
7/15/10 2:00	80.95	80.97	0.018
7/15/10 3:00	79.81	79.79	-0.018
7/15/10 4:00	79.44	79.37	-0.072
7/15/10 5:00	79.32	79.23	-0.09
7/15/10 6:00	79.16	79.04	-0.126
7/15/10 7:00	79.09	78.95	-0.144
7/15/10 8:00	79.11	78.94	-0.162
7/15/10 9:00	79.12	78.94	-0.18
7/15/10 10:00	79.05	78.85	-0.198
7/15/10 11:00	78.90	78.70	-0.198
7/15/10 12:00	78.80	78.58	-0.216
7/15/10 13:00	78.72	78.50	-0.216
7/15/10 14:00	78.67	78.49	-0.18
7/15/10 15:00	78.86	78.73	-0.126
7/15/10 16:00	79.65	79.57	-0.072
7/15/10 17:00	80.15	80.16	0.018
7/15/10 18:00	80.60	80.71	0.108

7/15/10 19:00	82.90	83.10	0.198
7/15/10 20:00	85.26	85.50	0.234
7/15/10 21:00	85.92	86.20	0.288
7/15/10 22:00	85.98	86.23	0.252
7/15/10 23:00	85.83	86.12	0.288
7/16/10 0:00	84.88	85.07	0.198
7/16/10 1:00	83.35	83.45	0.108
7/16/10 2:00	82.22	82.30	0.072
7/16/10 3:00	81.53	81.55	0.018
7/16/10 4:00	80.73	80.71	-0.018
7/16/10 5:00	80.25	80.21	-0.036
7/16/10 6:00	79.89	79.78	-0.108
7/16/10 7:00	79.50	79.38	-0.126
7/16/10 8:00	79.19	79.03	-0.162
7/16/10 9:00	79.02	78.84	-0.18
7/16/10 10:00	78.84	78.64	-0.198
7/16/10 11:00	78.64	78.43	-0.216
7/16/10 12:00	78.43	78.19	-0.234
7/16/10 13:00	78.31	78.07	-0.234
7/17/10 13:00			
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7/20/10 1:00	79.33	79.19	-0.144
7/20/10 2:00	81.15	81.10	-0.054
7/20/10 3:00	83.15	83.17	0.018
7/20/10 4:00	85.07	85.01	-0.054
7/20/10 5:00	86.24	86.24	0
7/20/10 6:00	87.11	87.11	0
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7/23/10 15:00			
7/23/10 16:00			
7/23/10 17:00			
7/23/10 18:00	80.40	80.25	-0.144
7/23/10 19:00	80.19	80.02	-0.162
7/23/10 20:00	79.97	79.81	-0.162
7/23/10 21:00	79.83	79.65	-0.18
7/23/10 22:00	79.83	79.65	-0.18
7/23/10 23:00	79.66	79.47	-0.198
7/24/10 0:00	79.87	79.70	-0.162
7/24/10 1:00	80.36	80.25	-0.108
7/24/10 2:00	80.79	80.75	-0.036
7/24/10 3:00	81.63	81.66	0.036
7/24/10 4:00	81.94	82.06	0.126
7/24/10 5:00	82.26	82.44	0.18
7/24/10 6:00	84.29	84.45	0.162
7/24/10 7:00	87.53	87.65	0.126
7/24/10 8:00	88.23	88.30	0.072
7/24/10 9:00	87.60	87.60	0
7/24/10 10:00	86.35	86.36	0.018
7/24/10 11:00	84.89	84.86	-0.036
7/24/10 12:00	83.43	83.34	-0.09
7/24/10 13:00	82.34	82.23	-0.108
7/24/10 14:00	81.55	81.42	-0.126
7/24/10 15:00	80.95	80.80	-0.144
7/24/10 16:00	80.50	80.33	-0.162
7/24/10 17:00	80.16	79.98	-0.18
7/24/10 18:00	79.82	79.62	-0.198
7/24/10 19:00	79.55	79.35	-0.198
7/24/10 20:00	79.38	79.18	-0.198
7/24/10 21:00	79.24	79.03	-0.216
7/24/10 22:00	79.08	78.85	-0.234
7/24/10 23:00	78.90	78.69	-0.216
7/25/10 0:00	78.98	78.80	-0.18
7/25/10 1:00	79.36	79.25	-0.108
7/25/10 2:00	80.29	80.25	-0.036



7/25/10 3:00	82.64	82.66	0.018
7/25/10 4:00	85.61	85.69	0.072
7/25/10 5:00	88.32	88.36	0.036
7/25/10 6:00	89.44	89.46	0.018
7/25/10 7:00	88.98	88.85	-0.126
7/25/10 8:00	89.39	89.43	0.036
7/25/10 9:00	90.49	90.47	-0.018
7/25/10 10:00	89.70	89.68	-0.018
7/25/10 11:00	87.41	87.32	-0.09
7/25/10 12:00	84.42	84.31	-0.108
7/25/10 13:00	82.07	81.98	-0.09
7/25/10 14:00	80.46	80.37	-0.09
7/25/10 15:00	79.43	79.31	-0.126
7/25/10 16:00	78.80	78.68	-0.126
7/25/10 17:00	78.64	78.51	-0.126
7/25/10 18:00	78.51	78.36	-0.144
7/25/10 19:00	78.30	78.14	-0.162
7/25/10 20:00	78.05	77.89	-0.162
7/25/10 21:00	77.79	77.63	-0.162
7/25/10 22:00	77.48	77.32	-0.162
7/25/10 23:00	77.14	76.98	-0.162
7/26/10 0:00	77.10	76.97	-0.126
7/26/10 1:00	77.98	77.93	-0.054
7/26/10 2:00	80.00	80.04	0.036
7/26/10 3:00	82.71	82.74	0.036
7/26/10 4:00	85.12	85.21	0.09
7/26/10 5:00	86.34	86.38	0.036
7/26/10 6:00	87.58	87.55	-0.036
7/26/10 7:00	88.45	88.43	-0.018
7/26/10 8:00	88.92	88.92	0
7/26/10 9:00	88.03	88.02	-0.018
7/26/10 10:00	86.62	86.56	-0.054
7/26/10 11:00	85.68	85.60	-0.072
7/26/10 12:00	84.66	84.59	-0.072
7/26/10 13:00	83.02	82.95	-0.072
7/26/10 14:00	81.57	81.48	-0.09
7/26/10 15:00	80.47	80.36	-0.108
7/26/10 16:00	79.70	79.60	-0.108
7/26/10 17:00	79.23	79.12	-0.108
7/26/10 18:00	78.94	78.83	-0.108
7/26/10 19:00	78.74	78.61	-0.126
7/26/10 20:00	78.58	78.45	-0.126
7/26/10 21:00	78.42	78.29	-0.126
7/26/10 22:00	78.25	78.12	-0.126
7/26/10 23:00	78.13	78.00	-0.126
7/27/10 0:00	78.08	77.99	-0.09
7/27/10 1:00	78.10	78.06	-0.036
7/27/10 2:00	78.08	78.10	0.018

7/27/10 3:00	78.44	78.57	0.126
7/27/10 4:00	79.48	79.70	0.216
7/27/10 5:00	80.59	80.92	0.324
7/27/10 6:00	81.10	81.50	0.396
7/27/10 7:00	82.49	82.92	0.432
7/27/10 8:00	85.20	85.58	0.378
7/27/10 9:00	86.64	86.86	0.216
7/27/10 10:00	86.84	86.95	0.108
7/27/10 11:00	85.41	85.44	0.036
7/27/10 12:00	83.65	83.63	-0.018
7/27/10 13:00	82.54	82.50	-0.036
7/27/10 14:00	81.57	81.52	-0.054
7/27/10 15:00	80.73	80.62	-0.108
7/27/10 16:00	80.09	79.97	-0.126
7/27/10 17:00	79.86	79.74	-0.126
7/27/10 18:00	79.79	79.64	-0.144
7/27/10 19:00	79.59	79.47	-0.126
7/27/10 20:00	79.32	79.20	-0.126
7/27/10 21:00	79.25	79.10	-0.144
7/27/10 22:00	79.31	79.18	-0.126
7/27/10 23:00	79.27	79.13	-0.144
7/28/10 23:00			
7/29/10 15:00	80.40	80.40	0
7/29/10 16:00	82.11	82.18	0.072
7/29/10 17:00	83.76	83.90	0.144
7/29/10 18:00	85.37	85.59	0.216
7/29/10 19:00	87.17	87.40	0.234
7/29/10 20:00	88.81	88.94	0.126
7/29/10 21:00	89.58	89.72	0.144
7/29/10 22:00	89.59	89.61	0.018
7/29/10 23:00	89.15	89.15	0
7/30/10 0:00	88.48	88.35	-0.126
7/30/10 1:00	87.02	86.89	-0.126
7/30/10 2:00	85.30	85.18	-0.126
7/30/10 3:00	84.09	83.97	-0.126
7/30/10 4:00	83.50	83.38	-0.126
7/30/10 5:00	82.42	82.30	-0.126
7/30/10 6:00	81.23	81.09	-0.144
7/30/10 7:00	81.64	81.52	-0.126
7/30/10 8:00	81.68	81.57	-0.108
7/30/10 9:00	81.46	81.39	-0.072
7/30/10 10:00	81.36	81.34	-0.018
7/30/10 11:00	81.25	81.23	-0.018
7/30/10 12:00	81.28	81.25	-0.036
7/30/10 13:00	81.19	81.17	-0.018
7/30/10 14:00	81.25	81.25	0
7/30/10 15:00	81.68	81.73	0.054
7/30/10 16:00	82.68	82.81	0.126

7/30/10 17:00	85.04	85.19	0.144
7/30/10 18:00	85.43	85.68	0.252
7/30/10 19:00	85.63	85.46	-0.162
7/30/10 20:00	83.84	83.79	-0.054
7/30/10 21:00	80.66	80.68	0.018
7/30/10 22:00	81.50	81.54	0.036
7/30/10 23:00	83.38	83.43	0.054
7/31/10 0:00	84.13	84.15	0.018
7/31/10 1:00	83.49	83.44	-0.054
7/31/10 2:00	82.49	82.36	-0.126
7/31/10 3:00	81.64	81.46	-0.18
7/31/10 4:00	81.06	80.87	-0.198
7/31/10 5:00	80.53	80.30	-0.234
7/31/10 6:00	80.12	79.87	-0.252
7/31/10 7:00	79.80	79.55	-0.252
7/31/10 8:00	79.61	79.34	-0.27
7/31/10 9:00	79.42	79.13	-0.288
7/31/10 10:00	79.30	79.00	-0.306
7/31/10 11:00	79.30	79.00	-0.306
7/31/10 12:00	79.19	78.86	-0.324
7/31/10 13:00	78.89	78.56	-0.324
7/31/10 14:00	79.00	78.71	-0.288
7/31/10 15:00	79.53	79.30	-0.234
7/31/10 16:00	80.44	80.30	-0.144
7/31/10 17:00	81.67	81.64	-0.036
7/31/10 18:00	82.77	82.79	0.018
7/31/10 19:00	83.56	83.57	0.018
7/31/10 20:00	83.42	83.39	-0.036
7/31/10 21:00	83.47	83.38	-0.09
7/31/10 22:00	83.12	83.10	-0.018
7/31/10 23:00	83.00	82.95	-0.054
8/1/10 0:00	82.72	82.66	-0.054
8/1/10 1:00	82.56	82.51	-0.054
8/1/10 2:00	81.99	81.94	-0.054
8/1/10 3:00	81.56	81.49	-0.072
8/1/10 4:00	81.13	81.06	-0.072
8/1/10 5:00	80.83	80.72	-0.108
8/1/10 6:00	80.52	80.42	-0.108
8/1/10 7:00	80.25	80.11	-0.144
8/1/10 8:00	79.90	79.75	-0.144
8/1/10 9:00	79.50	79.36	-0.144
8/1/10 10:00	79.16	78.99	-0.162
8/1/10 11:00	78.87	78.69	-0.18
8/1/10 12:00	78.57	78.37	-0.198
8/1/10 13:00	78.31	78.13	-0.18
8/1/10 14:00	78.26	78.10	-0.162
8/1/10 15:00	78.80	78.71	-0.09
8/1/10 16:00	79.75	79.75	0

8/1/10 17:00	80.76	80.87	0.108
8/1/10 18:00	81.77	81.99	0.216
8/1/10 19:00	82.46	82.76	0.306
8/1/10 20:00	82.95	83.28	0.324
8/1/10 21:00	83.20	83.59	0.396
8/1/10 22:00	83.20	83.48	0.288
8/1/10 23:00	83.16	83.26	0.108
8/2/10 0:00	82.80	82.87	0.072
8/2/10 1:00	82.24	82.22	-0.018
8/2/10 2:00	81.69	81.60	-0.09
8/2/10 3:00	81.27	81.18	-0.09
8/2/10 4:00	80.88	80.76	-0.126
8/2/10 5:00	80.69	80.55	-0.144
8/2/10 6:00	80.50	80.34	-0.162
8/2/10 7:00			
8/2/10 8:00			
8/2/10 9:00			
8/2/10 10:00			
8/2/10 11:00			
8/2/10 12:00			
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8/2/10 21:00			
8/2/10 22:00			
8/2/10 23:00			
8/3/10 0:00			
8/3/10 1:00			
8/3/10 2:00			
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8/3/10 15:00			
8/3/10 16:00			

8/3/10 17:00			
8/3/10 18:00			
8/3/10 19:00			
8/3/10 20:00			
8/3/10 21:00			
8/3/10 22:00	83.89	83.89	0
8/3/10 23:00	83.69	83.67	-0.018
8/4/10 0:00	83.42	83.38	-0.036
8/4/10 1:00	82.96	82.87	-0.09
8/4/10 2:00	82.45	82.35	-0.108
8/4/10 3:00	81.79	81.68	-0.108
8/4/10 4:00	81.39	81.28	-0.108
8/4/10 5:00	80.95	80.80	-0.144
8/4/10 6:00	80.47	80.33	-0.144
8/4/10 7:00	80.12	79.98	-0.144
8/4/10 8:00	79.76	79.60	-0.162
8/4/10 9:00	79.41	79.23	-0.18
8/4/10 10:00	79.07	78.87	-0.198
8/4/10 11:00	78.75	78.55	-0.198
8/4/10 12:00	78.45	78.25	-0.198
8/4/10 13:00	78.18	77.99	-0.198
8/4/10 14:00	78.18	78.02	-0.162
8/4/10 15:00	78.83	78.72	-0.108
8/4/10 16:00	79.71	79.70	-0.018
8/4/10 17:00	80.83	80.92	0.09
8/4/10 18:00	81.92	82.09	0.162
8/4/10 19:00	82.64	82.89	0.252
8/4/10 20:00	81.76	82.01	0.252
8/4/10 21:00	81.86	82.13	0.27
8/4/10 22:00	82.51	82.66	0.144
8/4/10 23:00	82.33	82.44	0.108
8/5/10 0:00	81.87	81.80	-0.072
8/5/10 1:00	81.38	81.25	-0.126
8/5/10 2:00	81.03	80.89	-0.144
8/5/10 3:00	80.62	80.47	-0.144
8/5/10 4:00	80.32	80.15	-0.162
8/5/10 5:00	80.18	80.00	-0.18
8/5/10 6:00	79.85	79.67	-0.18
8/5/10 7:00	79.47	79.27	-0.198
8/5/10 8:00	78.97	78.77	-0.198
8/5/10 9:00	78.54	78.32	-0.216
8/5/10 10:00	78.08	77.87	-0.216
8/5/10 11:00	77.66	77.42	-0.234
8/5/10 12:00	77.22	76.97	-0.252
8/5/10 13:00	76.88	76.64	-0.234
8/5/10 14:00	76.82	76.60	-0.216
8/5/10 15:00	77.49	77.35	-0.144
8/5/10 16:00	78.90	78.83	-0.072

8/5/10 17:00	80.66	80.69	0.036
8/5/10 18:00	82.06	82.21	0.144
8/5/10 19:00	83.46	83.71	0.252
8/5/10 20:00	84.31	84.65	0.342
8/5/10 21:00	84.55	84.91	0.36
8/5/10 22:00	84.30	84.71	0.414
8/5/10 23:00	84.17	84.62	0.45
8/6/10 0:00	82.71	83.12	0.414
8/6/10 1:00	81.46	81.73	0.27
8/6/10 2:00	80.55	80.78	0.234
8/6/10 3:00	79.70	79.89	0.198
8/6/10 4:00	79.21	79.36	0.144
8/6/10 5:00	78.99	79.10	0.108
8/6/10 6:00	78.84	78.88	0.036
8/6/10 7:00	78.57	78.55	-0.018
8/6/10 8:00	78.38	78.31	-0.072
8/6/10 9:00	78.16	78.07	-0.09
8/6/10 10:00	77.95	77.82	-0.126
8/6/10 11:00	77.73	77.61	-0.126
8/6/10 12:00	77.63	77.48	-0.144
8/6/10 13:00	77.46	77.30	-0.162
8/6/10 14:00	77.41	77.28	-0.126
8/6/10 15:00	77.55	77.48	-0.072
8/6/10 16:00	77.62	77.62	0
8/6/10 17:00	78.53	78.62	0.09
8/6/10 18:00	79.20	79.36	0.162
8/6/10 19:00	79.80	80.02	0.216
8/6/10 20:00	81.73	81.96	0.234
8/6/10 21:00	83.06	83.30	0.234
8/6/10 22:00	81.71	81.95	0.234
8/6/10 23:00	79.82	80.02	0.198
8/7/10 0:00	79.13	79.24	0.108
8/7/10 1:00	79.52	79.51	-0.018
8/7/10 2:00	79.17	79.12	-0.054
8/7/10 3:00	77.79	77.72	-0.072
8/7/10 4:00	77.50	77.41	-0.09
8/7/10 5:00	77.26	77.14	-0.126
8/7/10 6:00	77.04	76.91	-0.126
8/7/10 7:00	76.78	76.60	-0.18
8/7/10 8:00	76.66	76.48	-0.18
8/7/10 9:00	76.42	76.23	-0.198
8/7/10 10:00	76.13	75.93	-0.198
8/7/10 11:00	75.87	75.65	-0.216
8/7/10 12:00	75.53	75.29	-0.234
8/7/10 13:00	75.24	75.01	-0.234
8/7/10 14:00	75.30	75.11	-0.198
8/7/10 15:00	76.19	76.04	-0.144
8/7/10 16:00	78.17	78.10	-0.072



8/7/10 17:00	80.18	80.18	0
8/7/10 18:00	80.78	80.83	0.054
8/7/10 19:00	80.60	80.67	0.072
8/7/10 20:00	79.77	79.86	0.09
8/7/10 21:00	80.13	80.15	0.018
8/7/10 22:00	80.22	80.26	0.036
8/7/10 23:00	79.75	79.80	0.054
8/8/10 0:00	79.61	79.60	-0.018
8/8/10 1:00	78.97	78.88	-0.09
8/8/10 2:00	78.52	78.37	-0.144
8/8/10 3:00	77.65	77.50	-0.144
8/8/10 4:00	76.99	76.82	-0.162
8/8/10 5:00	76.70	76.54	-0.162
8/8/10 6:00	76.61	76.45	-0.162
8/8/10 7:00	76.59	76.43	-0.162
8/8/10 8:00	76.55	76.41	-0.144
8/8/10 9:00	76.41	76.27	-0.144
8/8/10 10:00	76.11	75.97	-0.144
8/8/10 11:00	75.97	75.84	-0.126
8/8/10 12:00	76.05	75.92	-0.126
8/8/10 13:00	76.16	76.06	-0.108
8/8/10 14:00	76.38	76.33	-0.054
8/8/10 15:00	76.89	76.89	0
8/8/10 16:00	77.66	77.75	0.09
8/8/10 17:00	78.70	78.86	0.162
8/8/10 18:00	79.00	79.20	0.198
8/8/10 19:00	79.11	79.34	0.234
8/8/10 20:00	79.80	80.00	0.198
8/8/10 21:00	79.66	79.77	0.108
8/8/10 22:00	79.57	79.67	0.108
8/8/10 23:00	80.11	80.11	0
8/9/10 0:00	80.17	80.15	-0.018
8/9/10 1:00	79.46	79.42	-0.036
8/9/10 2:00	78.83	78.76	-0.072
8/9/10 3:00	78.17	78.08	-0.09
8/9/10 4:00	77.50	77.39	-0.108
8/9/10 5:00	76.97	76.87	-0.108
8/9/10 6:00	76.67	76.56	-0.108
8/9/10 7:00	76.52	76.42	-0.108
8/9/10 8:00	76.46	76.34	-0.126
8/9/10 9:00	76.45	76.32	-0.126
8/9/10 10:00	76.50	76.36	-0.144
8/9/10 11:00	76.54	76.39	-0.144
8/9/10 12:00	76.42	76.27	-0.144
8/9/10 13:00	76.20	76.06	-0.144
8/9/10 14:00	76.22	76.11	-0.108
8/9/10 15:00	77.05	77.00	-0.054
8/9/10 16:00	79.25	79.25	0

8/9/10 17:00	82.09	82.16	0.072
8/9/10 18:00	84.94	85.07	0.126
8/9/10 19:00	87.31	87.46	0.144
8/9/10 20:00	88.07	88.16	0.09
8/9/10 21:00	87.30	87.28	-0.018
8/9/10 22:00	88.43	88.37	-0.054
8/9/10 23:00	87.77	87.77	0
8/10/10 0:00	86.59	86.58	-0.018
8/10/10 1:00	85.63	85.60	-0.036
8/10/10 2:00	84.03	83.96	-0.072
8/10/10 3:00	82.17	82.09	-0.072
8/10/10 4:00	80.82	80.73	-0.09
8/10/10 5:00	80.14	80.05	-0.09
8/10/10 6:00	79.83	79.74	-0.09
8/10/10 7:00	79.48	79.39	-0.09
8/10/10 8:00	79.15	79.06	-0.09
8/10/10 9:00	78.70	78.61	-0.09
8/10/10 10:00	78.40	78.31	-0.09
8/10/10 11:00	78.31	78.20	-0.108
8/10/10 12:00	77.97	77.90	-0.072
8/10/10 13:00	77.63	77.56	-0.072
8/10/10 14:00	77.58	77.54	-0.036
8/10/10 15:00	78.19	78.19	0
8/10/10 16:00	79.04	79.06	0.018
8/10/10 17:00	79.67	79.70	0.036
8/10/10 18:00	80.88	80.86	-0.018
8/10/10 19:00	81.06	81.14	0.072
8/10/10 20:00	81.08	81.15	0.072
8/10/10 21:00	83.77	83.81	0.036
8/10/10 22:00	86.15	86.20	0.054
8/10/10 23:00	86.31	86.29	-0.018
8/11/10 0:00	85.78	85.70	-0.072
8/11/10 1:00	84.35	84.26	-0.09
8/11/10 2:00	82.76	82.65	-0.108
8/11/10 3:00	81.08	80.95	-0.126
8/11/10 4:00	79.70	79.57	-0.126
8/11/10 5:00	78.81	78.69	-0.126
8/11/10 6:00	78.36	78.23	-0.126
8/11/10 7:00	77.95	77.83	-0.126
8/11/10 8:00	77.57	77.44	-0.126
8/11/10 9:00	77.35	77.22	-0.126
8/11/10 10:00	77.21	77.06	-0.144
8/11/10 11:00	76.76	76.62	-0.144
8/11/10 12:00	76.20	76.06	-0.144
8/11/10 13:00	75.75	75.61	-0.144
8/11/10 14:00	75.63	75.54	-0.09
8/11/10 15:00	76.01	75.95	-0.054
8/11/10 16:00	77.25	77.23	-0.018

8/11/10 17:00	79.76	79.74	-0.018
8/11/10 18:00	82.04	82.09	0.054
8/11/10 19:00	83.68	83.68	0
8/11/10 20:00	84.28	84.19	-0.09
8/11/10 21:00	84.25	84.18	-0.072
8/11/10 22:00	83.38	83.21	-0.162
8/11/10 23:00	82.37	82.30	-0.072
8/12/10 0:00	81.63	81.58	-0.054
8/12/10 1:00	80.19	80.12	-0.072
8/12/10 2:00	78.69	78.62	-0.072
8/12/10 3:00	77.31	77.22	-0.09
8/12/10 4:00	75.88	75.79	-0.09
8/12/10 5:00	74.82	74.71	-0.108
8/12/10 6:00	74.02	73.91	-0.108
8/12/10 7:00	73.49	73.36	-0.126
8/12/10 8:00	73.07	72.93	-0.144
8/12/10 9:00	72.82	72.68	-0.144
8/12/10 10:00	72.78	72.64	-0.144
8/12/10 11:00	72.80	72.64	-0.162
8/12/10 13:00	72.76	72.59	-0.162
8/12/10 14:00	72.46	72.32	-0.144
8/12/10 15:00	72.93	72.86	-0.072
8/12/10 16:00	75.16	75.16	0
8/12/10 17:00	78.84	78.91	0.072
8/12/10 18:00	82.58	82.75	0.162
8/12/10 19:00	86.25	86.50	0.252
8/12/10 20:00	89.06	89.17	0.108
8/12/10 21:00	89.14	89.26	0.126
8/12/10 22:00	88.01	88.17	0.162
8/12/10 23:00	87.46	87.46	0
8/13/10 0:00	86.57	86.46	-0.108
8/13/10 1:00	84.69	84.56	-0.126
8/13/10 2:00	82.14	82.02	-0.126
8/13/10 3:00	79.61	79.47	-0.144
8/13/10 4:00	77.84	77.72	-0.126
8/13/10 5:00	76.69	76.54	-0.144
8/13/10 6:00	75.95	75.79	-0.162
8/13/10 7:00	75.34	75.19	-0.144
8/13/10 8:00	74.68	74.52	-0.162
8/13/10 9:00	74.04	73.88	-0.162
8/13/10 10:00	73.50	73.34	-0.162
8/13/10 11:00	73.02	72.84	-0.18
8/13/10 12:00	72.59	72.41	-0.18
8/13/10 13:00	72.32	72.16	-0.162
8/13/10 14:00	72.25	72.10	-0.144
8/13/10 15:00	72.69	72.60	-0.09
8/13/10 16:00	74.77	74.77	0

8/13/10 17:00	78.42	78.53	0.108
8/13/10 18:00	82.96	83.14	0.18
8/13/10 19:00	86.73	86.95	0.216
8/13/10 20:00	89.32	89.34	0.018
8/13/10 21:00	89.79	89.85	0.054
8/13/10 22:00	88.57	88.63	0.054
8/13/10 23:00	86.76	86.81	0.054
8/14/10 0:00	86.07	86.09	0.018
8/14/10 1:00	84.40	84.31	-0.09
8/14/10 2:00	81.99	81.88	-0.108
8/14/10 3:00	79.87	79.76	-0.108
8/14/10 4:00	78.40	78.29	-0.108
8/14/10 5:00	77.49	77.36	-0.126
8/14/10 6:00	76.69	76.56	-0.126
8/14/10 7:00	76.10	75.97	-0.126
8/14/10 8:00	75.57	75.44	-0.126
8/14/10 9:00	75.08	74.96	-0.126
8/14/10 10:00	74.66	74.49	-0.162
8/14/10 11:00	74.21	74.06	-0.144
8/14/10 12:00	73.83	73.67	-0.162
8/14/10 13:00	73.49	73.33	-0.162
8/14/10 14:00	73.33	73.22	-0.108
8/14/10 15:00	73.68	73.63	-0.054
8/14/10 16:00	75.46	75.50	0.036
8/14/10 17:00	78.77	78.89	0.126
8/14/10 18:00	83.20	83.38	0.18
8/14/10 19:00	87.19	87.28	0.09
8/14/10 20:00	90.25	90.27	0.018
8/14/10 21:00	91.11	91.18	0.072
8/14/10 22:00	90.62	90.64	0.018
8/14/10 23:00	89.76	89.74	-0.018
8/15/10 0:00	88.24	88.18	-0.054
8/15/10 1:00	85.62	85.55	-0.072
8/15/10 2:00	83.11	83.05	-0.054
8/15/10 3:00	81.52	81.45	-0.072
8/15/10 4:00	80.47	80.40	-0.072
8/15/10 5:00	79.66	79.59	-0.072
8/15/10 6:00	79.02	78.93	-0.09
8/15/10 7:00	78.67	78.58	-0.09
8/15/10 8:00	78.38	78.29	-0.09
8/15/10 9:00	78.09	78.00	-0.09
8/15/10 10:00	77.76	77.65	-0.108
8/15/10 11:00	77.47	77.36	-0.108
8/15/10 12:00	77.39	77.26	-0.126
8/15/10 13:00	77.25	77.13	-0.126
8/15/10 14:00	77.22	77.13	-0.09
8/15/10 15:00	77.78	77.74	-0.036
8/15/10 16:00	79.11	79.14	0.036

8/15/10 17:00	81.23	81.36	0.126
8/15/10 18:00	83.75	83.95	0.198
8/15/10 19:00	86.62	86.83	0.216
8/15/10 20:00	89.63	89.90	0.27
8/15/10 21:00	91.85	92.08	0.234
8/15/10 22:00	90.99	91.27	0.288
8/15/10 23:00	88.36	88.68	0.324
8/16/10 0:00	87.05	87.30	0.252
8/16/10 1:00	86.70	86.90	0.198
8/16/10 2:00	85.59	85.71	0.126
8/16/10 3:00	83.62	83.71	0.09
8/16/10 4:00	81.79	81.84	0.054
8/16/10 5:00	80.56	80.57	0.018
8/16/10 6:00	79.81	79.81	0
8/16/10 7:00	79.39	79.36	-0.036
8/16/10 8:00	79.01	78.96	-0.054
8/16/10 9:00	78.53	78.44	-0.09
8/16/10 10:00	78.09	77.97	-0.126
8/16/10 11:00	77.60	77.44	-0.162
8/16/10 12:00	77.18	77.02	-0.162
8/16/10 13:00	77.00	76.82	-0.18
8/16/10 14:00	76.96	76.79	-0.162
8/16/10 15:00	77.48	77.36	-0.126
8/16/10 16:00	79.07	79.00	-0.072
8/16/10 17:00	82.24	82.26	0.018
8/16/10 18:00	86.53	86.53	0
8/16/10 19:00	90.04	90.11	0.072
8/16/10 20:00	91.54	91.63	0.09
8/16/10 21:00	90.22	90.24	0.018
8/16/10 22:00	89.28	89.37	0.09
8/16/10 23:00	89.42	89.49	0.072
8/17/10 0:00	89.32	89.24	-0.072
8/17/10 1:00	87.48	87.35	-0.126
8/17/10 2:00	85.01	84.85	-0.162
8/17/10 3:00	83.06	82.90	-0.162
8/17/10 4:00	81.50	81.32	-0.18
8/17/10 5:00	80.48	80.30	-0.18
8/17/10 6:00	79.79	79.59	-0.198
8/17/10 7:00	79.16	78.98	-0.18
8/17/10 8:00	78.60	78.40	-0.198
8/17/10 9:00	78.15	77.93	-0.216
8/17/10 10:00	77.86	77.66	-0.198
8/17/10 11:00	77.71	77.50	-0.216
8/17/10 12:00	77.75	77.55	-0.198
8/17/10 13:00	77.89	77.71	-0.18
8/17/10 14:00	77.94	77.77	-0.162
8/17/10 15:00	78.15	78.04	-0.108
8/17/10 16:00	78.87	78.83	-0.036

8/17/10 17:00	79.69	79.73	0.036
8/17/10 18:00	79.87	79.97	0.108
8/17/10 19:00			
8/17/10 20:00	79.54	79.72	0.18
8/17/10 21:00	79.52	79.72	0.198
8/17/10 22:00	79.05	79.25	0.198
8/17/10 23:00	78.14	78.35	0.216
8/18/10 0:00	77.23	77.41	0.18
8/18/10 1:00	76.18	76.29	0.108
8/18/10 2:00	75.43	75.52	0.09
8/18/10 3:00	75.09	75.09	0
8/18/10 4:00	75.21	75.19	-0.018
8/18/10 5:00	75.45	75.36	-0.09
8/18/10 6:00	75.53	75.40	-0.126
8/18/10 7:00	75.43	75.27	-0.162
8/18/10 8:00	75.30	75.12	-0.18
8/18/10 9:00	75.05	74.84	-0.216
8/18/10 10:00	74.82	74.61	-0.216
8/18/10 11:00	74.67	74.44	-0.234
8/18/10 12:00	74.64	74.40	-0.234
8/18/10 13:00	74.57	74.32	-0.252
8/18/10 14:00	74.44	74.23	-0.216
8/18/10 15:00	74.71	74.55	-0.162
8/18/10 16:00	75.92	75.83	-0.09
8/18/10 17:00	77.56	77.52	-0.036
8/18/10 18:00	79.53	79.61	0.072
8/18/10 19:00	81.59	81.68	0.09
8/18/10 20:00	83.26	83.37	0.108
8/18/10 21:00	84.00	83.96	-0.036
8/18/10 22:00	82.99	83.01	0.018
8/18/10 23:00	82.22	82.22	0
8/19/10 0:00	81.28	81.24	-0.036
8/19/10 1:00	80.33	80.25	-0.072
8/19/10 2:00	78.94	78.85	-0.09
8/19/10 3:00	77.76	77.65	-0.108
8/19/10 4:00	77.23	77.08	-0.144
8/19/10 5:00	77.18	77.02	-0.162
8/19/10 6:00	77.13	76.96	-0.162
8/19/10 7:00	76.79	76.61	-0.18
8/19/10 8:00	76.48	76.28	-0.198
8/19/10 9:00	76.23	76.03	-0.198
8/19/10 10:00	76.09	75.86	-0.234
8/19/10 11:00	76.26	76.03	-0.234
8/19/10 12:00	76.31	76.07	-0.234
8/19/10 13:00	75.96	75.70	-0.252
8/19/10 14:00	76.12	75.90	-0.216
8/19/10 15:00	76.55	76.37	-0.18
8/19/10 16:00	77.12	77.01	-0.108



8/19/10 17:00	77.92	77.90	-0.018
8/19/10 18:00	80.02	80.03	0.018
8/19/10 19:00	80.94	81.01	0.072
8/19/10 20:00	81.79	81.92	0.126
8/19/10 21:00	83.36	83.42	0.054
8/19/10 22:00	81.88	81.95	0.072
8/19/10 23:00	80.80	80.76	-0.036
8/20/10 0:00	79.78	79.75	-0.036
8/20/10 1:00	79.12	79.07	-0.054
8/20/10 2:00	78.25	78.18	-0.072
8/20/10 3:00	77.58	77.49	-0.09
8/20/10 4:00	77.27	77.14	-0.126
8/20/10 5:00	77.07	76.94	-0.126
8/20/10 6:00	76.86	76.72	-0.144
8/20/10 7:00	76.46	76.31	-0.144
8/20/10 8:00	75.98	75.82	-0.162
8/20/10 9:00	75.63	75.45	-0.18
8/20/10 10:00	75.42	75.24	-0.18
8/20/10 11:00	75.45	75.27	-0.18
8/20/10 12:00	75.43	75.25	-0.18
8/20/10 13:00	75.39	75.21	-0.18
8/20/10 14:00	75.31	75.15	-0.162
8/20/10 15:00	75.25	75.14	-0.108
8/20/10 16:00	75.20	75.16	-0.036
8/20/10 17:00	75.14	75.19	0.054
8/20/10 18:00	74.99	75.13	0.144
8/20/10 19:00	75.07	75.30	0.234
8/20/10 20:00	75.19	75.49	0.306
8/20/10 21:00	75.45	75.81	0.36
8/20/10 22:00	75.73	76.00	0.27
8/20/10 23:00	75.80	76.09	0.288
8/21/10 0:00	75.74	76.02	0.288
8/21/10 1:00	75.59	75.79	0.198
8/21/10 2:00	75.58	75.74	0.162
8/21/10 3:00	75.48	75.61	0.126
8/21/10 4:00	75.38	75.47	0.09
8/21/10 5:00	75.30	75.38	0.072
8/21/10 6:00	75.24	75.27	0.036
8/21/10 7:00	75.25	75.25	0
8/21/10 8:00	75.30	75.28	-0.018
8/21/10 9:00	75.32	75.29	-0.036
8/21/10 10:00	75.29	75.23	-0.054
8/21/10 11:00	75.17	75.10	-0.072
8/21/10 12:00	75.11	75.03	-0.072
8/21/10 13:00	75.07	74.98	-0.09
8/21/10 14:00	75.22	75.15	-0.072
8/21/10 15:00	75.78	75.76	-0.018
8/21/10 16:00	76.83	76.87	0.036

8/21/10 17:00	77.70	77.81	0.108
8/21/10 18:00	77.88	78.02	0.144
8/21/10 19:00	78.82	78.94	0.126
8/21/10 20:00	80.02	80.16	0.144
8/21/10 21:00	80.83	80.83	0
8/21/10 22:00	80.96	80.96	0
8/21/10 23:00	83.84	83.73	-0.108
8/22/10 0:00	84.16	84.07	-0.09
8/22/10 1:00	81.68	81.57	-0.108
8/22/10 2:00	79.85	79.74	-0.108
8/22/10 3:00	77.92	77.81	-0.108
8/22/10 4:00	76.52	76.38	-0.144
8/22/10 5:00	75.70	75.53	-0.162
8/22/10 6:00	75.13	74.97	-0.162
8/22/10 7:00	74.72	74.54	-0.18
8/22/10 8:00	74.34	74.14	-0.198
8/22/10 9:00	74.03	73.81	-0.216
8/22/10 10:00	73.97	73.76	-0.216
8/22/10 11:00	74.10	73.87	-0.234
8/22/10 12:00	73.99	73.72	-0.27
8/22/10 13:00	73.74	73.47	-0.27
8/22/10 14:00	73.62	73.37	-0.252
8/22/10 15:00	73.90	73.70	-0.198
8/22/10 16:00	75.14	75.01	-0.126
8/22/10 17:00	77.73	77.69	-0.036
8/22/10 18:00	80.74	80.80	0.054
8/22/10 19:00	84.01	84.06	0.054
8/22/10 20:00	84.74	84.77	0.036
8/22/10 21:00	84.36	84.38	0.018
8/22/10 22:00	84.12	84.14	0.018
8/22/10 23:00	84.03	84.01	-0.018
8/23/10 0:00	83.81	83.65	-0.162
8/23/10 1:00	81.82	81.68	-0.144
8/23/10 2:00	79.23	79.07	-0.162
8/23/10 3:00	77.44	77.27	-0.162
8/23/10 4:00	76.35	76.19	-0.162
8/23/10 5:00	75.71	75.55	-0.162
8/23/10 6:00	75.28	75.10	-0.18
8/23/10 7:00	74.84	74.65	-0.198
8/23/10 8:00	74.44	74.24	-0.198
8/23/10 9:00	74.06	73.86	-0.198
8/23/10 10:00	73.79	73.59	-0.198
8/23/10 11:00	73.55	73.36	-0.198
8/23/10 12:00	73.27	73.08	-0.198
8/23/10 13:00	72.92	72.71	-0.216
8/23/10 14:00	72.80	72.62	-0.18
8/23/10 15:00	73.42	73.29	-0.126
8/23/10 16:00	75.29	75.25	-0.036

8/23/10 17:00	77.13	77.16	0.036
8/23/10 18:00	79.82	79.97	0.144
8/23/10 19:00	82.25	82.48	0.234
8/23/10 20:00	82.22	82.49	0.27
8/23/10 21:00	80.81	81.10	0.288
8/23/10 22:00	79.47	79.77	0.306
8/23/10 23:00	78.63	78.90	0.27
8/24/10 0:00	78.30	78.48	0.18
8/24/10 1:00	78.39	78.53	0.144
8/24/10 2:00	78.31	78.41	0.108
8/24/10 3:00	76.89	76.95	0.054
8/24/10 4:00	75.38	75.40	0.018
8/24/10 5:00	74.59	74.56	-0.036
8/24/10 6:00	74.18	74.08	-0.108
8/24/10 7:00	73.90	73.76	-0.144
8/24/10 8:00	73.63	73.45	-0.18
8/24/10 9:00	73.37	73.19	-0.18
8/24/10 10:00	73.18	72.96	-0.216
8/24/10 11:00	72.98	72.74	-0.234
8/24/10 12:00	72.86	72.63	-0.234
8/24/10 13:00	72.97	72.72	-0.252
8/24/10 14:00	73.16	72.95	-0.216
8/24/10 15:00	73.72	73.54	-0.18
8/24/10 16:00	74.93	74.82	-0.108
8/24/10 17:00	77.18	77.18	0
8/24/10 18:00	80.23	80.34	0.108
8/24/10 19:00	82.66	82.84	0.18
8/24/10 20:00	84.47	84.58	0.108
8/24/10 21:00	85.42	85.52	0.108
8/24/10 22:00	85.53	85.42	-0.108
8/24/10 23:00	84.98	84.92	-0.054
8/25/10 0:00	83.41	83.34	-0.072
8/25/10 1:00	81.28	81.20	-0.072
8/25/10 2:00	79.10	79.03	-0.072
8/25/10 3:00	77.83	77.74	-0.09
8/25/10 4:00	77.00	76.90	-0.108
8/25/10 5:00	76.44	76.33	-0.108
8/25/10 6:00	76.04	75.93	-0.108
8/25/10 7:00	75.71	75.58	-0.126
8/25/10 8:00	75.37	75.22	-0.144
8/25/10 9:00	75.12	74.96	-0.162
8/25/10 10:00	74.89	74.72	-0.162
8/25/10 11:00	74.63	74.45	-0.18
8/25/10 12:00	74.34	74.16	-0.18
8/25/10 13:00	74.16	73.98	-0.18
8/25/10 14:00	74.21	74.05	-0.162
8/25/10 15:00	74.76	74.65	-0.108
8/25/10 16:00	76.48	76.46	-0.018

8/25/10 17:00	79.45	79.48	0.036
8/25/10 18:00	82.87	83.01	0.144
8/25/10 19:00	85.61	85.64	0.036
8/25/10 20:00	86.89	86.84	-0.054
8/25/10 21:00	87.72	87.70	-0.018
8/25/10 22:00	87.70	87.66	-0.036
8/25/10 23:00	87.00	86.95	-0.054
8/26/10 0:00	85.66	85.55	-0.108
8/26/10 1:00	83.48	83.35	-0.126
8/26/10 2:00	80.98	80.86	-0.126
8/26/10 3:00	78.53	78.37	-0.162
8/26/10 4:00	76.69	76.52	-0.162
8/26/10 5:00	75.39	75.21	-0.18
8/26/10 6:00	74.55	74.35	-0.198
8/26/10 7:00	73.85	73.66	-0.198
8/26/10 8:00	73.29	73.09	-0.198
8/26/10 9:00	72.77	72.58	-0.198
8/26/10 10:00	72.39	72.18	-0.216
8/26/10 11:00	72.09	71.87	-0.216
8/26/10 13:00	71.49	71.29	-0.198
8/26/10 14:00	71.35	71.19	-0.162
8/26/10 15:00	71.87	71.76	-0.108
8/26/10 16:00	73.85	73.83	-0.018
8/26/10 17:00	76.97	77.06	0.09
8/26/10 18:00	79.81	79.97	0.162
8/26/10 19:00	82.21	82.45	0.234
8/26/10 20:00	84.06	84.34	0.288
8/26/10 21:00	84.55	84.80	0.252
8/26/10 22:00	84.51	84.79	0.288
8/26/10 23:00	83.47	83.65	0.18
8/27/10 0:00	81.68	81.81	0.126
8/27/10 1:00	79.71	79.82	0.108
8/27/10 2:00	78.16	78.27	0.108
8/27/10 3:00	77.24	77.26	0.018
8/27/10 4:00	76.61	76.59	-0.018
8/27/10 5:00	76.13	76.11	-0.018
8/27/10 6:00	75.95	75.90	-0.054
8/27/10 7:00	75.73	75.64	-0.09
8/27/10 8:00	75.56	75.47	-0.09
8/27/10 9:00	75.41	75.32	-0.09
8/27/10 10:00	75.20	75.11	-0.09
8/27/10 11:00	74.80	74.69	-0.108
8/27/10 12:00	74.59	74.50	-0.09
8/27/10 13:00	74.74	74.66	-0.072
8/27/10 14:00	74.91	74.85	-0.054
8/27/10 15:00	74.66	74.65	-0.018
8/27/10 16:00	74.19	74.22	0.036

8/27/10 17:00	74.03	74.12	0.09
8/27/10 18:00	75.10	75.22	0.126
8/27/10 19:00	76.70	76.90	0.198
8/27/10 20:00	78.08	78.32	0.234
8/27/10 21:00	77.70	77.90	0.198
8/27/10 22:00	77.36	77.23	-0.126
8/27/10 23:00	77.86	77.77	-0.09
8/28/10 0:00	79.53	79.40	-0.126
8/28/10 1:00	78.63	78.47	-0.162
8/28/10 2:00	77.05	76.85	-0.198
8/28/10 3:00	75.90	75.74	-0.162
8/28/10 4:00	75.66	75.52	-0.144
8/28/10 5:00	75.25	75.12	-0.126
8/28/10 6:00	75.09	74.96	-0.126
8/28/10 7:00	74.97	74.84	-0.126
8/28/10 8:00	74.61	74.48	-0.126
8/28/10 9:00	74.17	74.03	-0.144
8/28/10 10:00	74.16	74.02	-0.144
8/28/10 11:00	73.94	73.79	-0.144
8/28/10 12:00	73.82	73.68	-0.144
8/28/10 13:00	73.82	73.69	-0.126
8/28/10 14:00	73.98	73.85	-0.126
8/28/10 15:00	74.15	74.06	-0.09
8/28/10 16:00	74.55	74.53	-0.018
8/28/10 17:00	75.15	75.22	0.072
8/28/10 18:00	75.15	75.31	0.162
8/28/10 19:00	75.36	75.56	0.198
8/28/10 20:00	76.96	77.14	0.18
8/28/10 21:00	78.47	78.67	0.198
8/28/10 22:00	77.09	77.25	0.162
8/28/10 23:00	75.34	75.46	0.126
8/29/10 0:00	75.06	75.02	-0.036
8/29/10 1:00	75.11	75.00	-0.108
8/29/10 2:00	74.38	74.24	-0.144
8/29/10 3:00	74.26	74.10	-0.162
8/29/10 4:00	74.29	74.11	-0.18
8/29/10 5:00	74.24	74.04	-0.198
8/29/10 6:00	74.06	73.86	-0.198
8/29/10 7:00	73.83	73.63	-0.198
8/29/10 8:00	73.60	73.40	-0.198
8/29/10 9:00	73.47	73.26	-0.216
8/29/10 10:00	73.34	73.13	-0.216
8/29/10 11:00	73.22	73.01	-0.216
8/29/10 12:00	73.12	72.90	-0.216
8/29/10 13:00	73.00	72.78	-0.216
8/29/10 14:00	72.94	72.74	-0.198
8/29/10 15:00	73.08	72.94	-0.144
8/29/10 16:00	73.65	73.58	-0.072

8/29/10 17:00	73.54	73.55	0.018
8/29/10 18:00	73.63	73.73	0.108
8/29/10 19:00	74.09	74.25	0.162
8/29/10 20:00	74.66	74.84	0.18
8/29/10 21:00	74.19	74.33	0.144
8/29/10 22:00	74.47	74.62	0.144
8/29/10 23:00	74.03	74.08	0.054
8/30/10 0:00	73.66	73.70	0.036
8/30/10 1:00	73.58	73.58	0
8/30/10 2:00	73.50	73.47	-0.036
8/30/10 3:00	73.25	73.18	-0.072
8/30/10 4:00	73.14	73.05	-0.09
8/30/10 5:00	73.08	72.97	-0.108
8/30/10 6:00	73.02	72.91	-0.108
8/30/10 7:00	72.92	72.82	-0.108
8/30/10 8:00	72.80	72.67	-0.126
8/30/10 9:00	72.72	72.59	-0.126
8/30/10 10:00	72.60	72.46	-0.144
8/30/10 11:00	72.48	72.32	-0.162
8/30/10 12:00	72.44	72.28	-0.162
8/30/10 13:00	72.37	72.21	-0.162
8/30/10 14:00	72.25	72.09	-0.162
8/30/10 15:00	72.33	72.20	-0.126
8/30/10 16:00	72.54	72.49	-0.054
8/30/10 17:00	72.77	72.79	0.018
8/30/10 18:00	72.61	72.68	0.072
8/30/10 19:00	72.88	72.99	0.108
8/30/10 20:00	73.23	73.36	0.126
8/30/10 21:00	73.22	73.33	0.108
8/30/10 22:00	73.00	73.12	0.126
8/30/10 23:00	72.98	73.07	0.09
8/31/10 0:00	72.90	72.93	0.036
8/31/10 1:00	72.68	72.70	0.018
8/31/10 2:00	72.50	72.50	0
8/31/10 3:00	72.23	72.21	-0.018
8/31/10 4:00	72.03	71.98	-0.054
8/31/10 5:00	71.85	71.78	-0.072
8/31/10 6:00	71.69	71.60	-0.09
8/31/10 7:00	71.51	71.40	-0.108
8/31/10 8:00	71.32	71.20	-0.126
8/31/10 9:00	71.20	71.03	-0.162
8/31/10 10:00	71.09	70.93	-0.162
8/31/10 11:00	70.94	70.76	-0.18
8/31/10 12:00	70.80	70.61	-0.198
8/31/10 13:00	70.67	70.47	-0.198
8/31/10 14:00	70.58	70.38	-0.198
8/31/10 15:00	70.59	70.43	-0.162
8/31/10 16:00	70.92	70.83	-0.09

8/31/10 17:00	71.44	71.38	-0.054
8/31/10 18:00	71.71	71.74	0.036
8/31/10 19:00			0.108
8/31/10 20:00	72.26	72.33	0.072
8/31/10 21:00	72.60	72.64	0.036
8/31/10 22:00	72.82	72.78	-0.036
8/31/10 23:00	72.80	72.64	-0.162



**Sonde 3 Environmental Lab (shallow)**

Day	Tdata (F)	Tmodified (F)	delta T (F)
6/22/10 16:00	77.59	78.40	0.81
6/22/10 17:00	77.70	77.76	0.054
6/22/10 18:00	77.68	77.65	-0.036
6/22/10 19:00	77.68	77.59	-0.09
6/22/10 20:00	77.49	77.27	-0.216
6/22/10 21:00	77.41	77.13	-0.288
6/22/10 22:00	77.29	76.95	-0.342
6/22/10 23:00	77.18	76.80	-0.378
6/23/10 0:00	77.04	76.62	-0.414
6/23/10 1:00	76.86	76.44	-0.414
6/23/10 2:00	76.71	76.28	-0.432
6/23/10 3:00	76.55	76.10	-0.45
6/23/10 4:00	76.44	76.03	-0.414
6/23/10 5:00	76.23	75.83	-0.396
6/23/10 6:00	75.69	75.36	-0.324
6/23/10 7:00	75.97	75.79	-0.18
6/23/10 8:00	76.30	76.32	0.018
6/23/10 9:00	77.09	77.32	0.234
6/23/10 10:00	77.95	78.39	0.432
6/23/10 15:00	79.90	80.03	0.126
6/23/10 16:00	79.78	79.89	0.108
6/23/10 17:00	79.52	79.38	-0.144
6/23/10 18:00	79.14	78.96	-0.18
6/23/10 19:00	78.69	78.44	-0.252
6/23/10 20:00	78.43	78.16	-0.27
6/23/10 21:00	78.20	77.87	-0.324
6/23/10 22:00	77.93	77.59	-0.342
6/23/10 23:00	77.72	77.36	-0.36
6/24/10 0:00	77.48	77.12	-0.36
6/24/10 1:00	77.29	77.02	-0.27
6/24/10 2:00	77.14	76.98	-0.162
6/24/10 3:00	77.06	76.91	-0.144
6/24/10 4:00	76.94	76.83	-0.108
6/24/10 5:00	76.79	76.67	-0.126
6/24/10 6:00	76.71	76.62	-0.09
6/24/10 7:00	76.77	76.88	0.108
6/24/10 8:00	76.90	77.06	0.162
6/24/10 9:00	77.32	77.57	0.252
6/24/10 10:00	78.11	78.24	0.126
6/24/10 11:00	79.05	78.94	-0.108
6/24/10 12:00	79.40	79.51	0.108
6/24/10 13:00	79.51	79.46	-0.054
6/24/10 14:00	79.66	79.58	-0.072

6/24/10 15:00	79.69	79.52	-0.162
6/24/10 16:00	79.63	79.69	0.054
6/24/10 17:00	79.48	79.45	-0.036
6/24/10 18:00	79.22	79.13	-0.09
6/24/10 19:00	78.90	78.74	-0.162
6/24/10 20:00	78.58	78.42	-0.162
6/24/10 21:00	78.36	78.34	-0.018
6/24/10 22:00	78.03	77.98	-0.054
6/24/10 23:00	77.81	77.73	-0.072
6/25/10 0:00	77.68	77.59	-0.09
6/25/10 1:00	77.56	77.45	-0.108
6/25/10 2:00	77.24	77.11	-0.126
6/25/10 3:00	77.06	76.92	-0.144
6/25/10 4:00	76.68	76.50	-0.18
6/25/10 5:00	76.45	76.25	-0.198
6/25/10 6:00	76.26	76.08	-0.18
6/25/10 7:00	76.73	76.68	-0.054
6/25/10 8:00	77.41	77.52	0.108
6/25/10 9:00	78.38	78.67	0.288
6/25/10 10:00	79.42	79.82	0.396
6/25/10 11:00	80.42	80.59	0.162
6/25/10 12:00	81.07	81.52	0.45
6/25/10 13:00	81.14	81.77	0.63
6/25/10 14:00	81.21	81.91	0.702
6/25/10 15:00	81.30	81.54	0.234
6/25/10 16:00	80.97	80.83	-0.144
6/25/10 17:00	80.86	80.74	-0.126
6/25/10 18:00	80.47	80.29	-0.18
6/25/10 19:00	79.91	79.64	-0.27
6/25/10 20:00	79.53	79.21	-0.324
6/25/10 21:00	78.93	78.53	-0.396
6/25/10 22:00	78.44	78.01	-0.432
6/25/10 23:00	77.79	77.34	-0.45
6/26/10 0:00	77.68	77.23	-0.45
6/26/10 1:00	76.94	76.46	-0.486
6/26/10 2:00	76.95	76.46	-0.486
6/26/10 3:00	76.59	76.09	-0.504
6/26/10 4:00	76.54	76.03	-0.504
6/26/10 5:00	76.42	75.93	-0.486
6/26/10 6:00	76.12	75.70	-0.414
6/26/10 7:00	76.40	76.10	-0.306
6/26/10 8:00	77.24	77.13	-0.108
6/26/10 9:00	78.44	78.56	0.126
6/26/10 10:00	79.74	80.08	0.342
6/26/10 11:00	80.92	81.20	0.288
6/26/10 12:00	81.71	82.23	0.522
6/26/10 13:00	82.08	81.83	-0.252
6/26/10 14:00	82.31	82.24	-0.072
6/26/10 15:00	82.24	82.19	-0.054
6/26/10 16:00	81.77	81.84	0.072

6/26/10 17:00	81.42	81.49	0.072
6/26/10 18:00	81.01	81.05	0.036
6/26/10 19:00	80.45	80.43	-0.018
6/26/10 20:00	80.01	79.86	-0.144
6/26/10 21:00	79.53	79.28	-0.252
6/26/10 22:00	79.06	78.72	-0.342
6/26/10 23:00	78.62	78.24	-0.378
6/27/10 0:00	78.23	77.84	-0.396
6/27/10 1:00	77.88	77.49	-0.396
6/27/10 2:00	77.56	77.20	-0.36
6/27/10 3:00	77.22	76.84	-0.378
6/27/10 4:00	76.87	76.49	-0.378
6/27/10 5:00	76.85	76.49	-0.36
6/27/10 6:00	76.69	76.39	-0.306
6/27/10 7:00	76.33	76.11	-0.216
6/27/10 8:00	76.69	76.62	-0.072
6/27/10 9:00	77.36	77.58	0.216
6/27/10 10:00	78.40	78.76	0.36
6/27/10 11:00	79.54	80.06	0.522
6/27/10 12:00	80.14	79.96	-0.18
6/27/10 13:00	80.19	80.26	0.072
6/27/10 14:00	80.47	80.47	0
6/27/10 15:00	81.18	81.14	-0.036
6/27/10 16:00	81.51	81.41	-0.108
6/27/10 17:00	81.50	81.41	-0.09
6/27/10 18:00	81.51	81.35	-0.162
6/27/10 19:00	81.14	81.00	-0.144
6/27/10 20:00	80.86	80.72	-0.144
6/27/10 21:00	80.51	80.36	-0.144
6/27/10 22:00	80.12	80.00	-0.126
6/27/10 23:00	79.73	79.62	-0.108
6/28/10 0:00	79.42	79.33	-0.09
6/28/10 1:00	79.22	79.18	-0.036
6/28/10 2:00	79.06	79.04	-0.018
6/28/10 3:00	78.94	78.93	-0.018
6/28/10 4:00	78.89	78.85	-0.036
6/28/10 5:00	78.80	78.78	-0.018
6/28/10 6:00	78.71	78.72	0.018
6/28/10 7:00	78.88	78.97	0.09
6/28/10 8:00	79.13	79.31	0.18
6/28/10 9:00	79.63	79.83	0.198
6/28/10 10:00	80.34	80.51	0.162
6/28/10 11:00	80.56	80.60	0.036
6/28/10 12:00	80.51	80.71	0.198
6/28/10 13:00	80.41	80.66	0.252
6/28/10 14:00	80.21	80.41	0.198
6/28/10 15:00	80.15	80.09	-0.054
6/28/10 16:00	80.22	80.06	-0.162
6/28/10 17:00	80.28	80.14	-0.144
6/28/10 18:00	80.30	80.08	-0.216

6/28/10 19:00	80.21	80.03	-0.18
6/28/10 20:00	80.01	79.83	-0.18
6/28/10 21:00	79.63	79.43	-0.198
6/28/10 22:00	79.34	79.12	-0.216
6/28/10 23:00	79.02	78.78	-0.234
6/29/10 0:00	78.76	78.53	-0.234
6/29/10 1:00	78.55	78.31	-0.234
6/29/10 2:00	78.48	78.26	-0.216
6/29/10 3:00	78.15	77.95	-0.198
6/29/10 4:00	78.14	77.93	-0.216
6/29/10 5:00	77.91	77.66	-0.252
6/29/10 6:00	77.90	77.70	-0.198
6/29/10 7:00	78.11	78.02	-0.09
6/29/10 8:00	78.26	78.30	0.036
6/29/10 9:00	78.46	78.62	0.162
6/29/10 10:00	78.98	78.54	-0.432
6/29/10 11:00	79.73	79.89	0.162
6/29/10 12:00	80.40	80.51	0.108
6/29/10 13:00	80.93	80.92	-0.018
6/29/10 14:00	81.37	81.15	-0.216
6/29/10 15:00	81.32	81.30	-0.018
6/29/10 16:00	81.14	81.14	0
6/29/10 17:00	80.68	80.54	-0.144
6/29/10 18:00	80.08	79.92	-0.162
6/29/10 19:00	79.39	79.28	-0.108
6/29/10 20:00	78.69	78.58	-0.108
6/29/10 21:00	78.00	77.87	-0.126
6/29/10 22:00	77.47	77.29	-0.18
6/29/10 23:00	76.75	76.55	-0.198
6/30/10 0:00	76.25	76.02	-0.234
6/30/10 1:00	75.97	75.72	-0.252
6/30/10 2:00	75.45	75.22	-0.234
6/30/10 3:00	75.06	74.80	-0.252
6/30/10 4:00	74.67	74.40	-0.27
6/30/10 5:00	74.10	73.81	-0.288
6/30/10 6:00	73.99	73.72	-0.27
6/30/10 7:00	74.24	74.13	-0.108
6/30/10 8:00	75.09	75.16	0.072
6/30/10 9:00	76.29	76.53	0.234
6/30/10 10:00	77.92	78.28	0.36
6/30/10 11:00	78.95	79.40	0.45
6/30/10 12:00	79.77	80.24	0.468
6/30/10 13:00	79.82	79.91	0.09
6/30/10 14:00	80.67	80.47	-0.198
6/30/10 15:00	80.38	80.29	-0.09
6/30/10 16:00	79.66	79.64	-0.018
6/30/10 17:00	78.99	78.94	-0.054
6/30/10 18:00	78.53	78.39	-0.144
6/30/10 19:00	78.06	77.86	-0.198
6/30/10 20:00	77.36	77.13	-0.234

6/30/10 21:00	76.66	76.39	-0.27
6/30/10 22:00	76.04	75.73	-0.306
6/30/10 23:00	75.56	75.26	-0.306
7/1/10 0:00	75.09	74.75	-0.342
7/1/10 1:00	74.37	73.99	-0.378
7/1/10 2:00	73.99	73.57	-0.414
7/1/10 3:00	73.63	73.20	-0.432
7/1/10 4:00	73.00	72.55	-0.45
7/1/10 5:00	72.80	72.35	-0.45
7/1/10 6:00	72.39	71.98	-0.414
7/1/10 7:00	72.84	72.55	-0.288
7/1/10 8:00	73.82	73.94	0.126
7/1/10 9:00	74.92	75.19	0.27
7/1/10 10:00	76.32	76.48	0.162
7/1/10 11:00	77.49	77.68	0.198
7/1/10 12:00	77.52	77.50	-0.018
7/1/10 13:00	77.32	77.43	0.108
7/1/10 14:00	77.31	77.31	0
7/1/10 15:00	77.28	76.94	-0.342
7/1/10 16:00	76.32	76.36	0.036
7/1/10 17:00	76.09	76.10	0.018
7/1/10 18:00	75.65	75.48	-0.162
7/1/10 19:00	75.31	75.15	-0.162
7/1/10 20:00	74.77	74.61	-0.162
7/1/10 21:00	74.17	73.99	-0.18
7/1/10 22:00	73.61	73.41	-0.198
7/1/10 23:00	73.18	72.95	-0.234
7/2/10 0:00	72.62	72.37	-0.252
7/2/10 1:00	72.58	72.31	-0.27
7/2/10 2:00	72.18	71.87	-0.306
7/2/10 3:00	72.02	71.69	-0.324
7/2/10 4:00	71.72	71.38	-0.342
7/2/10 5:00	71.29	70.91	-0.378
7/2/10 6:00	70.97	70.63	-0.342
7/2/10 7:00	71.52	71.29	-0.234
7/2/10 8:00	72.34	72.28	-0.054
7/2/10 9:00	73.57	73.76	0.198
7/2/10 10:00	75.08	75.55	0.468
7/2/10 11:00	76.14	76.63	0.486
7/2/10 12:00	77.23	77.32	0.09
7/2/10 13:00	77.76	78.05	0.288
7/2/10 14:00	77.15	77.22	0.072
7/2/10 15:00	77.04	77.20	0.162
7/2/10 16:00	76.89	76.87	-0.018
7/2/10 17:00	76.47	76.49	0.018
7/2/10 18:00	76.00	76.02	0.018
7/2/10 19:00	75.54	75.45	-0.09
7/2/10 20:00	75.15	74.97	-0.18
7/2/10 21:00	74.68	74.39	-0.288
7/2/10 22:00	74.07	73.71	-0.36

7/2/10 23:00	73.51	73.11	-0.396
7/3/10 0:00	72.99	72.57	-0.414
7/3/10 1:00	72.90	72.48	-0.414
7/3/10 2:00	72.58	72.17	-0.414
7/3/10 3:00	72.06	71.66	-0.396
7/3/10 4:00	72.01	71.65	-0.36
7/3/10 5:00	71.84	71.46	-0.378
7/3/10 6:00	71.76	71.42	-0.342
7/3/10 7:00	72.02	71.79	-0.234
7/3/10 8:00	72.93	72.89	-0.036
7/3/10 9:00	74.35	74.59	0.234
7/3/10 10:00	75.69	76.19	0.504
7/3/10 11:00	77.09	77.76	0.666
7/3/10 12:00	77.99	78.89	0.9
7/3/10 13:00	78.65	79.46	0.81
7/3/10 14:00	78.86	79.64	0.774
7/3/10 15:00	78.64	79.56	0.918
7/3/10 16:00	78.03	78.55	0.522
7/3/10 17:00	77.55	77.51	-0.036
7/3/10 18:00	77.16	76.94	-0.216
7/3/10 19:00	76.72	76.41	-0.306
7/3/10 20:00	76.19	75.83	-0.36
7/3/10 21:00	75.68	75.30	-0.378
7/3/10 22:00	75.14	74.73	-0.414
7/3/10 23:00	74.79	74.34	-0.45
7/4/10 0:00	74.40	73.94	-0.468
7/4/10 1:00	74.14	73.63	-0.504
7/4/10 2:00	73.58	73.06	-0.522
7/4/10 3:00	73.35	72.81	-0.54
7/4/10 4:00	73.34	72.80	-0.54
7/4/10 5:00	73.02	72.46	-0.558
7/4/10 6:00	73.05	72.51	-0.54
7/4/10 7:00	73.38	72.98	-0.396
7/4/10 8:00	74.26	74.07	-0.198
7/4/10 9:00	75.74	75.82	0.072
7/4/10 10:00	77.39	77.73	0.342
7/4/10 11:00	78.67	79.19	0.522
7/4/10 12:00	79.88	80.46	0.576
7/4/10 13:00	80.58	80.34	-0.234
7/4/10 14:00	80.80	80.62	-0.18
7/4/10 15:00	80.60	80.53	-0.072
7/4/10 16:00	80.27	80.02	-0.252
7/4/10 17:00	79.88	79.76	-0.126
7/4/10 18:00	79.62	79.53	-0.09
7/4/10 19:00	78.99	78.94	-0.054
7/4/10 20:00	78.34	78.28	-0.054
7/4/10 21:00	77.70	77.61	-0.09
7/4/10 22:00	77.23	77.12	-0.108
7/4/10 23:00	76.67	76.54	-0.126
7/5/10 0:00	76.17	76.03	-0.144

7/5/10 1:00	75.61	75.43	-0.18
7/5/10 2:00	75.18	74.98	-0.198
7/5/10 3:00	75.03	74.81	-0.216
7/5/10 4:00	74.82	74.59	-0.234
7/5/10 5:00	74.75	74.49	-0.252
7/5/10 6:00	74.66	74.43	-0.234
7/5/10 7:00	75.05	74.93	-0.126
7/5/10 8:00	75.99	76.06	0.072
7/5/10 9:00	77.75	78.09	0.342
7/5/10 10:00	79.20	79.81	0.612
7/5/10 11:00	80.85	81.68	0.828
7/5/10 12:00	82.21	82.57	0.36
7/5/10 13:00	82.80	82.85	0.054
7/5/10 14:00	83.13	83.37	0.234
7/5/10 15:00	83.09	83.25	0.162
7/5/10 16:00	82.67	82.46	-0.216
7/5/10 17:00	82.25	82.05	-0.198
7/5/10 18:00	81.99	81.83	-0.162
7/5/10 19:00	81.41	81.21	-0.198
7/5/10 20:00	80.92	80.69	-0.234
7/5/10 21:00	80.34	80.07	-0.27
7/5/10 22:00	79.75	79.44	-0.306
7/5/10 23:00	79.16	78.84	-0.324
7/6/10 0:00	78.62	78.30	-0.324
7/6/10 1:00	78.22	77.92	-0.306
7/6/10 2:00	77.89	77.57	-0.324
7/6/10 3:00	77.60	77.27	-0.324
7/6/10 4:00	77.27	76.95	-0.324
7/6/10 5:00	77.14	76.83	-0.306
7/6/10 6:00	77.16	76.91	-0.252
7/6/10 7:00	77.51	77.37	-0.144
7/6/10 8:00	78.56	78.61	0.054
7/6/10 9:00	80.21	80.52	0.306
7/6/10 10:00	81.86	82.39	0.522
7/6/10 11:00	83.78	84.17	0.396
7/6/10 12:00	85.45	85.88	0.432
7/6/10 13:00	85.46	85.96	0.504
7/6/10 14:00	84.84	85.52	0.684
7/6/10 15:00	84.81	84.88	0.072
7/6/10 16:00	84.57	84.70	0.126
7/6/10 17:00	84.25	84.41	0.162
7/6/10 18:00	84.03	84.07	0.036
7/6/10 19:00	83.90	83.84	-0.054
7/6/10 20:00	83.35	83.17	-0.18
7/6/10 21:00	82.62	82.24	-0.378
7/6/10 22:00	81.96	81.53	-0.432
7/6/10 23:00	81.64	81.21	-0.432
7/7/10 0:00	81.04	80.62	-0.414
7/7/10 1:00	80.66	80.23	-0.432
7/7/10 2:00	80.31	79.88	-0.432



7/7/10 3:00	80.00	79.58	-0.414
7/7/10 4:00	79.75	79.34	-0.414
7/7/10 5:00	79.45	79.07	-0.378
7/7/10 6:00	79.36	79.04	-0.324
7/7/10 7:00	79.79	79.59	-0.198
7/7/10 8:00	80.75	80.73	-0.018
7/7/10 9:00	82.40	82.61	0.216
7/7/10 10:00	84.24	84.36	0.126
7/7/10 11:00	86.29	86.58	0.288
7/7/10 12:00	87.24	87.53	0.288
7/7/10 13:00	88.07	88.07	0
7/7/10 14:00	88.07	87.69	-0.378
7/7/10 15:00	87.60	87.54	-0.054
7/7/10 16:00	87.08	87.22	0.144
7/7/10 17:00	86.71	86.76	0.054
7/7/10 18:00	86.22	85.80	-0.414
7/7/10 19:00	85.58	85.22	-0.36
7/7/10 20:00	84.83	84.48	-0.342
7/7/10 21:00	83.74	83.38	-0.36
7/7/10 22:00	82.89	82.54	-0.342
7/7/10 23:00	82.19	81.85	-0.342
7/8/10 0:00	81.02	80.71	-0.306
7/8/10 1:00	80.62	80.33	-0.288
7/8/10 2:00	80.07	79.80	-0.27
7/8/10 3:00	79.74	79.51	-0.234
7/8/10 4:00	79.86	79.61	-0.252
7/8/10 5:00	79.76	79.51	-0.252
7/8/10 6:00	79.16	78.94	-0.216
7/8/10 7:00	80.11	80.01	-0.108
7/8/10 8:00	81.19	81.26	0.072
7/8/10 9:00	82.80	83.12	0.324
7/8/10 10:00	84.84	85.70	0.864
7/8/10 11:00	87.14	87.68	0.54
7/8/10 17:00	86.79	86.61	-0.18
7/8/10 18:00	85.89	85.65	-0.234
7/8/10 19:00	85.16	84.93	-0.234
7/8/10 20:00	84.27	84.02	-0.252
7/8/10 21:00	83.65	83.40	-0.252
7/8/10 22:00	83.24	82.99	-0.252
7/8/10 23:00	82.76	82.49	-0.27
7/9/10 0:00	82.38	82.09	-0.288
7/9/10 1:00	82.12	81.83	-0.288
7/9/10 2:00	81.79	81.49	-0.306
7/9/10 3:00	81.44	81.14	-0.306
7/9/10 4:00	81.08	80.77	-0.306

7/9/10 5:00	80.68	80.37	-0.306
7/9/10 6:00	80.62	80.44	-0.18
7/9/10 7:00	80.94	80.92	-0.018
7/9/10 8:00	80.83	80.95	0.126
7/9/10 9:00	81.04	81.22	0.18
7/9/10 10:00	82.09	82.24	0.144
7/9/10 12:00	84.92	85.15	0.234
7/9/10 13:00	85.33	85.60	0.27
7/9/10 14:00	85.54	85.75	0.216
7/9/10 15:00	85.59	85.15	-0.432
7/9/10 16:00	85.41	85.26	-0.144
7/9/10 17:00	85.19	85.11	-0.072
7/9/10 18:00	84.62	84.49	-0.126
7/9/10 19:00	83.85	83.67	-0.18
7/9/10 20:00	83.22	83.02	-0.198
7/9/10 21:00	82.84	82.64	-0.198
7/9/10 22:00	82.47	82.27	-0.198
7/9/10 23:00	82.36	82.16	-0.198
7/10/10 0:00	82.04	81.88	-0.162
7/10/10 1:00	81.71	81.55	-0.162
7/10/10 2:00	81.48	81.32	-0.162
7/10/10 3:00	81.27	81.14	-0.126
7/10/10 4:00	81.09	80.96	-0.126
7/10/10 5:00	80.82	80.67	-0.144
7/10/10 6:00	80.56	80.42	-0.144
7/10/10 7:00	80.21	80.14	-0.072
7/10/10 8:00	80.16	80.24	0.072
7/10/10 9:00	80.14	80.34	0.198
7/10/10 10:00	80.25	80.61	0.36
7/10/10 11:00	80.38	80.99	0.612
7/10/10 12:00	80.83	81.67	0.846
7/10/10 13:00	81.57	82.43	0.864
7/10/10 14:00	82.53	83.23	0.702
7/10/10 15:00	83.17	83.10	-0.072
7/10/10 16:00	83.05	82.83	-0.216
7/10/10 17:00	83.02	82.69	-0.324
7/10/10 18:00	82.67	82.34	-0.324
7/10/10 19:00	82.11	81.75	-0.36
7/10/10 20:00	81.57	81.14	-0.432
7/10/10 21:00	81.51	81.08	-0.432
7/10/10 22:00	81.00	80.55	-0.45
7/10/10 23:00	80.48	80.01	-0.468
7/11/10 0:00	79.89	79.41	-0.486
7/11/10 1:00	79.42	78.94	-0.486
7/11/10 2:00	78.89	78.40	-0.486
7/11/10 3:00	78.48	77.96	-0.522
7/11/10 4:00	78.04	77.52	-0.522
7/11/10 5:00	77.73	77.21	-0.522
7/11/10 6:00	77.54	77.04	-0.504
7/11/10 7:00	77.49	77.13	-0.36

7/11/10 8:00	78.04	77.89	-0.144
7/11/10 9:00	79.45	79.54	0.09
7/11/10 10:00	81.74	82.10	0.36
7/11/10 11:00	84.13	84.54	0.414
7/11/10 12:00	86.00	86.63	0.63
7/11/10 13:00	86.64	87.02	0.378
7/11/10 14:00	86.28	86.09	-0.198
7/11/10 15:00	85.40	85.11	-0.288
7/11/10 16:00	85.27	85.14	-0.126
7/11/10 17:00	84.54	84.42	-0.126
7/11/10 18:00	84.11	83.89	-0.216
7/11/10 19:00	83.55	83.30	-0.252
7/11/10 20:00	82.81	82.51	-0.306
7/11/10 21:00	81.91	81.53	-0.378
7/11/10 22:00	81.19	80.81	-0.378
7/11/10 23:00	80.47	80.07	-0.396
7/12/10 0:00	79.75	79.37	-0.378
7/12/10 1:00	79.09	78.71	-0.378
7/12/10 2:00	78.50	78.16	-0.342
7/12/10 3:00	77.95	77.61	-0.342
7/12/10 4:00	77.52	77.16	-0.36
7/12/10 5:00	77.14	76.80	-0.342
7/12/10 6:00	77.01	76.74	-0.27
7/12/10 7:00	77.20	77.06	-0.144
7/12/10 8:00	77.57	77.59	0.018
7/12/10 9:00	78.73	79.02	0.288
7/12/10 10:00	80.65	81.23	0.576
7/12/10 11:00	83.03	83.40	0.378
7/12/10 12:00	84.78	85.18	0.396
7/12/10 13:00	84.94	85.19	0.252
7/12/10 14:00	84.74	85.13	0.396
7/12/10 15:00	84.03	83.85	-0.18
7/12/10 16:00	82.94	82.83	-0.108
7/12/10 17:00	81.61	81.57	-0.036
7/12/10 18:00	80.35	80.14	-0.216
7/12/10 19:00	79.89	79.66	-0.234
7/12/10 20:00	79.59	79.32	-0.27
7/12/10 21:00	79.31	79.01	-0.306
7/12/10 22:00	79.09	78.76	-0.324
7/12/10 23:00	78.76	78.45	-0.306
7/13/10 0:00	78.43	78.09	-0.342
7/13/10 1:00	78.14	77.82	-0.324
7/13/10 2:00	77.90	77.58	-0.324
7/13/10 3:00	77.67	77.32	-0.342
7/13/10 4:00	77.53	77.26	-0.27
7/13/10 5:00	77.09	76.82	-0.27
7/13/10 6:00	77.36	77.13	-0.234
7/13/10 7:00	77.49	77.38	-0.108
7/13/10 8:00	77.52	77.61	0.09
7/13/10 9:00	77.54	77.81	0.27

7/13/10 10:00	78.40	78.90	0.504
7/13/10 11:00	79.85	80.59	0.738
7/13/10 12:00	81.27	82.01	0.738
7/13/10 13:00	81.65	82.34	0.684
7/13/10 14:00	81.77	82.22	0.45
7/13/10 15:00	81.75	82.11	0.36
7/13/10 16:00	81.58	81.92	0.342
7/13/10 17:00	81.42	81.68	0.252
7/13/10 18:00	81.22	81.11	-0.108
7/13/10 19:00	80.87	80.60	-0.27
7/13/10 20:00	80.59	80.26	-0.324
7/13/10 21:00	80.21	79.84	-0.378
7/13/10 22:00	79.94	79.51	-0.432
7/13/10 23:00	79.75	79.32	-0.432
7/14/10 0:00	79.42	78.97	-0.45
7/14/10 1:00	79.20	78.76	-0.432
7/14/10 2:00	79.01	78.56	-0.45
7/14/10 3:00	78.76	78.31	-0.45
7/14/10 4:00	78.53	78.10	-0.432
7/14/10 5:00	78.34	77.92	-0.414
7/14/10 6:00	78.19	77.79	-0.396
7/14/10 7:00	78.03	77.76	-0.27
7/14/10 8:00	78.09	77.99	-0.108
7/14/10 9:00	78.20	78.31	0.108
7/14/10 10:00	78.43	78.75	0.324
7/14/10 11:00	78.85	79.24	0.396
7/14/10 12:00	79.01	79.50	0.486
7/14/10 13:00	79.18	79.65	0.468
7/14/10 14:00	79.66	79.78	0.126
7/14/10 15:00	80.34	80.56	0.216
7/14/10 16:00	80.82	80.86	0.036
7/14/10 17:00	80.58	80.49	-0.09
7/14/10 18:00	80.60	80.50	-0.108
7/14/10 19:00	80.08	79.90	-0.18
7/14/10 20:00	79.59	79.32	-0.27
7/14/10 21:00	79.08	78.74	-0.342
7/14/10 22:00	78.66	78.28	-0.378
7/14/10 23:00	78.22	77.80	-0.414
7/15/10 0:00	78.04	77.60	-0.432
7/15/10 1:00	77.89	77.44	-0.45
7/15/10 2:00	77.63	77.14	-0.486
7/15/10 3:00	77.57	77.08	-0.486
7/15/10 4:00	77.28	76.78	-0.504
7/15/10 5:00	77.30	76.80	-0.504
7/15/10 6:00	77.23	76.78	-0.45
7/15/10 7:00	77.27	76.97	-0.306
7/15/10 8:00	77.40	77.25	-0.144
7/15/10 9:00	77.89	77.90	0.018
7/15/10 10:00	78.28	78.55	0.27
7/15/10 11:00	78.86	79.37	0.504

7/15/10 12:00	80.59	81.32	0.738
7/15/10 13:00	82.69	83.29	0.594
7/16/10 13:00			
7/17/10 13:00			
7/18/10 13:00			
7/19/10 1:00	79.84	79.62	-0.216
7/19/10 2:00	79.36	79.16	-0.198
7/19/10 3:00	79.17	78.96	-0.216
7/19/10 4:00	79.02	78.84	-0.18
7/19/10 5:00	78.85	78.67	-0.18
7/19/10 6:00	78.76	78.60	-0.162
7/19/10 7:00	78.70	78.65	-0.054
7/19/10 8:00	79.12	79.23	0.108
7/19/10 9:00	80.71	81.07	0.36
7/19/10 10:00	82.83	83.19	0.36
7/19/10 11:00	84.30	84.75	0.45
7/19/10 12:00	85.79	85.79	0
7/19/10 13:00	86.62	86.50	-0.126
7/19/10 14:00	85.78	85.85	0.072
7/19/10 15:00	85.38	85.20	-0.18
7/19/10 16:00	84.88	84.92	0.036
7/19/10 17:00	84.43	84.54	0.108
7/19/10 18:00	83.97	83.99	0.018
7/19/10 19:00	83.54	83.40	-0.144
7/19/10 20:00	83.02	82.84	-0.18
7/19/10 21:00	82.67	82.44	-0.234
7/19/10 22:00	81.94	81.67	-0.27
7/19/10 23:00	81.64	81.35	-0.288
7/20/10 0:00	81.13	80.83	-0.306
7/20/10 1:00	80.63	80.30	-0.324
7/20/10 2:00	80.20	79.86	-0.342
7/20/10 3:00	79.82	79.48	-0.342
7/20/10 4:00	79.48	79.13	-0.342
7/20/10 5:00	79.19	78.83	-0.36
7/20/10 6:00	79.04	78.68	-0.36
7/20/10 7:00	79.12	78.87	-0.252
7/20/10 8:00	79.33	79.22	-0.108
7/20/10 9:00	79.49	79.60	0.108
7/20/10 10:00	79.83	80.08	0.252
7/20/10 11:00	80.03	80.48	0.45
7/20/10 12:00	80.53	81.07	0.54
7/20/10 13:00	82.46	82.71	0.252
7/20/10 14:00	83.96	84.07	0.108
7/20/10 15:00	84.41	84.39	-0.018
7/20/10 16:00	84.25	84.09	-0.162
7/20/10 17:00	83.62	83.51	-0.108
7/20/10 18:00	83.29	83.09	-0.198
7/20/10 19:00	83.02	82.73	-0.288
7/20/10 20:00	82.64	82.32	-0.324
7/20/10 21:00	82.12	81.77	-0.342

7/20/10 22:00	81.56	81.18	-0.378
7/20/10 23:00	81.12	80.73	-0.396
7/21/10 0:00	80.77	80.35	-0.414
7/21/10 1:00	80.38	79.97	-0.414
7/21/10 2:00	80.05	79.64	-0.414
7/21/10 3:00	79.78	79.37	-0.414
7/21/10 4:00	79.61	79.20	-0.414
7/21/10 5:00	79.35	78.92	-0.432
7/21/10 6:00	79.25	78.87	-0.378
7/21/10 7:00	79.24	78.98	-0.252
7/21/10 8:00	79.49	79.45	-0.036
7/21/10 9:00	80.23	80.38	0.144
7/21/10 10:00	81.76	81.90	0.144
7/21/10 11:00	82.83	83.01	0.18
7/21/10 12:00	85.03	84.94	-0.09
7/21/10 13:00	86.09	86.15	0.054
7/21/10 14:00	86.83	86.42	-0.414
7/21/10 15:00	87.08	87.51	0.432
7/21/10 16:00	86.88	86.54	-0.342
7/21/10 17:00	86.32	86.40	0.072
7/21/10 18:00	85.51	85.29	-0.216
7/21/10 19:00	84.44	84.33	-0.108
7/21/10 20:00	83.48	83.39	-0.09
7/21/10 21:00	82.90	82.81	-0.09
7/21/10 22:00	82.25	82.12	-0.126
7/21/10 23:00	81.68	81.54	-0.144
7/22/10 0:00	81.14	80.98	-0.162
7/22/10 1:00	80.69	80.49	-0.198
7/22/10 2:00	80.31	80.10	-0.216
7/22/10 3:00	79.79	79.56	-0.234
7/22/10 4:00	79.34	79.08	-0.252
7/22/10 5:00	78.99	78.76	-0.234
7/22/10 6:00	78.69	78.49	-0.198
7/22/10 7:00	78.80	78.74	-0.054
7/22/10 8:00	79.90	80.03	0.126
7/22/10 9:00	81.60	81.91	0.306
7/22/10 10:00	83.60	83.57	-0.036
7/22/10 11:00	85.20	85.38	0.18
7/22/10 12:00	85.91	85.78	-0.126
7/22/10 13:00	85.98	85.92	-0.054
7/22/10 14:00	86.52	86.54	0.018
7/22/10 15:00	86.90	86.92	0.018
7/22/10 16:00	86.68	86.65	-0.036
7/22/10 17:00	85.82	85.69	-0.126
7/22/10 18:00	84.67	84.56	-0.108
7/22/10 19:00	83.72	83.62	-0.108
7/22/10 20:00	82.77	82.64	-0.126
7/22/10 21:00	82.10	81.94	-0.162
7/22/10 22:00	81.41	81.23	-0.18
7/22/10 23:00	80.87	80.69	-0.18

7/23/10 0:00	80.36	80.16	-0.198
7/23/10 1:00	79.94	79.74	-0.198
7/23/10 2:00	79.68	79.48	-0.198
7/23/10 3:00	79.34	79.16	-0.18
7/23/10 4:00	79.04	78.84	-0.198
7/23/10 5:00	78.80	78.61	-0.198
7/23/10 6:00	78.58	78.42	-0.162
7/23/10 7:00	78.48	78.43	-0.054
7/23/10 8:00	78.35	78.40	0.054
7/23/10 9:00	78.32	78.55	0.234
7/23/10 10:00	78.48	78.95	0.468
7/23/10 11:00	78.89	79.61	0.72
7/23/10 12:00	79.16	80.10	0.936
7/23/10 17:00	82.51	82.36	-0.144
7/23/10 18:00	82.49	82.31	-0.18
7/23/10 19:00	82.24	82.04	-0.198
7/23/10 20:00	81.95	81.73	-0.216
7/23/10 21:00	81.52	81.30	-0.216
7/23/10 22:00	81.01	80.76	-0.252
7/23/10 23:00	80.51	80.27	-0.234
7/24/10 0:00	80.19	79.96	-0.234
7/24/10 1:00	79.70	79.48	-0.216
7/24/10 2:00	79.66	79.49	-0.162
7/24/10 3:00	79.27	79.13	-0.144
7/24/10 4:00	78.95	78.81	-0.144
7/24/10 5:00	78.60	78.45	-0.144
7/24/10 6:00	78.61	78.50	-0.108
7/24/10 7:00	78.84	78.85	0.018
7/24/10 8:00	79.69	79.84	0.144
7/24/10 9:00	81.21	81.55	0.342
7/24/10 10:00	82.79	83.24	0.45
7/24/10 11:00	84.14	84.59	0.45
7/24/10 12:00	85.24	85.64	0.396
7/24/10 13:00	86.38	86.25	-0.126
7/24/10 14:00	86.90	86.94	0.036
7/24/10 15:00	86.97	86.76	-0.216
7/24/10 16:00	86.50	86.39	-0.108
7/24/10 17:00	86.13	85.80	-0.324
7/24/10 18:00	85.87	85.67	-0.198
7/24/10 19:00	85.64	85.46	-0.18
7/24/10 20:00	85.06	84.90	-0.162
7/24/10 21:00	84.50	84.35	-0.144
7/24/10 22:00	83.80	83.67	-0.126
7/24/10 23:00	82.85	82.67	-0.18
7/25/10 0:00	82.17	82.08	-0.09
7/25/10 1:00	81.57	81.53	-0.036



7/25/10 2:00	81.03	80.99	-0.036
7/25/10 3:00	80.56	80.59	0.036
7/25/10 4:00	80.47	80.48	0.018
7/25/10 5:00	80.13	80.15	0.018
7/25/10 6:00	80.22	80.24	0.018
7/25/10 7:00	80.11	80.18	0.072
7/25/10 8:00	80.25	80.43	0.18
7/25/10 9:00	81.07	81.38	0.306
7/25/10 10:00	82.18	82.49	0.306
7/25/10 11:00	83.39	83.93	0.54
7/25/10 12:00	83.98	82.59	-1.386
7/25/10 13:00	83.64	82.99	-0.648
7/25/10 14:00	82.11	81.78	-0.324
7/25/10 15:00	81.71	81.53	-0.18
7/25/10 16:00	81.52	81.45	-0.072
7/25/10 17:00	81.52	81.39	-0.126
7/25/10 18:00	81.35	81.12	-0.234
7/25/10 19:00	81.26	80.93	-0.324
7/25/10 20:00	80.88	80.48	-0.396
7/25/10 21:00	80.25	79.84	-0.414
7/25/10 22:00	79.71	79.28	-0.432
7/25/10 23:00	79.16	78.73	-0.432
7/26/10 0:00	78.75	78.26	-0.486
7/26/10 1:00	78.31	77.83	-0.486
7/26/10 2:00	78.17	77.65	-0.522
7/26/10 3:00	77.80	77.26	-0.54
7/26/10 4:00	77.65	77.11	-0.54
7/26/10 5:00	77.39	76.83	-0.558
7/26/10 6:00	77.27	76.74	-0.522
7/26/10 7:00	77.44	77.01	-0.432
7/26/10 8:00	78.20	77.93	-0.27
7/26/10 9:00	79.35	79.33	-0.018
7/26/10 10:00	80.87	81.12	0.252
7/26/10 11:00	82.28	82.53	0.252
7/26/10 12:00	83.30	83.38	0.072
7/26/10 13:00	84.02	83.90	-0.126
7/26/10 14:00	83.97	83.81	-0.162
7/26/10 15:00	83.49	83.60	0.108
7/26/10 16:00	82.96	82.80	-0.162
7/26/10 17:00	82.54	82.49	-0.054
7/26/10 18:00	81.96	81.94	-0.018
7/26/10 19:00	81.26	81.20	-0.054
7/26/10 20:00	80.70	80.61	-0.09
7/26/10 21:00	80.20	80.07	-0.126
7/26/10 22:00	79.69	79.53	-0.162
7/26/10 23:00	79.20	79.00	-0.198
7/27/10 0:00	78.79	78.56	-0.234
7/27/10 1:00	78.52	78.27	-0.252
7/27/10 2:00	78.07	77.80	-0.27
7/27/10 3:00	77.84	77.55	-0.288

7/27/10 4:00	77.58	77.29	-0.288
7/27/10 5:00	77.36	77.07	-0.288
7/27/10 6:00	77.05	76.80	-0.252
7/27/10 7:00	77.02	76.86	-0.162
7/27/10 8:00	77.48	77.48	0
7/27/10 9:00	78.58	78.83	0.252
7/27/10 10:00	80.01	80.50	0.486
7/27/10 11:00	81.30	82.04	0.738
7/27/10 12:00	82.25	83.13	0.882
7/27/10 13:00	82.83	83.55	0.72
7/27/10 14:00	82.94	83.69	0.756
7/27/10 15:00	82.50	82.77	0.27
7/27/10 16:00	82.12	81.85	-0.27
7/27/10 17:00	81.78	81.53	-0.252
7/27/10 18:00	81.37	81.05	-0.324
7/27/10 19:00	80.74	80.34	-0.396
7/27/10 20:00	80.31	79.92	-0.396
7/27/10 21:00	79.93	79.52	-0.414
7/27/10 22:00	79.61	79.17	-0.432
7/27/10 23:00	79.21	78.78	-0.432
7/28/10 0:00	78.81	78.40	-0.414
7/28/10 1:00	78.77	78.34	-0.432
7/28/10 2:00	78.59	78.16	-0.432
7/28/10 3:00	78.47	78.02	-0.45
7/28/10 4:00	78.35	77.90	-0.45
7/28/10 5:00	78.39	77.95	-0.432
7/28/10 6:00	78.10	77.68	-0.414
7/28/10 7:00	78.36	78.08	-0.288
7/28/10 8:00	78.78	78.80	0.018
7/28/10 9:00	79.53	79.88	0.342
7/28/10 10:00	80.27	80.72	0.45
7/28/10 11:00	81.00	81.13	0.126
7/28/10 12:00	81.95	82.13	0.18
7/28/10 13:00	82.41	82.64	0.234
7/28/10 14:00	82.54	82.20	-0.342
7/28/10 15:00	82.54	82.46	-0.072
7/28/10 16:00	82.39	82.10	-0.288
7/28/10 17:00	82.20	82.20	0
7/28/10 18:00	81.87	81.82	-0.054
7/28/10 19:00	81.56	81.49	-0.072
7/28/10 20:00	81.30	81.19	-0.108
7/28/10 21:00	81.01	80.90	-0.108
7/28/10 22:00	80.71	80.58	-0.126
7/28/10 23:00	80.47	80.34	-0.126
7/29/10 0:00	80.24	80.12	-0.126
7/29/10 1:00	80.08	79.96	-0.126
7/29/10 2:00	79.87	79.74	-0.126
7/29/10 3:00	79.79	79.65	-0.144
7/29/10 4:00	79.69	79.57	-0.126
7/29/10 5:00	79.55	79.40	-0.144

7/29/10 6:00	79.45	79.33	-0.126
7/29/10 7:00	79.36	79.33	-0.036
7/29/10 8:00	79.41	79.50	0.09
7/29/10 9:00	79.68	79.93	0.252
7/29/10 10:00	80.26	80.73	0.468
7/29/10 11:00	80.89	81.25	0.36
7/29/10 12:00	81.71	81.22	-0.486
7/29/10 13:00	82.53	82.53	0
7/29/10 14:00	82.83	82.85	0.018
7/29/10 15:00	82.75	82.91	0.162
7/29/10 16:00	82.59	82.45	-0.144
7/29/10 17:00	82.25	82.14	-0.108
7/29/10 18:00	81.68	81.54	-0.144
7/29/10 19:00	80.94	80.83	-0.108
7/29/10 20:00	80.36	80.24	-0.126
7/29/10 21:00	79.86	79.68	-0.18
7/29/10 22:00	79.43	79.24	-0.198
7/29/10 23:00	79.06	78.85	-0.216
7/30/10 0:00	78.83	78.59	-0.234
7/30/10 1:00	78.58	78.32	-0.252
7/30/10 2:00	78.19	77.92	-0.27
7/30/10 3:00	77.72	77.47	-0.252
7/30/10 4:00	77.31	77.05	-0.252
7/30/10 5:00	77.12	76.87	-0.252
7/30/10 6:00	76.53	76.26	-0.27
7/30/10 7:00	76.82	76.64	-0.18
7/30/10 8:00	77.49	77.49	0
7/30/10 9:00	78.48	78.71	0.234
7/30/10 10:00	79.83	80.30	0.468
7/30/10 11:00	81.10	81.55	0.45
7/30/10 12:00	81.89	82.56	0.666
7/30/10 13:00	82.27	82.70	0.432
7/30/10 14:00	82.26	82.60	0.342
7/30/10 15:00	81.98	81.83	-0.144
7/30/10 16:00	81.88	81.81	-0.072
7/30/10 17:00	81.57	81.15	-0.414
7/30/10 18:00	81.28	81.01	-0.27
7/30/10 19:00	80.90	80.63	-0.27
7/30/10 20:00	80.28	80.01	-0.27
7/30/10 21:00	79.70	79.43	-0.27
7/30/10 22:00	78.90	78.61	-0.288
7/30/10 23:00	78.31	78.01	-0.306
7/31/10 0:00	77.85	77.54	-0.306
7/31/10 1:00	77.23	76.91	-0.324
7/31/10 2:00	76.76	76.46	-0.306
7/31/10 3:00	76.46	76.11	-0.342
7/31/10 4:00	76.05	75.73	-0.324
7/31/10 5:00	75.65	75.33	-0.324
7/31/10 6:00	75.21	74.91	-0.306
7/31/10 7:00	75.53	75.32	-0.216

7/31/10 8:00	76.38	76.31	-0.072
7/31/10 9:00	77.54	77.72	0.18
7/31/10 10:00	79.00	79.43	0.432
7/31/10 11:00	80.88	81.60	0.72
7/31/10 12:00	82.46	83.43	0.972
7/31/10 13:00	83.17	84.34	1.17
7/31/10 14:00	82.93	83.81	0.882
7/31/10 15:00	82.42	83.39	0.972
7/31/10 16:00	81.86	82.83	0.972
7/31/10 17:00	81.60	82.34	0.738
7/31/10 18:00	81.05	81.23	0.18
7/31/10 19:00	80.72	80.79	0.072
7/31/10 20:00	80.12	80.09	-0.036
7/31/10 21:00	79.39	79.28	-0.108
7/31/10 22:00	78.67	78.43	-0.234
7/31/10 23:00	77.97	77.63	-0.342
8/1/10 0:00	77.39	76.99	-0.396
8/1/10 1:00	76.82	76.39	-0.432
8/1/10 2:00	76.56	76.11	-0.45
8/1/10 3:00	76.20	75.75	-0.45
8/1/10 4:00	76.02	75.59	-0.432
8/1/10 5:00	76.08	75.69	-0.396
8/1/10 6:00	76.00	75.61	-0.396
8/1/10 7:00	75.87	75.58	-0.288
8/1/10 8:00	75.91	75.76	-0.144
8/1/10 9:00	76.20	76.29	0.09
8/1/10 10:00	76.62	76.96	0.342
8/1/10 11:00	76.89	77.32	0.432
8/1/10 12:00	77.42	77.98	0.558
8/1/10 13:00	78.26	78.68	0.414
8/1/10 14:00	79.14	79.41	0.27
8/1/10 15:00	79.08	79.37	0.288
8/1/10 16:00	79.06	79.21	0.144
8/1/10 17:00	78.80	78.71	-0.09
8/1/10 18:00	78.61	78.29	-0.324
8/1/10 19:00	78.07	77.69	-0.378
8/1/10 20:00	77.46	77.06	-0.396
8/1/10 21:00	77.03	76.61	-0.414
8/1/10 22:00	76.52	76.07	-0.45
8/1/10 23:00	76.19	75.76	-0.432
8/2/10 0:00	75.79	75.39	-0.396
8/2/10 1:00	75.51	75.11	-0.396
8/2/10 2:00	75.26	74.87	-0.396
8/2/10 3:00	75.11	74.68	-0.432
8/2/10 4:00	74.59	74.16	-0.432
8/2/10 5:00	74.35	73.90	-0.45
8/2/10 6:00	74.20	73.76	-0.432
8/2/10 7:00	74.53	74.19	-0.342
8/2/10 8:00	75.40	75.22	-0.18
8/2/10 9:00	77.09	77.16	0.072

8/2/10 10:00	78.99	79.17	0.18
8/2/10 11:00	79.57	79.77	0.198
8/2/10 12:00	79.32	79.48	0.162
8/2/10 13:00	79.37	79.48	0.108
8/2/10 14:00	79.30	79.17	-0.126
8/2/10 15:00	79.03	79.03	0
8/2/10 16:00	79.21	79.29	0.072
8/2/10 17:00	78.80	78.66	-0.144
8/2/10 18:00	78.66	78.42	-0.234
8/2/10 19:00	78.22	77.94	-0.288
8/2/10 20:00	77.77	77.48	-0.288
8/2/10 21:00	77.44	77.19	-0.252
8/2/10 22:00	76.75	76.48	-0.27
8/2/10 23:00	76.34	76.09	-0.252
8/3/10 0:00	76.04	75.83	-0.216
8/3/10 1:00	75.77	75.61	-0.162
8/3/10 2:00	75.61	75.47	-0.144
8/3/10 3:00	75.43	75.31	-0.126
8/3/10 4:00	75.19	75.10	-0.09
8/3/10 5:00	75.04	74.93	-0.108
8/3/10 6:00	75.24	75.19	-0.054
8/3/10 7:00	75.40	75.45	0.054
8/3/10 8:00	75.64	75.83	0.198
8/3/10 9:00	76.15	76.49	0.342
8/3/10 10:00	76.66	77.09	0.432
8/3/10 11:00	77.05	77.39	0.342
8/3/10 12:00	77.45	77.83	0.378
8/3/10 13:00	77.86	78.03	0.162
8/3/10 14:00	78.12	78.10	-0.018
8/3/10 15:00	78.25	78.32	0.072
8/3/10 16:00	78.48	78.33	-0.144
8/3/10 17:00	78.65	78.54	-0.108
8/3/10 18:00	78.57	78.46	-0.108
8/3/10 19:00	78.33	78.17	-0.162
8/3/10 20:00	78.05	77.86	-0.198
8/3/10 21:00	77.75	77.54	-0.216
8/3/10 22:00	77.27	77.06	-0.216
8/3/10 23:00	76.94	76.72	-0.216
8/4/10 0:00	76.50	76.28	-0.216
8/4/10 1:00	76.12	75.90	-0.216
8/4/10 2:00	76.15	75.93	-0.216
8/4/10 3:00	75.99	75.75	-0.234
8/4/10 4:00	75.90	75.67	-0.234
8/4/10 5:00	75.78	75.55	-0.234
8/4/10 6:00	75.53	75.30	-0.234
8/4/10 7:00	75.75	75.59	-0.162
8/4/10 8:00	76.69	76.71	0.018
8/4/10 9:00	78.41	78.57	0.162
8/4/10 10:00	80.00	80.34	0.342
8/4/10 11:00	81.32	81.61	0.288

8/4/10 12:00	81.82	82.00	0.18
8/4/10 13:00	82.80	82.82	0.018
8/4/10 14:00	83.35	83.13	-0.216
8/4/10 15:00	83.57	83.54	-0.036
8/4/10 16:00	83.48	83.57	0.09
8/4/10 17:00	82.63	82.58	-0.054
8/4/10 18:00	82.40	82.33	-0.072
8/4/10 19:00	81.95	81.80	-0.144
8/4/10 20:00	81.65	81.47	-0.18
8/4/10 21:00	81.26	81.08	-0.18
8/4/10 22:00	80.77	80.60	-0.162
8/4/10 23:00	80.27	80.14	-0.126
8/5/10 0:00	79.86	79.72	-0.144
8/5/10 1:00	79.55	79.42	-0.126
8/5/10 2:00	79.10	79.01	-0.09
8/5/10 3:00	78.58	78.47	-0.108
8/5/10 4:00	78.36	78.27	-0.09
8/5/10 5:00	78.04	77.98	-0.054
8/5/10 6:00	77.78	77.75	-0.036
8/5/10 7:00	77.71	77.71	0
8/5/10 8:00	78.09	78.18	0.09
8/5/10 9:00	78.25	78.29	0.036
8/5/10 10:00	78.66	78.71	0.054
8/5/10 11:00	79.21	79.11	-0.108
8/5/10 12:00	79.69	79.97	0.288
8/5/10 13:00	80.25	80.25	0
8/5/10 14:00	81.69	81.65	-0.036
8/5/10 15:00	82.87	82.92	0.054
8/5/10 16:00	82.76	82.60	-0.162
8/5/10 17:00	82.32	82.20	-0.126
8/5/10 18:00	81.65	81.51	-0.144
8/5/10 19:00	81.23	81.07	-0.162
8/5/10 20:00	80.77	80.60	-0.162
8/5/10 21:00	80.33	80.16	-0.162
8/5/10 22:00	80.01	79.87	-0.144
8/5/10 23:00	79.53	79.39	-0.144
8/6/10 0:00	79.03	78.87	-0.162
8/6/10 1:00	78.54	78.38	-0.162
8/6/10 2:00	78.14	77.98	-0.162
8/6/10 3:00	77.87	77.71	-0.162
8/6/10 4:00	77.65	77.47	-0.18
8/6/10 5:00	77.31	77.11	-0.198
8/6/10 6:00	77.14	76.98	-0.162
8/6/10 8:00	77.13	77.20	0.072
8/6/10 9:00	78.02	78.09	0.072
8/6/10 10:00	80.05	79.96	-0.09
8/6/10 11:00	80.85	81.03	0.18
8/6/10 12:00	82.13	82.01	-0.126
8/6/10 13:00	82.27	82.07	-0.198

8/6/10 14:00	81.97	81.92	-0.054
8/6/10 15:00	81.39	81.01	-0.378
8/6/10 16:00	81.44	81.48	0.036
8/6/10 17:00	80.72	80.70	-0.018
8/6/10 18:00	79.59	79.53	-0.054
8/6/10 19:00	78.52	78.43	-0.09
8/6/10 20:00	77.98	77.87	-0.108
8/6/10 21:00	77.55	77.41	-0.144
8/6/10 22:00	77.35	77.17	-0.18
8/6/10 23:00	77.01	76.81	-0.198
8/7/10 0:00	76.75	76.53	-0.216
8/7/10 1:00	76.38	76.13	-0.252
8/7/10 2:00	76.14	75.88	-0.252
8/7/10 3:00	76.02	75.75	-0.27
8/7/10 4:00	76.00	75.73	-0.27
8/7/10 5:00	75.70	75.42	-0.288
8/7/10 6:00	75.72	75.45	-0.27
8/7/10 7:00	75.87	75.69	-0.18
8/7/10 8:00	76.36	76.34	-0.018
8/7/10 9:00	77.35	77.54	0.198
8/7/10 10:00	79.20	79.58	0.378
8/7/10 11:00	80.72	81.23	0.504
8/7/10 12:00	82.17	82.89	0.72
8/7/10 13:00	83.25	83.07	-0.18
8/7/10 14:00	83.26	83.24	-0.018
8/7/10 15:00	83.08	83.23	0.144
8/7/10 16:00	83.01	82.69	-0.324
8/7/10 17:00	81.86	81.59	-0.27
8/7/10 18:00	80.15	79.93	-0.216
8/7/10 19:00	79.52	79.32	-0.198
8/7/10 20:00	79.44	79.22	-0.216
8/7/10 21:00	78.98	78.76	-0.216
8/7/10 22:00	78.47	78.25	-0.216
8/7/10 23:00	77.94	77.70	-0.234
8/8/10 0:00	77.34	77.11	-0.234
8/8/10 1:00	76.91	76.67	-0.234
8/8/10 2:00	76.39	76.14	-0.252
8/8/10 3:00	75.74	75.51	-0.234
8/8/10 4:00	75.50	75.26	-0.234
8/8/10 5:00	75.30	75.07	-0.234
8/8/10 6:00	75.16	74.93	-0.234
8/8/10 7:00	75.23	75.09	-0.144
8/8/10 8:00	76.13	76.15	0.018
8/8/10 9:00	77.42	77.69	0.27
8/8/10 10:00	79.26	79.75	0.486
8/8/10 11:00	81.22	81.76	0.54
8/8/10 12:00	82.39	82.71	0.324
8/8/10 13:00	83.04	82.55	-0.486
8/8/10 14:00	83.74	83.76	0.018
8/8/10 15:00	83.46	83.53	0.072



8/8/10 16:00	83.03	83.11	0.072
8/8/10 17:00	82.63	82.58	-0.054
8/8/10 18:00	81.73	81.44	-0.288
8/8/10 19:00	80.65	80.40	-0.252
8/8/10 20:00	79.88	79.65	-0.234
8/8/10 21:00	79.44	79.21	-0.234
8/8/10 22:00	78.95	78.70	-0.252
8/8/10 23:00	78.40	78.15	-0.252
8/9/10 0:00	77.84	77.60	-0.234
8/9/10 1:00	77.35	77.11	-0.234
8/9/10 2:00	76.75	76.52	-0.234
8/9/10 3:00	76.27	76.02	-0.252
8/9/10 4:00	76.09	75.84	-0.252
8/9/10 5:00	76.10	75.82	-0.288
8/9/10 6:00	75.92	75.64	-0.288
8/9/10 7:00	76.23	76.10	-0.126
8/9/10 8:00	77.07	77.11	0.036
8/9/10 9:00	78.30	78.57	0.27
8/9/10 10:00	80.05	80.52	0.468
8/9/10 11:00	81.75	82.16	0.414
8/9/10 12:00	83.96	83.76	-0.198
8/9/10 13:00	85.49	85.49	0
8/9/10 14:00	83.94	84.09	0.144
8/9/10 15:00	84.09	83.98	-0.108
8/9/10 16:00	83.96	83.91	-0.054
8/9/10 17:00	83.73	83.66	-0.072
8/9/10 18:00	83.04	82.95	-0.09
8/9/10 19:00	82.54	82.47	-0.072
8/9/10 20:00	81.85	81.74	-0.108
8/9/10 21:00	81.14	81.02	-0.126
8/9/10 22:00	80.47	80.33	-0.144
8/9/10 23:00	79.91	79.77	-0.144
8/10/10 0:00	79.55	79.39	-0.162
8/10/10 1:00	79.22	79.06	-0.162
8/10/10 2:00	78.83	78.67	-0.162
8/10/10 3:00	78.60	78.42	-0.18
8/10/10 4:00	78.32	78.14	-0.18
8/10/10 5:00	78.22	78.04	-0.18
8/10/10 6:00	78.07	77.89	-0.18
8/10/10 7:00	78.09	77.98	-0.108
8/10/10 8:00	78.78	78.82	0.036
8/10/10 9:00	79.63	79.86	0.234
8/10/10 10:00	80.43	80.92	0.486
8/10/10 11:00	81.63	82.15	0.522
8/10/10 12:00	82.71	83.12	0.414
8/10/10 13:00	83.98	84.49	0.504
8/10/10 14:00	84.50	84.75	0.252
8/10/10 15:00	84.18	84.59	0.414
8/10/10 16:00	83.98	84.45	0.468
8/10/10 17:00	83.70	83.92	0.216

8/10/10 18:00	83.45	83.50	0.054
8/10/10 19:00	83.11	83.00	-0.108
8/10/10 20:00	82.53	82.35	-0.18
8/10/10 21:00	81.85	81.61	-0.234
8/10/10 22:00	81.14	80.84	-0.306
8/10/10 23:00	80.49	80.15	-0.342
8/11/10 0:00	79.91	79.52	-0.396
8/11/10 1:00	79.57	79.16	-0.414
8/11/10 2:00	79.27	78.80	-0.468
8/11/10 3:00	78.95	78.49	-0.468
8/11/10 4:00	78.57	78.10	-0.468
8/11/10 5:00	78.42	77.94	-0.486
8/11/10 6:00	78.32	77.81	-0.504
8/11/10 7:00	78.27	77.89	-0.378
8/11/10 8:00	78.63	78.40	-0.234
8/11/10 9:00	79.93	79.91	-0.018
8/11/10 10:00	81.93	82.13	0.198
8/11/10 11:00	83.41	83.36	-0.054
8/11/10 12:00	83.30	83.44	0.144
8/11/10 13:00	83.87	84.07	0.198
8/11/10 14:00	84.35	84.23	-0.126
8/11/10 15:00	84.00	84.07	0.072
8/11/10 16:00	83.98	84.02	0.036
8/11/10 17:00	83.71	83.40	-0.306
8/11/10 18:00	83.05	82.71	-0.342
8/11/10 19:00	82.44	82.10	-0.342
8/11/10 20:00	81.74	81.40	-0.342
8/11/10 21:00	81.17	80.83	-0.342
8/11/10 22:00	80.69	80.34	-0.342
8/11/10 23:00	80.22	79.88	-0.342
8/12/10 0:00	79.86	79.52	-0.342
8/12/10 1:00	79.44	79.12	-0.324
8/12/10 2:00	79.16	78.88	-0.288
8/12/10 3:00	79.05	78.75	-0.306
8/12/10 4:00	79.03	78.72	-0.306
8/12/10 5:00	78.96	78.71	-0.252
8/12/10 6:00	78.96	78.75	-0.216
8/12/10 7:00	78.95	78.83	-0.126
8/12/10 8:00	79.00	79.00	0
8/12/10 9:00	79.20	79.42	0.216
8/12/10 10:00	79.26	79.57	0.306
8/12/10 11:00	79.05	79.48	0.432
8/12/10 12:00	79.16	79.76	0.594
8/12/10 13:00	79.05	79.41	0.36
8/12/10 14:00	79.21	79.53	0.324
8/12/10 15:00	78.86	79.13	0.27
8/12/10 16:00	78.38	78.70	0.324
8/12/10 17:00	78.13	78.32	0.198
8/12/10 18:00	77.70	77.70	0
8/12/10 19:00	77.38	77.29	-0.09

8/12/10 20:00	77.33	77.08	-0.252
8/12/10 21:00	77.38	77.05	-0.324
8/12/10 22:00	77.35	76.96	-0.396
8/12/10 23:00	77.28	76.83	-0.45
8/13/10 0:00	77.17	76.68	-0.486
8/13/10 1:00	77.09	76.63	-0.468
8/13/10 2:00	76.96	76.47	-0.486
8/13/10 3:00	76.84	76.36	-0.486
8/13/10 4:00	76.77	76.28	-0.486
8/13/10 5:00	76.65	76.19	-0.468
8/13/10 6:00	76.49	76.02	-0.468
8/13/10 7:00	76.40	76.06	-0.342
8/13/10 8:00	76.60	76.42	-0.18
8/13/10 9:00	76.95	76.95	0
8/13/10 10:00	77.51	77.72	0.216
8/13/10 11:00	78.60	78.98	0.378
8/13/10 12:00	80.17	80.50	0.324
8/13/10 13:00	80.87	81.12	0.252
8/13/10 14:00	81.05	80.78	-0.27
8/13/10 15:00	81.06	80.99	-0.072
8/13/10 16:00	80.96	80.89	-0.072
8/13/10 17:00	80.01	79.88	-0.126
8/13/10 18:00	79.25	79.03	-0.216
8/13/10 19:00	78.72	78.47	-0.252
8/13/10 20:00	78.31	78.01	-0.306
8/13/10 21:00	78.21	77.87	-0.342
8/13/10 22:00	77.99	77.63	-0.36
8/13/10 23:00	77.74	77.36	-0.378
8/14/10 0:00	77.16	76.77	-0.396
8/14/10 1:00	76.80	76.41	-0.396
8/14/10 2:00	76.30	75.88	-0.414
8/14/10 3:00	75.32	74.89	-0.432
8/14/10 4:00	75.19	74.76	-0.432
8/14/10 5:00	74.97	74.54	-0.432
8/14/10 6:00	74.82	74.39	-0.432
8/14/10 7:00	74.99	74.63	-0.36
8/14/10 8:00	75.20	74.98	-0.216
8/14/10 9:00	75.55	75.55	0
8/14/10 10:00	76.19	76.41	0.216
8/14/10 11:00	77.24	77.42	0.18
8/14/10 12:00	77.85	78.12	0.27
8/14/10 13:00	78.49	78.85	0.36
8/14/10 14:00	79.42	79.45	0.036
8/14/10 15:00	80.08	80.11	0.036
8/14/10 16:00	79.85	79.58	-0.27
8/14/10 17:00	79.06	78.86	-0.198
8/14/10 18:00	78.29	78.09	-0.198
8/14/10 19:00	77.75	77.51	-0.234
8/14/10 20:00	77.24	76.95	-0.288
8/14/10 21:00	77.04	76.73	-0.306

8/14/10 22:00	77.06	76.72	-0.342
8/14/10 23:00	76.80	76.46	-0.342
8/15/10 0:00	76.43	76.07	-0.36
8/15/10 1:00	75.90	75.56	-0.342
8/15/10 2:00	75.52	75.19	-0.324
8/15/10 3:00	75.25	74.95	-0.306
8/15/10 4:00	75.16	74.89	-0.27
8/15/10 5:00	75.05	74.80	-0.252
8/15/10 6:00	75.02	74.77	-0.252
8/15/10 7:00	74.96	74.78	-0.18
8/15/10 8:00	74.74	74.68	-0.054
8/15/10 9:00	74.75	74.92	0.162
8/15/10 10:00	74.78	75.17	0.396
8/15/10 11:00	74.64	75.25	0.612
8/15/10 12:00	74.66	75.42	0.756
8/15/10 13:00	73.98	74.84	0.864
8/15/10 14:00	74.57	75.54	0.972
8/15/10 15:00	74.64	74.94	0.306
8/15/10 16:00	74.69	75.05	0.36
8/15/10 17:00	74.64	74.94	0.306
8/15/10 18:00	74.60	74.69	0.09
8/15/10 19:00	74.53	74.50	-0.036
8/15/10 20:00	74.50	74.37	-0.126
8/15/10 21:00	74.46	74.26	-0.198
8/15/10 22:00	74.41	74.16	-0.252
8/15/10 23:00	74.39	74.11	-0.288
8/16/10 0:00	74.36	74.02	-0.342
8/16/10 1:00	74.35	74.01	-0.342
8/16/10 2:00	74.35	73.97	-0.378
8/16/10 3:00	74.34	73.96	-0.378
8/16/10 4:00	74.21	73.84	-0.378
8/16/10 5:00	74.20	73.81	-0.396
8/16/10 6:00	74.29	73.91	-0.378
8/16/10 7:00	74.37	74.03	-0.342
8/16/10 8:00	74.62	74.52	-0.108
8/16/10 9:00	75.04	75.11	0.072
8/16/10 10:00	75.63	75.90	0.27
8/16/10 11:00	76.00	76.27	0.27
8/16/10 12:00	76.32	76.46	0.144
8/16/10 13:00	76.69	76.85	0.162
8/16/10 14:00	76.98	76.69	-0.288
8/16/10 15:00	77.37	77.23	-0.144
8/16/10 16:00	77.79	77.54	-0.252
8/16/10 17:00	77.95	77.86	-0.09
8/16/10 18:00	77.92	77.83	-0.09
8/16/10 19:00	77.62	77.50	-0.126
8/16/10 20:00	77.13	76.97	-0.162
8/16/10 21:00	76.57	76.37	-0.198
8/16/10 22:00	76.03	75.80	-0.234
8/16/10 23:00	75.57	75.30	-0.27

8/17/10 0:00	75.11	74.80	-0.306
8/17/10 1:00	74.77	74.45	-0.324
8/17/10 2:00	74.36	74.00	-0.36
8/17/10 3:00	74.08	73.69	-0.396
8/17/10 4:00	73.85	73.44	-0.414
8/17/10 5:00	73.61	73.19	-0.414
8/17/10 6:00	73.36	72.93	-0.432
8/17/10 7:00	73.12	72.76	-0.36
8/17/10 8:00	73.20	72.98	-0.216
8/17/10 9:00	74.24	74.24	0
8/17/10 10:00	76.29	76.54	0.252
8/17/10 11:00	78.88	79.31	0.432
8/17/10 12:00	79.58	79.76	0.18
8/17/10 13:00	79.80	79.79	-0.018
8/17/10 14:00	80.19	80.19	0
8/17/10 15:00	80.10	80.10	0
8/17/10 16:00	79.78	79.66	-0.126
8/17/10 17:00	79.48	79.12	-0.36
8/17/10 18:00	78.78	78.51	-0.27
8/17/10 19:00	78.36	78.11	-0.252
8/17/10 20:00	77.75	77.50	-0.252
8/17/10 21:00	77.09	76.82	-0.27
8/17/10 22:00	76.42	76.15	-0.27
8/17/10 23:00	76.10	75.83	-0.27
8/18/10 0:00	75.71	75.44	-0.27
8/18/10 1:00	75.25	74.96	-0.288
8/18/10 2:00	74.78	74.51	-0.27
8/18/10 3:00	74.37	74.12	-0.252
8/18/10 4:00	74.05	73.80	-0.252
8/18/10 5:00	73.72	73.49	-0.234
8/18/10 6:00	73.44	73.21	-0.234
8/18/10 7:00	73.25	73.09	-0.162
8/18/10 8:00	73.52	73.50	-0.018
8/18/10 9:00	74.68	74.86	0.18
8/18/10 10:00	75.45	75.88	0.432
8/18/10 11:00	76.99	77.62	0.63
8/18/10 12:00	78.06	78.87	0.81
8/18/10 13:00	78.29	78.97	0.684
8/18/10 14:00	78.25	78.88	0.63
8/18/10 15:00	78.05	78.56	0.504
8/18/10 16:00	77.91	78.23	0.324
8/18/10 17:00	77.78	77.83	0.054
8/18/10 18:00	77.54	77.48	-0.054
8/18/10 19:00	77.09	76.97	-0.126
8/18/10 20:00	76.58	76.34	-0.234
8/18/10 21:00	76.03	75.70	-0.324
8/18/10 22:00	75.24	74.86	-0.378
8/18/10 23:00	74.51	74.06	-0.45
8/19/10 0:00	74.40	73.94	-0.468
8/19/10 1:00	74.00	73.55	-0.45

8/19/10 2:00	73.41	72.95	-0.468
8/19/10 3:00	73.22	72.75	-0.468
8/19/10 4:00	73.02	72.57	-0.45
8/19/10 5:00	72.87	72.41	-0.468
8/19/10 6:00	72.76	72.31	-0.45
8/19/10 7:00	72.64	72.26	-0.378
8/19/10 8:00	72.77	72.55	-0.216
8/19/10 9:00	73.42	73.42	0
8/19/10 10:00	75.29	75.58	0.288
8/19/10 11:00	77.94	78.41	0.468
8/19/10 12:00	80.04	80.55	0.504
8/19/10 13:00	80.88	80.79	-0.09
8/19/10 14:00	81.72	81.77	0.054
8/19/10 15:00	81.55	81.06	-0.486
8/19/10 16:00	80.81	80.74	-0.072
8/19/10 17:00	80.12	80.05	-0.072
8/19/10 18:00	79.73	79.64	-0.09
8/19/10 19:00	79.29	79.18	-0.108
8/19/10 20:00	78.75	78.62	-0.126
8/19/10 21:00	78.16	78.02	-0.144
8/19/10 22:00	77.47	77.29	-0.18
8/19/10 23:00	76.80	76.62	-0.18
8/20/10 0:00	76.37	76.18	-0.198
8/20/10 1:00	76.01	75.78	-0.234
8/20/10 2:00	75.63	75.38	-0.252
8/20/10 3:00	75.09	74.80	-0.288
8/20/10 4:00	74.72	74.43	-0.288
8/20/10 5:00	74.36	74.06	-0.306
8/20/10 6:00	74.19	73.89	-0.306
8/20/10 7:00	74.29	74.09	-0.198
8/20/10 8:00	74.43	74.35	-0.072
8/20/10 9:00	76.25	76.41	0.162
8/20/10 10:00	77.94	78.23	0.288
8/20/10 11:00	80.33	80.80	0.468
8/20/10 12:00	82.15	82.02	-0.126
8/20/10 13:00	83.00	82.84	-0.162
8/20/10 14:00	83.38	83.38	0
8/20/10 15:00	83.21	83.12	-0.09
8/20/10 16:00	82.49	82.42	-0.072
8/20/10 17:00	81.44	81.20	-0.234
8/20/10 18:00	80.00	79.76	-0.234
8/20/10 19:00	78.72	78.47	-0.252
8/20/10 20:00	78.09	77.82	-0.27
8/20/10 21:00	77.45	77.17	-0.288
8/20/10 22:00	76.86	76.57	-0.288
8/20/10 23:00	76.30	76.00	-0.306
8/21/10 0:00	75.73	75.42	-0.306
8/21/10 1:00	75.33	75.04	-0.288
8/21/10 2:00	74.82	74.55	-0.27
8/21/10 3:00	74.69	74.42	-0.27

8/21/10 4:00	74.39	74.12	-0.27
8/21/10 5:00	74.25	74.01	-0.234
8/21/10 6:00	74.03	73.81	-0.216
8/21/10 7:00	73.98	73.87	-0.108
8/21/10 8:00	74.23	74.25	0.018
8/21/10 9:00	75.17	75.43	0.252
8/21/10 10:00	76.63	77.09	0.468
8/21/10 11:00	77.56	78.17	0.612
8/21/10 12:00	78.87	79.41	0.54
8/21/10 13:00	79.66	80.25	0.594
8/21/10 14:00	80.10	80.35	0.252
8/21/10 15:00	80.29	80.64	0.342
8/21/10 16:00	79.96	79.87	-0.09
8/21/10 17:00	79.51	79.42	-0.09
8/21/10 18:00	78.49	78.40	-0.09
8/21/10 19:00	78.07	77.94	-0.126
8/21/10 20:00	77.52	77.27	-0.252
8/21/10 21:00	77.01	76.74	-0.27
8/21/10 22:00	76.82	76.56	-0.252
8/21/10 23:00	76.53	76.39	-0.144
8/22/10 0:00	76.27	76.09	-0.18
8/22/10 1:00	76.10	75.92	-0.18
8/22/10 2:00	75.93	75.79	-0.144
8/22/10 3:00	75.68	75.57	-0.108
8/22/10 4:00	75.59	75.48	-0.108
8/22/10 5:00	75.33	75.26	-0.072
8/22/10 6:00	75.16	75.11	-0.054
8/22/10 7:00	75.07	75.07	0
8/22/10 8:00	75.03	75.14	0.108
8/22/10 9:00	75.09	75.30	0.216
8/22/10 10:00	74.65	74.81	0.162
8/22/10 11:00	74.69	74.87	0.18
8/22/10 12:00	75.13	75.47	0.342
8/22/10 13:00	75.64	76.00	0.36
8/22/10 14:00	75.86	76.06	0.198
8/22/10 15:00	76.14	75.42	-0.72
8/22/10 16:00	76.32	76.01	-0.306
8/22/10 17:00	76.28	76.03	-0.252
8/22/10 18:00	75.95	75.70	-0.252
8/22/10 19:00	75.82	75.60	-0.216
8/22/10 20:00	75.40	75.29	-0.108
8/22/10 21:00	75.04	74.95	-0.09
8/22/10 22:00	74.59	74.50	-0.09
8/22/10 23:00	74.27	74.20	-0.072
8/23/10 0:00	74.16	74.07	-0.09
8/23/10 1:00	73.96	73.87	-0.09
8/23/10 2:00	73.87	73.76	-0.108
8/23/10 3:00	73.60	73.48	-0.126
8/23/10 4:00	73.58	73.47	-0.108
8/23/10 5:00	73.43	73.29	-0.144

8/23/10 6:00	73.58	73.46	-0.126
8/23/10 7:00	73.37	73.28	-0.09
8/23/10 8:00	73.45	73.46	0.018
8/23/10 9:00	73.72	73.90	0.18
8/23/10 10:00	73.70	74.10	0.396
8/23/10 11:00	73.89	74.48	0.594
8/23/10 12:00	74.46	74.93	0.468
8/23/10 13:00	75.57	75.82	0.252
8/23/10 14:00	76.13	76.43	0.306
8/23/10 15:00	76.20	76.33	0.126
8/23/10 16:00	75.74	75.79	0.054
8/23/10 17:00	75.31	74.95	-0.36
8/23/10 18:00	75.09	74.70	-0.396
8/23/10 19:00	74.45	74.05	-0.396
8/23/10 20:00	73.90	73.52	-0.378
8/23/10 21:00	73.53	73.21	-0.324
8/23/10 22:00	73.35	73.06	-0.288
8/23/10 23:00	73.15	72.86	-0.288
8/24/10 1:00	72.67	72.40	-0.27
8/24/10 2:00	72.49	72.20	-0.288
8/24/10 3:00	72.33	72.06	-0.27
8/24/10 4:00	72.19	71.90	-0.288
8/24/10 5:00	72.06	71.75	-0.306
8/24/10 6:00	71.88	71.59	-0.288
8/24/10 7:00	71.84	71.63	-0.216
8/24/10 8:00	72.12	72.06	-0.054
8/24/10 9:00	72.46	72.59	0.126
8/24/10 10:00	72.60	72.96	0.36
8/24/10 11:00	72.67	73.15	0.486
8/24/10 12:00	72.84	73.29	0.45
8/24/10 13:00	73.18	73.54	0.36
8/24/10 14:00	73.40	73.56	0.162
8/24/10 15:00	73.60	73.72	0.126
8/24/10 16:00	73.47	73.33	-0.144
8/24/10 17:00	73.49	73.34	-0.144
8/24/10 18:00	73.34	73.16	-0.18
8/24/10 19:00	73.11	72.89	-0.216
8/24/10 20:00	72.87	72.62	-0.252
8/24/10 21:00	72.68	72.40	-0.288
8/24/10 22:00	72.32	72.02	-0.306
8/24/10 23:00	72.15	71.83	-0.324
8/25/10 0:00	72.05	71.71	-0.342
8/25/10 1:00	71.92	71.57	-0.342
8/25/10 2:00	71.79	71.45	-0.342
8/25/10 3:00	71.72	71.36	-0.36
8/25/10 4:00	71.62	71.26	-0.36
8/25/10 5:00	71.63	71.29	-0.342
8/25/10 6:00	71.50	71.16	-0.342
8/25/10 7:00	71.33	71.04	-0.288



8/25/10 8:00	71.43	71.25	-0.18
8/25/10 9:00	71.95	71.97	0.018
8/25/10 10:00	72.65	72.83	0.18
8/25/10 11:00	72.72	72.99	0.27
8/25/10 12:00	72.79	73.06	0.27
8/25/10 13:00	72.90	73.13	0.234
8/25/10 14:00	73.04	73.09	0.054
8/25/10 15:00	73.12	73.28	0.162
8/25/10 16:00	73.03	73.05	0.018
8/25/10 17:00	72.84	72.75	-0.09
8/25/10 18:00	72.61	72.50	-0.108
8/25/10 19:00	72.34	72.18	-0.162
8/25/10 20:00	72.03	71.82	-0.216
8/25/10 21:00	71.78	71.52	-0.252
8/25/10 22:00	71.56	71.25	-0.306
8/25/10 23:00	71.37	71.03	-0.342
8/26/10 0:00	71.22	70.84	-0.378
8/26/10 1:00	71.07	70.66	-0.414
8/26/10 2:00	70.97	70.54	-0.432
8/26/10 3:00	70.84	70.39	-0.45
8/26/10 4:00	70.70	70.21	-0.486
8/26/10 5:00	70.60	70.12	-0.486
8/26/10 6:00	70.56	70.11	-0.45
8/26/10 7:00	70.56	70.15	-0.414
8/26/10 8:00	70.61	70.33	-0.288
8/26/10 9:00	70.73	70.66	-0.072
8/26/10 10:00	71.23	71.29	0.054
8/26/10 11:00	71.79	72.04	0.252
8/26/10 12:00	71.88	72.23	0.342
8/26/10 13:00	72.05	72.08	0.036
8/26/10 14:00	72.10	72.05	-0.054
8/26/10 15:00	72.11	71.95	-0.162
8/26/10 16:00	72.20	71.84	-0.36
8/26/10 17:00	72.30	72.17	-0.126
8/26/10 18:00	72.24	72.12	-0.126
8/26/10 19:00	72.14	71.96	-0.18
8/26/10 20:00	72.01	71.82	-0.198
8/26/10 21:00	71.91	71.69	-0.216
8/26/10 22:00	71.79	71.56	-0.234
8/26/10 23:00	71.70	71.45	-0.252
8/27/10 0:00	71.56	71.28	-0.288
8/27/10 1:00	71.42	71.11	-0.306
8/27/10 2:00	71.29	70.97	-0.324
8/27/10 3:00	71.22	70.90	-0.324
8/27/10 4:00	71.14	70.80	-0.342
8/27/10 5:00	71.06	70.69	-0.378
8/27/10 6:00	70.96	70.57	-0.396
8/27/10 7:00	70.86	70.52	-0.342
8/27/10 8:00	70.80	70.59	-0.216
8/27/10 9:00	70.84	70.87	0.036

8/27/10 10:00	71.21	71.48	0.27
8/27/10 11:00	71.68	72.07	0.396
8/27/10 12:00	71.87	72.27	0.396
8/27/10 13:00	71.93	72.06	0.126
8/27/10 14:00	72.09	72.16	0.072
8/27/10 15:00	72.06	71.97	-0.09
8/27/10 16:00	71.98	71.92	-0.054
8/27/10 17:00	71.88	71.72	-0.162
8/27/10 18:00	71.87	71.67	-0.198
8/27/10 19:00	71.82	71.60	-0.216
8/27/10 20:00	71.74	71.47	-0.27
8/27/10 21:00	71.59	71.30	-0.288
8/27/10 22:00	71.40	71.10	-0.306
8/27/10 23:00	71.20	70.87	-0.324
8/28/10 0:00	70.99	70.66	-0.324
8/28/10 1:00	70.79	70.45	-0.342
8/28/10 2:00	70.61	70.24	-0.378
8/28/10 3:00	70.46	70.08	-0.378
8/28/10 4:00	70.32	69.94	-0.378
8/28/10 5:00	70.23	69.83	-0.396
8/28/10 6:00	70.15	69.76	-0.396
8/28/10 7:00	70.04	69.72	-0.324
8/28/10 8:00	70.08	69.90	-0.18
8/28/10 9:00	70.43	70.45	0.018
8/28/10 10:00	71.04	71.34	0.306
8/28/10 11:00	71.73	72.28	0.558
8/28/10 12:00	72.19	72.99	0.792
8/28/10 13:00	72.52	73.30	0.774
8/28/10 14:00	72.60	73.52	0.918
8/28/10 15:00	72.45	73.22	0.774
8/28/10 16:00	72.24	72.83	0.594
8/28/10 17:00	72.10	72.64	0.54
8/28/10 18:00	72.05	72.39	0.342
8/28/10 19:00	72.05	72.26	0.216
8/28/10 20:00	72.01	72.12	0.108
8/28/10 21:00	71.91	71.89	-0.018
8/28/10 22:00	71.73	71.60	-0.126
8/28/10 23:00	71.53	71.31	-0.216
8/29/10 0:00	71.28	70.99	-0.288
8/29/10 1:00	71.09	70.73	-0.36
8/29/10 2:00	70.91	70.52	-0.396
8/29/10 3:00	70.75	70.34	-0.414
8/29/10 4:00	70.64	70.17	-0.468
8/29/10 5:00	70.52	70.02	-0.504
8/29/10 6:00	70.43	69.93	-0.504
8/29/10 7:00	70.34	69.88	-0.468
8/29/10 8:00	70.40	70.06	-0.342
8/29/10 9:00	70.91	70.78	-0.126
8/29/10 10:00	71.60	71.74	0.144
8/29/10 11:00	72.37	72.80	0.432

8/29/10 12:00	73.06	73.74	0.684
8/29/10 13:00	73.51	74.39	0.882
8/29/10 14:00	73.65	74.17	0.522
8/29/10 15:00	73.59	73.70	0.108
8/29/10 16:00	73.43	73.39	-0.036
8/29/10 17:00	73.27	73.24	-0.036
8/29/10 18:00	73.18	73.09	-0.09
8/29/10 19:00	73.14	72.96	-0.18
8/29/10 20:00	73.12	72.87	-0.252
8/29/10 21:00	73.03	72.74	-0.288
8/29/10 22:00	72.93	72.57	-0.36
8/29/10 23:00	72.79	72.39	-0.396
8/30/10 0:00	72.62	72.23	-0.396
8/30/10 1:00	72.44	72.02	-0.414
8/30/10 2:00	72.24	71.81	-0.432
8/30/10 3:00	72.06	71.65	-0.414
8/30/10 4:00	71.92	71.48	-0.432
8/30/10 5:00	71.85	71.38	-0.468
8/30/10 6:00	71.76	71.27	-0.486
8/30/10 7:00	71.68	71.21	-0.468
8/30/10 8:00	71.67	71.34	-0.324
8/30/10 9:00	71.81	71.74	-0.072
8/30/10 10:00	72.55	72.73	0.18
8/30/10 11:00	73.61	74.04	0.432
8/30/10 12:00	74.44	75.14	0.702
8/30/10 13:00	75.06	75.29	0.234
8/30/10 14:00	75.36	75.11	-0.252
8/30/10 15:00	75.36	75.27	-0.09
8/30/10 16:00	75.25	75.16	-0.09
8/30/10 17:00	75.06	75.00	-0.054
8/30/10 18:00	74.85	74.78	-0.072
8/30/10 19:00	74.73	74.62	-0.108
8/30/10 20:00	74.66	74.48	-0.18
8/30/10 21:00	74.57	74.37	-0.198
8/30/10 22:00	74.46	74.22	-0.234
8/30/10 23:00	74.35	74.09	-0.252
8/31/10 0:00	74.21	73.94	-0.27
8/31/10 1:00	74.07	73.80	-0.27
8/31/10 2:00	73.89	73.62	-0.27
8/31/10 3:00	73.71	73.42	-0.288
8/31/10 4:00	73.48	73.17	-0.306
8/31/10 5:00	73.32	73.00	-0.324
8/31/10 6:00	73.14	72.82	-0.324
8/31/10 7:00	72.96	72.68	-0.288
8/31/10 8:00	73.06	72.90	-0.162
8/31/10 9:00	73.72	73.77	0.054
8/31/10 10:00	74.72	75.02	0.306
8/31/10 11:00	75.97	76.49	0.522
8/31/10 12:00	76.85	77.41	0.558
8/31/10 13:00	77.21	77.51	0.306

8/31/10 14:00	77.45	77.66	0.216
8/31/10 15:00	77.29	77.49	0.198
8/31/10 16:00	77.09	77.05	-0.036
8/31/10 17:00	76.87	76.85	-0.018
8/31/10 18:00	76.58	76.35	-0.234
8/31/10 19:00	76.50	76.23	-0.27
8/31/10 20:00	76.33	76.00	-0.324
8/31/10 21:00	76.15	75.80	-0.342
8/31/10 22:00	75.91	75.53	-0.378
8/31/10 23:00	75.72	75.32	-0.396

**Sonde 6 Test Track (shallow)**

Day	Tdata (F)	Tmodified (F)	delta T (F)
6/25/10 14:00	80.05	80.21	0.162
6/25/10 15:00	80.63	80.79	0.162
6/25/10 16:00	81.10	81.21	0.108
6/25/10 17:00	81.33	81.44	0.108
6/25/10 18:00	81.07	81.16	0.09
6/25/10 19:00	80.68	80.73	0.054
6/25/10 20:00	80.01	80.04	0.036
6/25/10 21:00	79.09	79.09	0
6/25/10 22:00	78.22	78.21	-0.018
6/25/10 23:00	77.48	77.45	-0.036
6/26/10 0:00	76.92	76.87	-0.054
6/26/10 1:00	76.44	76.38	-0.054
6/26/10 2:00	76.24	76.16	-0.072
6/27/10 14:00			
6/28/10 14:00			
6/29/10 14:00			
6/30/10 14:00			
7/1/10 14:00			
7/2/10 14:00	76.51	76.61	0.108
7/2/10 15:00	77.09	77.22	0.126
7/2/10 16:00	77.65	77.76	0.108
7/2/10 17:00	78.26	78.36	0.108
7/2/10 18:00	78.11	78.22	0.108
7/2/10 19:00	77.58	77.65	0.072
7/2/10 20:00	76.85	76.92	0.072
7/2/10 21:00	75.90	75.92	0.018
7/2/10 22:00	74.94	74.94	0
7/2/10 23:00	73.97	73.95	-0.018
7/3/10 0:00	73.15	73.09	-0.054
7/3/10 1:00	72.62	72.55	-0.072
7/3/10 2:00	72.15	72.06	-0.09
7/3/10 3:00	71.74	71.65	-0.09
7/3/10 4:00	71.45	71.33	-0.126
7/3/10 5:00	70.99	70.88	-0.108
7/3/10 6:00	70.82	70.71	-0.108
7/3/10 7:00	70.76	70.65	-0.108
7/3/10 8:00	71.00	70.93	-0.072
7/3/10 9:00	71.42	71.38	-0.036
7/3/10 10:00	72.32	72.36	0.036
7/3/10 11:00	73.40	73.47	0.072
7/3/10 12:00	74.69	74.81	0.126
7/3/10 13:00	75.92	76.08	0.162
7/3/10 14:00	77.23	77.42	0.198
7/3/10 15:00	78.38	78.62	0.234
7/3/10 16:00	79.21	79.43	0.216
7/3/10 17:00	79.73	79.91	0.18
7/3/10 18:00	79.86	80.01	0.144

7/3/10 19:00	79.57	79.66	0.09
7/3/10 20:00	78.84	78.91	0.072
7/3/10 21:00	77.86	77.94	0.072
7/3/10 22:00	76.82	76.88	0.054
7/3/10 23:00	75.82	75.88	0.054
7/4/10 0:00	74.87	74.89	0.018
7/4/10 1:00	74.19	74.19	0
7/4/10 2:00	73.63	73.62	-0.018
7/4/10 3:00	73.25	73.21	-0.036
7/4/10 4:00	72.92	72.86	-0.054
7/4/10 5:00	72.50	72.44	-0.054
7/4/10 6:00	72.36	72.31	-0.054
7/4/10 7:00	72.19	72.13	-0.054
7/4/10 8:00	72.36	72.34	-0.018
7/4/10 9:00	72.96	72.96	0
7/4/10 10:00	73.74	73.80	0.054
7/4/10 11:00	74.92	75.03	0.108
7/4/10 12:00	76.24	76.38	0.144
7/4/10 13:00	77.79	77.88	0.09
7/4/10 14:00	79.02	79.07	0.054
7/4/10 15:00	80.24	80.28	0.036
7/4/10 16:00	81.13	81.11	-0.018
7/4/10 17:00	81.67	81.61	-0.054
7/4/10 18:00	81.74	81.67	-0.072
7/4/10 19:00	81.45	81.37	-0.072
7/4/10 20:00	80.73	80.66	-0.072
7/4/10 21:00	79.75	79.68	-0.072
7/4/10 22:00	78.68	78.61	-0.072
7/4/10 23:00	77.68	77.59	-0.09
7/5/10 0:00	76.83	76.76	-0.072
7/5/10 1:00	76.18	76.07	-0.108
7/5/10 2:00	75.81	75.70	-0.108
7/5/10 3:00	75.39	75.29	-0.108
7/5/10 4:00	75.20	75.10	-0.108
7/5/10 5:00	74.98	74.88	-0.108
7/5/10 6:00	74.59	74.48	-0.108
7/5/10 7:00	74.57	74.46	-0.108
7/5/10 8:00	74.69	74.62	-0.072
7/5/10 9:00	75.14	75.12	-0.018
7/5/10 10:00	75.92	75.96	0.036
7/5/10 11:00	77.04	77.13	0.09
7/5/10 12:00	78.32	78.45	0.126
7/5/10 13:00	79.96	80.09	0.126
7/5/10 14:00	81.51	81.67	0.162
7/5/10 15:00	82.85	83.02	0.162
7/5/10 16:00	83.85	83.96	0.108
7/5/10 17:00	84.45	84.52	0.072
7/5/10 18:00	84.62	84.70	0.072
7/5/10 19:00	84.31	84.36	0.054
7/5/10 20:00	83.60	83.64	0.036

7/5/10 21:00	82.62	82.64	0.018
7/5/10 22:00	81.55	81.55	0
7/5/10 23:00	80.50	80.47	-0.036
7/6/10 0:00	79.57	79.52	-0.054
7/6/10 1:00	78.90	78.83	-0.072
7/6/10 2:00	78.44	78.37	-0.072
7/6/10 3:00	78.20	78.11	-0.09
7/6/10 4:00	77.96	77.87	-0.09
7/6/10 5:00	77.78	77.68	-0.108
7/6/10 6:00	77.47	77.36	-0.108
7/6/10 7:00	77.35	77.28	-0.072
7/6/10 8:00	77.51	77.47	-0.036
7/6/10 9:00	77.93	77.93	0
7/6/10 10:00	78.63	78.67	0.036
7/6/10 11:00	79.75	79.83	0.072
7/6/10 12:00	81.23	81.34	0.108
7/6/10 13:00	82.83	82.98	0.144
7/6/10 14:00	84.46	84.64	0.18
7/6/10 15:00	85.82	85.98	0.162
7/6/10 16:00	86.84	87.00	0.162
7/6/10 17:00	87.39	87.55	0.162
7/6/10 18:00	87.46	87.61	0.144
7/6/10 19:00	87.09	87.22	0.126
7/6/10 20:00	86.42	86.51	0.09
7/6/10 21:00	85.62	85.68	0.054
7/6/10 22:00	84.70	84.72	0.018
7/6/10 23:00	83.62	83.60	-0.018
7/7/10 0:00	82.59	82.54	-0.054
7/7/10 1:00	81.84	81.78	-0.054
7/7/10 2:00	81.27	81.20	-0.072
7/7/10 3:00	80.86	80.79	-0.072
7/7/10 4:00	80.69	80.60	-0.09
7/7/10 5:00	80.43	80.32	-0.108
7/7/10 6:00	80.24	80.15	-0.09
7/7/10 7:00	80.20	80.11	-0.09
7/7/10 8:00	80.25	80.20	-0.054
7/7/10 9:00	80.60	80.59	-0.018
7/7/10 10:00	81.28	81.26	-0.018
7/7/10 11:00	82.31	82.35	0.036
7/7/10 12:00	83.68	83.75	0.072
7/7/10 13:00	84.79	84.85	0.054
7/7/10 14:00	85.78	85.78	0
7/7/10 15:00	86.85	86.87	0.018
7/7/10 16:00	87.49	87.53	0.036
7/7/10 17:00	88.13	88.15	0.018
7/7/10 18:00	88.27	88.21	-0.054
7/7/10 19:00	87.95	87.88	-0.072
7/7/10 20:00	87.17	87.10	-0.072
7/7/10 21:00	86.27	86.18	-0.09
7/7/10 22:00	85.26	85.17	-0.09

7/7/10 23:00	84.23	84.12	-0.108
7/8/10 0:00	83.28	83.16	-0.126
7/8/10 1:00	82.45	82.32	-0.126
7/8/10 2:00	81.99	81.86	-0.126
7/8/10 3:00	81.61	81.47	-0.144
7/8/10 4:00	81.29	81.14	-0.144
7/8/10 5:00	81.15	81.01	-0.144
7/8/10 6:00	80.86	80.71	-0.144
7/8/10 7:00	80.66	80.53	-0.126
7/8/10 8:00	80.75	80.66	-0.09
7/8/10 9:00	81.10	81.05	-0.054
7/8/10 10:00	81.73	81.73	0
7/8/10 11:00	82.82	82.89	0.072
7/8/10 12:00	84.20	84.31	0.108
7/8/10 13:00	85.75	85.89	0.144
7/8/10 14:00	87.17	87.30	0.126
7/8/10 15:00	88.18	88.21	0.036
7/8/10 16:00	89.18	89.21	0.036
7/8/10 17:00	89.56	89.58	0.018
7/8/10 18:00	89.04	89.04	0
7/8/10 19:00	88.34	88.29	-0.054
7/8/10 20:00	87.40	87.35	-0.054
7/8/10 21:00	86.43	86.36	-0.072
7/8/10 22:00	85.61	85.54	-0.072
7/9/10 0:00	84.13	84.04	-0.09
7/9/10 1:00	83.39	83.30	-0.09
7/9/10 2:00	82.79	82.70	-0.09
7/9/10 3:00	82.51	82.42	-0.09
7/9/10 4:00	82.28	82.17	-0.108
7/9/10 5:00	82.10	81.99	-0.108
7/9/10 6:00	82.00	81.90	-0.108
7/9/10 7:00	81.81	81.70	-0.108
7/9/10 8:00	81.65	81.58	-0.072
7/9/10 9:00	81.64	81.61	-0.036
7/9/10 10:00	81.97	81.95	-0.018
7/9/10 11:00	82.40	82.40	0
7/9/10 12:00	82.98	83.02	0.036
7/9/10 13:00	83.56	83.61	0.054
7/9/10 14:00	84.83	84.91	0.072
7/9/10 15:00	86.02	86.04	0.018
7/9/10 16:00	86.27	86.27	0
7/9/10 17:00	86.68	86.66	-0.018
7/9/10 18:00	87.02	86.99	-0.036
7/9/10 19:00	86.58	86.52	-0.054
7/9/10 20:00	85.92	85.87	-0.054
7/9/10 21:00	85.28	85.20	-0.072
7/9/10 22:00	84.58	84.51	-0.072
7/9/10 23:00	83.89	83.81	-0.072
7/10/10 0:00	83.21	83.12	-0.09



7/10/10 1:00	82.41	82.32	-0.09
7/10/10 2:00	81.78	81.69	-0.09
7/10/10 3:00	81.41	81.32	-0.09
7/10/10 4:00	81.06	80.97	-0.09
7/10/10 5:00	80.76	80.65	-0.108
7/10/10 6:00	80.66	80.57	-0.09
7/10/10 7:00	80.42	80.33	-0.09
7/10/10 8:00	80.57	80.50	-0.072
7/10/10 9:00	80.45	80.40	-0.054
7/10/10 10:00	80.42	80.42	0
7/10/10 11:00	80.38	80.43	0.054
7/10/10 12:00	80.63	80.74	0.108
7/10/10 13:00	80.96	81.10	0.144
7/10/10 14:00	81.70	81.86	0.162
7/10/10 15:00	82.51	82.62	0.108
7/10/10 16:00	83.18	83.27	0.09
7/10/10 17:00	83.83	83.85	0.018
7/10/10 18:00	84.30	84.30	0
7/10/10 19:00	84.25	84.22	-0.036
7/10/10 20:00	83.81	83.74	-0.072
7/10/10 21:00	83.15	83.08	-0.072
7/10/10 22:00	82.38	82.29	-0.09
7/10/10 23:00	81.63	81.54	-0.09
7/11/10 0:00	80.86	80.75	-0.108
7/11/10 1:00	80.27	80.16	-0.108
7/11/10 2:00	79.59	79.47	-0.126
7/11/10 3:00	79.28	79.16	-0.126
7/11/10 4:00	78.85	78.70	-0.144
7/11/10 5:00	78.36	78.22	-0.144
7/11/10 6:00	78.06	77.92	-0.144
7/11/10 7:00	77.91	77.77	-0.144
7/11/10 8:00	78.11	78.00	-0.108
7/11/10 9:00	78.47	78.40	-0.072
7/11/10 10:00	79.18	79.15	-0.036
7/11/10 11:00	80.14	80.14	0
7/11/10 12:00	81.40	81.45	0.054
7/11/10 13:00	82.99	83.06	0.072
7/11/10 14:00	84.49	84.52	0.036
7/11/10 15:00	85.87	85.86	-0.018
7/11/10 16:00	86.99	86.97	-0.018
7/11/10 17:00	87.35	87.33	-0.018
7/11/10 18:00	87.15	87.12	-0.036
7/11/10 19:00	86.69	86.62	-0.072
7/11/10 20:00	85.90	85.81	-0.09
7/11/10 21:00	84.77	84.66	-0.108
7/11/10 22:00	83.62	83.49	-0.126
7/11/10 23:00	82.38	82.23	-0.144
7/12/10 0:00	81.14	80.98	-0.162
7/12/10 1:00	79.88	79.72	-0.162
7/12/10 2:00	79.01	78.85	-0.162

7/12/10 3:00	78.40	78.20	-0.198
7/12/10 4:00	78.04	77.86	-0.18
7/12/10 5:00	77.69	77.49	-0.198
7/12/10 6:00	77.43	77.25	-0.18
7/12/10 7:00	77.25	77.09	-0.162
7/12/10 8:00	77.22	77.08	-0.144
7/12/10 9:00	77.59	77.52	-0.072
7/12/10 10:00	78.36	78.32	-0.036
7/12/10 11:00	79.28	79.30	0.018
7/12/10 12:00	80.62	80.67	0.054
7/12/10 13:00	81.91	82.00	0.09
7/12/10 14:00	82.81	82.93	0.126
7/12/10 15:00	83.46	83.53	0.072
7/12/10 16:00	83.66	83.73	0.072
7/12/10 17:00	83.44	83.53	0.09
7/12/10 18:00	82.87	82.91	0.036
7/12/10 19:00	82.06	82.08	0.018
7/12/10 20:00	81.26	81.24	-0.018
7/12/10 21:00	80.46	80.44	-0.018
7/12/10 22:00	79.61	79.57	-0.036
7/12/10 23:00	78.85	78.81	-0.036
7/13/10 0:00	78.26	78.23	-0.036
7/13/10 1:00	77.95	77.89	-0.054
7/13/10 2:00	77.81	77.74	-0.072
7/13/10 3:00	77.77	77.70	-0.072
7/13/10 4:00	77.57	77.50	-0.072
7/13/10 5:00	77.56	77.49	-0.072
7/13/10 6:00	77.44	77.36	-0.072
7/13/10 7:00	77.43	77.37	-0.054
7/13/10 8:00	77.42	77.39	-0.036
7/13/10 9:00	77.42	77.42	0
7/13/10 10:00	77.59	77.65	0.054
7/13/10 11:00	78.17	78.27	0.108
7/13/10 12:00	78.84	78.98	0.144
7/13/10 13:00	79.22	79.38	0.162
7/13/10 14:00	80.08	80.24	0.162
7/13/10 15:00	80.96	81.14	0.18
7/13/10 16:00	81.44	81.62	0.18
7/13/10 17:00	81.55	81.73	0.18
7/13/10 18:00	81.66	81.81	0.144
7/13/10 19:00	81.72	81.81	0.09
7/13/10 20:00	81.25	81.34	0.09
7/13/10 21:00	80.71	80.76	0.054
7/13/10 22:00	80.17	80.19	0.018
7/13/10 23:00	79.70	79.70	0
7/14/10 0:00	79.34	79.34	0
7/14/10 1:00	79.12	79.10	-0.018
7/14/10 2:00	78.98	78.95	-0.036
7/14/10 3:00	78.82	78.77	-0.054
7/14/10 4:00	78.68	78.63	-0.054

7/14/10 5:00	78.30	78.25	-0.054
7/14/10 6:00	78.22	78.15	-0.072
7/14/10 7:00	78.12	78.05	-0.072
7/14/10 8:00	78.22	78.19	-0.036
7/14/10 9:00	78.25	78.23	-0.018
7/14/10 10:00	78.35	78.38	0.036
7/14/10 11:00	78.42	78.47	0.054
7/14/10 12:00	78.54	78.65	0.108
7/14/10 13:00	78.81	78.94	0.126
7/14/10 14:00	79.17	79.26	0.09
7/14/10 15:00	79.77	79.89	0.126
7/14/10 16:00	80.36	80.47	0.108
7/14/10 17:00	80.56	80.64	0.072
7/14/10 18:00	81.01	81.09	0.072
7/14/10 19:00	80.64	80.69	0.054
7/14/10 20:00	80.03	80.07	0.036
7/14/10 21:00	79.45	79.45	0
7/14/10 22:00	78.80	78.80	0
7/14/10 23:00	78.15	78.12	-0.036
7/15/10 0:00	77.54	77.50	-0.036
7/15/10 1:00	77.30	77.25	-0.054
7/15/10 2:00	77.29	77.22	-0.072
7/15/10 3:00	77.22	77.15	-0.072
7/15/10 4:00	77.11	77.02	-0.09
7/15/10 5:00	77.16	77.07	-0.09
7/15/10 6:00	77.05	76.95	-0.108
7/15/10 7:00	77.11	77.02	-0.09
7/15/10 8:00	77.27	77.20	-0.072
7/15/10 9:00	77.25	77.20	-0.054
7/15/10 10:00	77.48	77.48	0
7/15/10 11:00	78.05	78.09	0.036
7/15/10 12:00	79.06	79.15	0.09
7/15/10 13:00	80.15	80.26	0.108
7/15/10 14:00	81.17	81.32	0.144
7/15/10 15:00	82.22	82.36	0.144
7/15/10 16:00	83.25	83.41	0.162
7/15/10 17:00	83.94	84.08	0.144
7/15/10 18:00	84.01	84.10	0.09
7/15/10 19:00	83.74	83.81	0.072
7/15/10 20:00	83.17	83.22	0.054
7/15/10 21:00	82.30	82.33	0.036
7/15/10 22:00	81.28	81.30	0.018
7/15/10 23:00	80.33	80.33	0
7/16/10 0:00	79.54	79.52	-0.018
7/16/10 1:00	79.10	79.06	-0.036
7/16/10 2:00	78.59	78.53	-0.054
7/16/10 3:00	78.50	78.43	-0.072
7/16/10 4:00	78.23	78.14	-0.09
7/16/10 5:00	78.02	77.93	-0.09
7/16/10 6:00	77.78	77.67	-0.108

7/16/10 7:00	77.72	77.63	-0.09
7/16/10 8:00	77.97	77.90	-0.072
7/16/10 9:00	78.27	78.24	-0.036
7/16/10 10:00	79.03	79.03	0
7/16/10 11:00	80.02	79.98	-0.036
7/16/10 12:00	80.76	80.74	-0.018
7/16/10 13:00	82.95	82.95	0
7/16/10 14:00	83.89	83.89	0
7/16/10 15:00	84.61	84.57	-0.036
7/16/10 16:00	84.24	84.20	-0.036
7/16/10 17:00	83.87	83.85	-0.018
7/16/10 18:00	83.76	83.71	-0.054
7/16/10 19:00	83.20	83.13	-0.072
7/16/10 20:00	82.41	82.34	-0.072
7/16/10 21:00	81.51	81.44	-0.072
7/16/10 22:00	80.48	80.39	-0.09
7/16/10 23:00	79.66	79.57	-0.09
7/17/10 0:00	79.11	79.03	-0.072
7/17/10 1:00	78.88	78.79	-0.09
7/17/10 2:00	78.67	78.58	-0.09
7/17/10 3:00	78.54	78.47	-0.072
7/17/10 4:00	78.45	78.36	-0.09
7/17/10 5:00	78.40	78.31	-0.09
7/17/10 6:00	78.35	78.26	-0.09
7/17/10 7:00	78.31	78.23	-0.072
7/17/10 8:00	78.43	78.37	-0.054
7/17/10 9:00	78.70	78.70	0
7/17/10 10:00	79.20	79.21	0.018
7/17/10 11:00	80.01	80.06	0.054
7/17/10 12:00	81.12	81.19	0.072
7/17/10 13:00	82.30	82.36	0.054
7/17/10 14:00	83.48	83.50	0.018
7/17/10 15:00	84.52	84.50	-0.018
7/17/10 16:00	85.31	85.27	-0.036
7/17/10 17:00	85.68	85.64	-0.036
7/17/10 18:00	85.85	85.82	-0.036
7/17/10 19:00	85.55	85.51	-0.036
7/17/10 20:00	84.80	84.75	-0.054
7/17/10 21:00	83.94	83.89	-0.054
7/18/10 3:00	79.67	79.60	-0.072
7/18/10 4:00	79.51	79.45	-0.054
7/18/10 5:00	79.52	79.45	-0.072
7/18/10 6:00	79.42	79.36	-0.054
7/18/10 7:00	79.50	79.48	-0.018
7/18/10 8:00	79.65	79.65	0
7/18/10 9:00	79.95	79.99	0.036
7/18/10 10:00	80.31	80.36	0.054
7/18/10 11:00	81.04	81.11	0.072
7/18/10 12:00	82.03	82.07	0.036
7/18/10 13:00	83.01	82.99	-0.018

7/18/10 14:00	84.02	84.06	0.036
7/18/10 15:00	85.04	85.01	-0.036
7/18/10 16:00	85.81	85.77	-0.036
7/18/10 17:00	86.18	86.15	-0.036
7/18/10 18:00	86.24	86.20	-0.036
7/18/10 19:00	85.98	85.94	-0.036
7/18/10 20:00	85.34	85.29	-0.054
7/18/10 21:00	84.57	84.52	-0.054
7/18/10 22:00	83.70	83.62	-0.072
7/18/10 23:00	82.63	82.56	-0.072
7/19/10 0:00	81.62	81.53	-0.09
7/19/10 1:00	80.83	80.74	-0.09
7/19/10 2:00	80.48	80.39	-0.09
7/19/10 3:00	80.29	80.18	-0.108
7/19/10 4:00	79.94	79.85	-0.09
7/19/10 5:00	79.97	79.88	-0.09
7/19/10 6:00	79.84	79.73	-0.108
7/19/10 7:00	79.54	79.47	-0.072
7/19/10 8:00	79.65	79.57	-0.072
7/19/10 9:00	80.12	80.14	0.018
7/19/10 10:00	80.76	80.83	0.072
7/19/10 11:00	81.66	81.75	0.09
7/19/10 12:00	82.81	82.91	0.108
7/19/10 13:00	83.93	84.00	0.072
7/19/10 14:00	84.38	84.44	0.054
7/19/10 15:00	84.83	84.83	0
7/19/10 16:00	85.66	85.69	0.036
7/19/10 17:00	86.11	86.17	0.054
7/19/10 18:00	86.06	86.10	0.036
7/19/10 19:00	85.78	85.78	0
7/19/10 20:00	85.23	85.23	0
7/19/10 21:00	84.44	84.43	-0.018
7/19/10 22:00	83.70	83.68	-0.018
7/19/10 23:00	82.91	82.88	-0.036
7/20/10 0:00	82.02	81.97	-0.054
7/20/10 1:00	81.21	81.15	-0.054
7/20/10 2:00	80.60	80.53	-0.072
7/20/10 3:00	80.15	80.08	-0.072
7/20/10 4:00	80.02	79.94	-0.072
7/20/10 5:00	79.84	79.75	-0.09
7/20/10 6:00	79.63	79.54	-0.09
7/20/10 7:00	79.60	79.51	-0.09
7/20/10 8:00	79.54	79.47	-0.072
7/20/10 9:00	79.57	79.53	-0.036
7/20/10 10:00	79.83	79.83	0
7/20/10 11:00	79.91	79.97	0.054
7/20/10 12:00	80.25	80.32	0.072
7/20/10 13:00	80.83	80.92	0.09
7/20/10 14:00	81.69	81.76	0.072
7/20/10 15:00	82.48	82.55	0.072

7/20/10 16:00	83.32	83.35	0.036
7/20/10 17:00	84.24	84.25	0.018
7/20/10 18:00	84.44	84.44	0
7/20/10 19:00	84.23	84.21	-0.018
7/20/10 20:00	83.77	83.74	-0.036
7/20/10 21:00	83.20	83.14	-0.054
7/20/10 22:00	82.51	82.46	-0.054
7/20/10 23:00	81.79	81.72	-0.072
7/21/10 0:00	81.10	81.03	-0.072
7/21/10 1:00	80.53	80.44	-0.09
7/21/10 2:00	80.07	79.98	-0.09
7/21/10 3:00	79.92	79.83	-0.09
7/21/10 4:00	79.76	79.66	-0.108
7/21/10 5:00	79.56	79.45	-0.108
7/21/10 6:00	79.42	79.31	-0.108
7/21/10 7:00	79.18	79.09	-0.09
7/21/10 8:00	79.31	79.24	-0.072
7/21/10 9:00	79.64	79.61	-0.036
7/21/10 10:00	80.25	80.25	0
7/21/10 11:00	81.09	81.13	0.036
7/21/10 12:00	82.06	82.08	0.018
7/21/10 13:00	82.97	83.00	0.036
7/21/10 14:00	83.31	83.27	-0.036
7/21/10 15:00	84.05	84.05	0
7/21/10 16:00	85.29	85.27	-0.018
7/21/10 17:00	85.63	85.61	-0.018
7/21/10 18:00	85.60	85.55	-0.054
7/21/10 19:00	85.41	85.33	-0.072
7/21/10 20:00	84.98	84.89	-0.09
7/21/10 21:00	84.31	84.24	-0.072
7/21/10 22:00	83.50	83.41	-0.09
7/21/10 23:00	82.67	82.58	-0.09
7/22/10 0:00	81.75	81.66	-0.09
7/22/10 1:00	80.86	80.77	-0.09
7/22/10 2:00	80.03	79.93	-0.108
7/22/10 3:00	79.37	79.26	-0.108
7/22/10 4:00	79.08	78.98	-0.108
7/22/10 5:00	78.87	78.74	-0.126
7/22/10 6:00	78.76	78.66	-0.108
7/22/10 7:00	78.68	78.59	-0.09
7/22/10 8:00	78.77	78.70	-0.072
7/22/10 9:00	79.13	79.09	-0.036
7/22/10 10:00	79.66	79.64	-0.018
7/22/10 11:00	80.46	80.49	0.036
7/22/10 12:00	81.43	81.47	0.036
7/22/10 13:00	82.51	82.53	0.018
7/22/10 14:00	83.50	83.48	-0.018
7/22/10 15:00	84.52	84.52	0
7/22/10 16:00	85.10	85.08	-0.018
7/22/10 17:00	85.50	85.46	-0.036

7/22/10 18:00	85.59	85.55	-0.036
7/22/10 19:00	85.30	85.27	-0.036
7/22/10 20:00	84.88	84.84	-0.036
7/22/10 21:00	84.21	84.16	-0.054
7/22/10 22:00	83.42	83.37	-0.054
7/22/10 23:00	82.57	82.50	-0.072
7/23/10 0:00	81.69	81.64	-0.054
7/23/10 1:00	80.80	80.73	-0.072
7/23/10 2:00	80.10	80.02	-0.072
7/23/10 3:00	79.62	79.53	-0.09
7/23/10 4:00	79.24	79.17	-0.072
7/23/10 5:00	79.06	78.97	-0.09
7/23/10 6:00	78.98	78.90	-0.072
7/23/10 7:00	78.92	78.85	-0.072
7/23/10 8:00	78.63	78.60	-0.036
7/23/10 9:00	78.61	78.59	-0.018
7/23/10 10:00	78.57	78.60	0.036
7/23/10 11:00	78.71	78.80	0.09
7/23/10 12:00	78.99	79.12	0.126
7/23/10 13:00	79.30	79.48	0.18
7/23/10 14:00	80.16	80.38	0.216
7/23/10 15:00	81.27	81.48	0.216
7/23/10 16:00	82.04	82.22	0.18
7/23/10 17:00	82.59	82.72	0.126
7/23/10 18:00	82.86	82.95	0.09
7/23/10 19:00	82.95	83.01	0.054
7/23/10 20:00	82.81	82.85	0.036
7/23/10 21:00	82.55	82.59	0.036
7/23/10 22:00	82.09	82.09	0
7/23/10 23:00	81.55	81.52	-0.036
7/24/10 0:00	81.00	80.96	-0.036
7/24/10 1:00	80.39	80.34	-0.054
7/24/10 2:00	79.83	79.75	-0.072
7/24/10 3:00	79.36	79.29	-0.072
7/24/10 4:00	79.07	79.00	-0.072
7/24/10 5:00	78.89	78.82	-0.072
7/24/10 6:00	78.66	78.59	-0.072
7/24/10 7:00	78.73	78.68	-0.054
7/24/10 8:00	78.96	78.92	-0.036
7/24/10 9:00	79.49	79.51	0.018
7/24/10 10:00	80.17	80.23	0.054
7/24/10 11:00	81.03	81.12	0.09
7/24/10 12:00	82.17	82.30	0.126
7/24/10 13:00	83.48	83.57	0.09
7/24/10 14:00	84.46	84.57	0.108
7/24/10 15:00	85.20	85.26	0.054
7/24/10 16:00	86.13	86.17	0.036
7/24/10 17:00	86.97	86.93	-0.036
7/24/10 19:00	87.05	87.00	-0.054
7/24/10 20:00	86.49	86.44	-0.054

7/24/10 21:00	85.79	85.74	-0.054
7/24/10 22:00	84.54	84.47	-0.072
7/24/10 23:00	83.41	83.30	-0.108
7/25/10 23:00			
7/26/10 23:00			
7/27/10 23:00			
7/28/10 11:00	78.89	78.96	0.072
7/28/10 12:00	80.02	80.13	0.108
7/28/10 13:00	81.03	81.16	0.126
7/28/10 14:00	82.01	82.07	0.054
7/28/10 15:00	82.79	82.85	0.054
7/28/10 16:00	83.37	83.33	-0.036
7/28/10 17:00	83.58	83.57	-0.018
7/28/10 18:00	83.37	83.34	-0.036
7/28/10 19:00	82.96	82.93	-0.036
7/28/10 20:00	82.36	82.31	-0.054
7/28/10 21:00	81.63	81.57	-0.054
7/28/10 22:00	80.94	80.87	-0.072
7/28/10 23:00	80.38	80.31	-0.072
7/29/10 0:00	79.92	79.86	-0.054
7/29/10 1:00	79.53	79.46	-0.072
7/29/10 2:00	79.37	79.30	-0.072
7/29/10 3:00	79.07	79.00	-0.072
7/29/10 4:00	78.87	78.80	-0.072
7/29/10 5:00	78.77	78.70	-0.072
7/29/10 6:00	78.61	78.53	-0.072
7/29/10 7:00	78.50	78.43	-0.072
7/29/10 8:00	78.67	78.62	-0.054
7/29/10 9:00	78.80	78.80	0
7/29/10 10:00	79.39	79.43	0.036
7/29/10 11:00	79.91	79.98	0.072
7/29/10 12:00	80.60	80.62	0.018
7/29/10 13:00	81.41	81.32	-0.09
7/29/10 14:00	82.33	82.26	-0.072
7/29/10 15:00	83.08	83.04	-0.036
7/29/10 16:00	83.68	83.66	-0.018
7/29/10 17:00	83.91	83.87	-0.036
7/29/10 18:00	83.73	83.67	-0.054
7/29/10 19:00	83.24	83.17	-0.072
7/29/10 20:00	82.43	82.36	-0.072
7/29/10 21:00	81.43	81.34	-0.09
7/29/10 22:00	80.53	80.46	-0.072
7/29/10 23:00	79.62	79.53	-0.09
7/30/10 0:00	78.80	78.69	-0.108
7/30/10 1:00	78.40	78.29	-0.108
7/30/10 2:00	77.86	77.73	-0.126
7/30/10 3:00	77.47	77.32	-0.144
7/30/10 4:00	77.06	76.93	-0.126
7/30/10 5:00	76.78	76.65	-0.126
7/30/10 6:00	76.48	76.33	-0.144



7/30/10 7:00	76.33	76.21	-0.126
7/30/10 8:00	76.30	76.21	-0.09
7/30/10 9:00	75.02	74.94	-0.072
7/30/10 11:00	78.12	78.15	0.036
7/30/10 12:00	79.08	79.17	0.09
7/30/10 13:00	80.02	80.14	0.126
7/30/10 14:00	81.11	81.23	0.126
7/30/10 15:00	81.88	81.97	0.09
7/30/10 16:00	82.23	82.32	0.09
7/30/10 17:00	82.12	82.14	0.018
7/30/10 18:00	81.85	81.83	-0.018
7/30/10 19:00	81.24	81.19	-0.054
7/30/10 20:00	80.41	80.35	-0.054
7/30/10 21:00	79.64	79.58	-0.054
7/30/10 22:00	79.03	78.96	-0.072
7/30/10 23:00	78.40	78.31	-0.09
7/31/10 0:00	77.94	77.83	-0.108
7/31/10 1:00	77.68	77.58	-0.108
7/31/10 2:00	77.41	77.31	-0.108
7/31/10 3:00	77.27	77.15	-0.126
7/31/10 4:00	76.99	76.84	-0.144
7/31/10 5:00	76.55	76.41	-0.144
7/31/10 6:00	76.22	76.07	-0.144
7/31/10 7:00	75.88	75.74	-0.144
7/31/10 8:00	75.66	75.56	-0.108
7/31/10 9:00	75.84	75.77	-0.072
7/31/10 10:00	76.44	76.41	-0.036
7/31/10 11:00	77.27	77.31	0.036
7/31/10 12:00	78.55	78.62	0.072
7/31/10 13:00	79.86	79.98	0.126
7/31/10 14:00	81.03	81.19	0.162
7/31/10 15:00	82.28	82.46	0.18
7/31/10 16:00	82.76	82.96	0.198
7/31/10 17:00	83.05	83.25	0.198
7/31/10 18:00	83.07	83.21	0.144
7/31/10 19:00	82.58	82.73	0.144
7/31/10 20:00	81.70	81.82	0.126
7/31/10 21:00	80.77	80.88	0.108
7/31/10 22:00	79.73	79.80	0.072
7/31/10 23:00	78.85	78.91	0.054
8/1/10 0:00	78.16	78.20	0.036
8/1/10 1:00	77.77	77.77	0
8/1/10 2:00	77.55	77.55	0
8/1/10 3:00	77.28	77.26	-0.018
8/1/10 4:00	77.08	77.04	-0.036
8/1/10 5:00	76.85	76.80	-0.054
8/1/10 6:00	76.78	76.73	-0.054
8/1/10 7:00	76.64	76.59	-0.054
8/1/10 8:00	76.60	76.56	-0.036
8/1/10 9:00	76.46	76.46	0

8/1/10 10:00	76.47	76.51	0.036
8/1/10 11:00	76.66	76.73	0.072
8/1/10 12:00	76.93	77.05	0.126
8/1/10 13:00	77.62	77.77	0.144
8/1/10 14:00	78.22	78.37	0.144
8/1/10 15:00	78.63	78.79	0.162
8/1/10 16:00	79.25	79.40	0.144
8/1/10 17:00	79.48	79.57	0.09
8/1/10 18:00	79.36	79.41	0.054
8/1/10 19:00	78.93	78.96	0.036
8/1/10 20:00	78.41	78.43	0.018
8/1/10 21:00	77.99	77.98	-0.018
8/1/10 22:00	77.44	77.44	0
8/1/10 23:00	76.94	76.92	-0.018
8/2/10 0:00	76.54	76.46	-0.072
8/2/10 1:00	76.26	76.21	-0.054
8/2/10 2:00	76.05	75.97	-0.072
8/2/10 3:00	75.76	75.67	-0.09
8/2/10 4:00	75.53	75.44	-0.09
8/2/10 5:00	75.32	75.23	-0.09
8/2/10 6:00	75.15	75.04	-0.108
8/2/10 7:00	74.89	74.80	-0.09
8/2/10 8:00	75.01	74.93	-0.072
8/2/10 9:00	75.25	75.21	-0.036
8/2/10 10:00	75.83	75.83	0
8/2/10 11:00	76.29	76.31	0.018
8/2/10 12:00	76.93	76.96	0.036
8/2/10 13:00	77.66	77.69	0.036
8/2/10 14:00	78.49	78.50	0.018
8/2/10 15:00	78.54	78.56	0.018
8/2/10 16:00	78.74	78.78	0.036
8/2/10 17:00	78.82	78.82	0
8/2/10 18:00	78.77	78.73	-0.036
8/2/10 19:00	78.49	78.44	-0.054
8/2/10 20:00	78.11	78.04	-0.072
8/2/10 21:00	77.65	77.56	-0.09
8/2/10 22:00	77.20	77.11	-0.09
8/2/10 23:00	76.66	76.57	-0.09
8/3/10 0:00	76.29	76.20	-0.09
8/3/10 1:00	76.01	75.92	-0.09
8/3/10 2:00	75.72	75.61	-0.108
8/3/10 3:00	75.57	75.48	-0.09
8/3/10 4:00	75.54	75.45	-0.09
8/3/10 5:00	75.50	75.39	-0.108
8/3/10 6:00	75.43	75.34	-0.09
8/3/10 7:00	75.36	75.29	-0.072
8/3/10 8:00	75.46	75.43	-0.036
8/3/10 9:00	75.84	75.84	0
8/3/10 10:00	76.16	76.22	0.054
8/3/10 11:00	76.33	76.41	0.072

8/3/10 12:00	76.78	76.91	0.126
8/3/10 13:00	77.28	77.39	0.108
8/3/10 14:00	77.56	77.65	0.09
8/3/10 15:00	78.02	78.13	0.108
8/3/10 16:00	78.47	78.51	0.036
8/3/10 17:00	78.67	78.68	0.018
8/3/10 18:00	78.62	78.62	0
8/3/10 19:00	78.53	78.53	0
8/3/10 20:00	78.33	78.31	-0.018
8/3/10 21:00	78.00	77.98	-0.018
8/3/10 22:00	77.57	77.53	-0.036
8/3/10 23:00	77.22	77.18	-0.036
8/4/10 0:00	76.87	76.81	-0.054
8/4/10 1:00	76.52	76.46	-0.054
8/4/10 2:00	76.25	76.18	-0.072
8/4/10 3:00	76.06	76.00	-0.054
8/4/10 4:00	75.89	75.82	-0.072
8/4/10 5:00	75.84	75.79	-0.054
8/4/10 6:00	75.77	75.70	-0.072
8/4/10 7:00	75.78	75.73	-0.054
8/4/10 8:00	75.99	75.96	-0.036
8/4/10 9:00	76.56	76.55	-0.018
8/4/10 10:00	77.20	77.24	0.036
8/4/10 11:00	77.96	78.03	0.072
8/4/10 12:00	79.06	79.13	0.072
8/4/10 13:00	80.02	80.09	0.072
8/4/10 14:00	81.61	81.65	0.036
8/4/10 15:00	82.99	82.99	0
8/4/10 16:00	84.03	84.03	0
8/4/10 17:00	84.38	84.38	0
8/4/10 18:00	84.55	84.55	0
8/4/10 19:00	84.48	84.45	-0.036
8/4/10 20:00	83.95	83.91	-0.036
8/4/10 21:00	83.31	83.27	-0.036
8/4/10 22:00	82.73	82.68	-0.054
8/4/10 23:00	82.00	81.94	-0.054
8/5/10 0:00	81.17	81.10	-0.072
8/5/10 1:00	80.50	80.44	-0.054
8/5/10 2:00	79.90	79.85	-0.054
8/5/10 3:00	79.39	79.34	-0.054
8/5/10 4:00	78.93	78.88	-0.054
8/5/10 5:00	78.44	78.39	-0.054
8/5/10 6:00	78.08	78.03	-0.054
8/5/10 7:00	77.95	77.91	-0.036
8/5/10 8:00	77.94	77.90	-0.036
8/5/10 9:00	77.99	77.99	0
8/5/10 10:00	78.24	78.24	0
8/5/10 11:00	78.88	78.88	0
8/5/10 12:00	79.30	79.34	0.036
8/5/10 13:00	79.96	79.99	0.036

8/5/10 14:00	81.12	81.16	0.036
8/5/10 15:00	81.83	81.88	0.054
8/5/10 16:00	82.49	82.51	0.018
8/5/10 17:00	83.10	83.10	0
8/5/10 18:00	83.43	83.39	-0.036
8/5/10 19:00	83.56	83.50	-0.054
8/5/10 20:00	83.30	83.25	-0.054
8/5/10 21:00	82.74	82.68	-0.054
8/5/10 22:00	82.09	82.01	-0.072
8/5/10 23:00	81.33	81.26	-0.072
8/6/10 0:00	80.55	80.46	-0.09
8/6/10 1:00	79.80	79.73	-0.072
8/6/10 2:00	79.17	79.08	-0.09
8/6/10 3:00	78.58	78.50	-0.072
8/6/10 4:00	77.99	77.90	-0.09
8/6/10 5:00	77.64	77.55	-0.09
8/6/10 6:00	77.40	77.31	-0.09
8/6/10 7:00	77.16	77.07	-0.09
8/6/10 8:00	77.18	77.13	-0.054
8/6/10 9:00	77.34	77.29	-0.054
8/6/10 10:00	77.71	77.67	-0.036
8/6/10 11:00	78.27	78.27	0
8/6/10 12:00	79.06	79.06	0
8/6/10 13:00	79.85	79.82	-0.036
8/6/10 14:00	80.64	80.59	-0.054
8/6/10 15:00	81.36	81.27	-0.09
8/6/10 16:00	81.93	81.86	-0.072
8/6/10 17:00	82.33	82.27	-0.054
8/6/10 18:00	82.41	82.36	-0.054
8/6/10 19:00	82.09	82.03	-0.054
8/6/10 20:00	81.63	81.55	-0.072
8/6/10 21:00	80.94	80.87	-0.072
8/6/10 22:00	80.13	80.06	-0.072
8/6/10 23:00	79.09	79.00	-0.09
8/7/10 0:00	78.02	77.91	-0.108
8/7/10 1:00	77.06	76.95	-0.108
8/7/10 2:00	76.14	76.03	-0.108
8/7/10 3:00	75.56	75.45	-0.108
8/7/10 4:00	75.22	75.10	-0.126
8/7/10 5:00	75.00	74.88	-0.126
8/7/10 6:00	74.78	74.65	-0.126
8/7/10 7:00	74.73	74.62	-0.108
8/7/10 8:00	74.75	74.67	-0.072
8/7/10 9:00	75.16	75.13	-0.036
8/7/10 10:00	75.84	75.86	0.018
8/7/10 11:00	76.93	76.99	0.054
8/7/10 12:00	78.24	78.35	0.108
8/7/10 13:00	79.45	79.52	0.072
8/7/10 14:00	80.83	80.90	0.072
8/7/10 15:00	82.04	82.13	0.09

8/7/10 16:00	83.03	83.07	0.036
8/7/10 17:00	83.77	83.74	-0.036
8/7/10 18:00	84.00	83.95	-0.054
8/7/10 19:00	83.89	83.84	-0.054
8/7/10 20:00	83.40	83.35	-0.054
8/7/10 21:00	82.64	82.57	-0.072
8/7/10 22:00	81.78	81.71	-0.072
8/7/10 23:00	80.77	80.70	-0.072
8/8/10 0:00	79.68	79.59	-0.09
8/8/10 1:00	78.73	78.64	-0.09
8/8/10 2:00	77.85	77.76	-0.09
8/8/10 3:00	77.03	76.94	-0.09
8/8/10 4:00	76.28	76.19	-0.09
8/8/10 5:00	75.79	75.69	-0.108
8/8/10 6:00	75.45	75.34	-0.108
8/8/10 7:00	75.25	75.16	-0.09
8/8/10 8:00	75.29	75.22	-0.072
8/8/10 9:00	75.73	75.71	-0.018
8/8/10 10:00	76.37	76.39	0.018
8/8/10 11:00	77.33	77.39	0.054
8/8/10 12:00	78.42	78.53	0.108
8/8/10 13:00	79.93	79.98	0.054
8/8/10 14:00	81.37	81.45	0.072
8/8/10 15:00	82.39	82.46	0.072
8/8/10 16:00	83.20	83.27	0.072
8/8/10 17:00	83.91	83.95	0.036
8/8/10 18:00	84.24	84.22	-0.018
8/8/10 19:00	84.11	84.08	-0.036
8/8/10 20:00	83.66	83.62	-0.036
8/8/10 21:00	82.78	82.74	-0.036
8/8/10 22:00	81.74	81.68	-0.054
8/8/10 23:00	80.70	80.65	-0.054
8/9/10 0:00	79.84	79.79	-0.054
8/9/10 1:00	79.06	79.01	-0.054
8/9/10 2:00	78.35	78.29	-0.054
8/9/10 3:00	77.69	77.62	-0.072
8/9/10 4:00	77.09	77.02	-0.072
8/9/10 5:00	76.58	76.49	-0.09
8/9/10 6:00	76.24	76.17	-0.072
8/9/10 7:00	76.06	75.98	-0.072
8/9/10 8:00	76.16	76.13	-0.036
8/9/10 9:00	76.63	76.63	0
8/9/10 10:00	77.37	77.41	0.036
8/9/10 11:00	78.29	78.36	0.072
8/9/10 12:00	79.27	79.33	0.054
8/9/10 13:00	80.56	80.61	0.054
8/9/10 14:00	82.43	82.49	0.054
8/9/10 15:00	83.45	83.48	0.036
8/9/10 16:00	84.47	84.47	0
8/9/10 17:00	85.31	85.31	0

8/9/10 18:00	85.65	85.61	-0.036
8/9/10 19:00	85.54	85.52	-0.018
8/9/10 20:00	85.22	85.19	-0.036
8/9/10 21:00	84.60	84.56	-0.036
8/9/10 22:00	83.63	83.59	-0.036
8/9/10 23:00	82.58	82.53	-0.054
8/10/10 0:00	81.65	81.61	-0.036
8/10/10 1:00	80.88	80.83	-0.054
8/10/10 2:00	80.25	80.20	-0.054
8/10/10 3:00	79.66	79.61	-0.054
8/10/10 4:00	79.21	79.15	-0.054
8/10/10 5:00	78.82	78.75	-0.072
8/10/10 6:00	78.47	78.40	-0.072
8/10/10 7:00	78.33	78.27	-0.054
8/10/10 8:00	78.37	78.34	-0.036
8/10/10 9:00	78.81	78.81	0
8/10/10 10:00	79.43	79.48	0.054
8/10/10 11:00	80.06	80.13	0.072
8/10/10 12:00	80.99	81.10	0.108
8/10/10 13:00	82.18	82.32	0.144
8/10/10 14:00	83.68	83.83	0.144
8/10/10 15:00	84.27	84.45	0.18
8/10/10 16:00	85.00	85.18	0.18
8/10/10 17:00	85.80	85.96	0.162
8/10/10 18:00	86.24	86.39	0.144
8/10/10 19:00	86.00	86.10	0.108
8/10/10 20:00	85.37	85.46	0.09
8/10/10 21:00	84.78	84.85	0.072
8/10/10 22:00	84.17	84.22	0.054
8/10/10 23:00	83.42	83.47	0.054
8/11/10 0:00	82.56	82.59	0.036
8/11/10 1:00	81.74	81.76	0.018
8/11/10 2:00	81.07	81.09	0.018
8/11/10 3:00	80.44	80.42	-0.018
8/11/10 4:00	79.88	79.82	-0.054
8/11/10 5:00	79.34	79.29	-0.054
8/11/10 6:00	78.96	78.90	-0.054
8/11/10 7:00	78.68	78.62	-0.054
8/11/10 8:00	78.66	78.62	-0.036
8/11/10 9:00	78.89	78.87	-0.018
8/11/10 10:00	79.59	79.61	0.018
8/11/10 11:00	80.48	80.50	0.018
8/11/10 12:00	81.35	81.38	0.036
8/11/10 13:00	82.59	82.65	0.054
8/11/10 14:00	83.86	83.90	0.036
8/11/10 15:00	84.88	84.93	0.054
8/11/10 16:00	85.63	85.69	0.054
8/11/10 17:00	86.33	86.32	-0.018
8/11/10 18:00	86.55	86.50	-0.054
8/11/10 19:00	86.48	86.43	-0.054

8/11/10 20:00	86.11	86.04	-0.072
8/11/10 21:00	85.37	85.28	-0.09
8/11/10 22:00	84.33	84.24	-0.09
8/11/10 23:00	83.32	83.23	-0.09
8/12/10 0:00	82.47	82.36	-0.108
8/12/10 1:00	81.74	81.63	-0.108
8/12/10 2:00	81.07	80.96	-0.108
8/12/10 3:00	80.47	80.34	-0.126
8/12/10 4:00	79.96	79.84	-0.126
8/12/10 5:00	79.46	79.35	-0.108
8/12/10 6:00	79.03	78.93	-0.108
8/12/10 7:00	78.80	78.71	-0.09
8/12/10 8:00	78.75	78.68	-0.072
8/12/10 9:00	78.78	78.72	-0.054
8/12/10 10:00	78.88	78.85	-0.036
8/12/10 11:00	78.85	78.86	0.018
8/12/10 12:00	78.96	79.03	0.072
8/12/10 13:00	78.99	79.07	0.072
8/12/10 14:00	78.96	79.05	0.09
8/12/10 15:00	78.80	78.89	0.09
8/12/10 16:00	78.71	78.83	0.126
8/12/10 17:00	78.40	78.50	0.108
8/12/10 18:00	78.11	78.18	0.072
8/12/10 19:00	77.68	77.74	0.054
8/12/10 20:00	77.34	77.36	0.018
8/12/10 21:00	77.10	77.10	0
8/12/10 23:00	76.51	76.46	-0.054
8/13/10 0:00	76.29	76.24	-0.054
8/13/10 1:00	76.10	76.01	-0.09
8/13/10 2:00	75.94	75.85	-0.09
8/13/10 3:00	76.03	75.94	-0.09
8/13/10 4:00	75.91	75.80	-0.108
8/13/10 5:00	75.91	75.78	-0.126
8/13/10 6:00	75.81	75.69	-0.126
8/13/10 7:00	75.69	75.56	-0.126
8/13/10 8:00	75.62	75.51	-0.108
8/13/10 9:00	75.75	75.68	-0.072
8/13/10 10:00	75.89	75.86	-0.036
8/13/10 11:00	76.36	76.34	-0.018
8/13/10 12:00	76.92	76.94	0.018
8/13/10 13:00	77.89	77.92	0.036
8/13/10 14:00	78.77	78.76	-0.018
8/13/10 15:00	79.19	79.19	0
8/13/10 16:00	79.43	79.43	0
8/13/10 17:00	79.97	79.95	-0.018
8/13/10 18:00	80.02	79.98	-0.036
8/13/10 19:00	79.78	79.74	-0.036
8/13/10 20:00	79.40	79.35	-0.054
8/13/10 21:00	78.92	78.85	-0.072

8/13/10 22:00	78.41	78.34	-0.072
8/13/10 23:00	77.84	77.75	-0.09
8/14/10 0:00	77.31	77.20	-0.108
8/14/10 1:00	76.77	76.66	-0.108
8/14/10 2:00	76.42	76.30	-0.126
8/14/10 3:00	76.19	76.08	-0.108
8/14/10 4:00	75.99	75.87	-0.126
8/14/10 5:00	75.86	75.73	-0.126
8/14/10 6:00	75.65	75.50	-0.144
8/14/10 7:00	75.58	75.45	-0.126
8/14/10 8:00	75.64	75.53	-0.108
8/14/10 9:00	75.75	75.66	-0.09
8/14/10 10:00	75.94	75.91	-0.036
8/14/10 11:00	76.31	76.29	-0.018
8/14/10 12:00	76.77	76.77	0
8/14/10 13:00	77.63	77.66	0.036
8/14/10 14:00	78.53	78.55	0.018
8/14/10 15:00	79.64	79.66	0.018
8/14/10 16:00	80.10	80.10	0
8/14/10 17:00	80.17	80.15	-0.018
8/14/10 18:00	80.20	80.18	-0.018
8/14/10 19:00	79.98	79.95	-0.036
8/14/10 20:00	79.56	79.52	-0.036
8/14/10 21:00	78.94	78.89	-0.054
8/14/10 22:00	78.35	78.27	-0.072
8/14/10 23:00	77.72	77.65	-0.072
8/15/10 0:00	77.11	77.02	-0.09
8/15/10 1:00	76.61	76.52	-0.09
8/15/10 2:00	76.28	76.19	-0.09
8/15/10 3:00	76.10	75.99	-0.108
8/15/10 4:00	75.94	75.83	-0.108
8/15/10 5:00	75.83	75.73	-0.108
8/15/10 6:00	75.73	75.64	-0.09
8/15/10 7:00	75.59	75.50	-0.09
8/15/10 8:00	75.50	75.41	-0.09
8/15/10 9:00	75.44	75.38	-0.054
8/15/10 10:00	75.28	75.28	0
8/15/10 11:00	75.08	75.14	0.054
8/15/10 12:00	75.13	75.22	0.09
8/15/10 13:00	74.93	75.05	0.126
8/15/10 14:00	74.89	75.05	0.162
8/15/10 15:00	74.90	75.03	0.126
8/15/10 16:00	74.87	75.03	0.162
8/15/10 17:00	74.81	74.98	0.162
8/15/10 18:00	74.76	74.89	0.126
8/15/10 19:00	74.66	74.76	0.108
8/15/10 20:00	74.70	74.79	0.09
8/15/10 21:00	74.68	74.75	0.072
8/15/10 22:00	74.78	74.85	0.072
8/15/10 23:00	74.59	74.63	0.036



8/16/10 0:00	74.54	74.58	0.036
8/16/10 1:00	74.53	74.55	0.018
8/16/10 2:00	74.42	74.44	0.018
8/16/10 3:00	74.42	74.42	0
8/16/10 4:00	74.30	74.30	0
8/16/10 5:00	74.30	74.30	0
8/16/10 6:00	74.28	74.26	-0.018
8/16/10 7:00	74.24	74.24	0
8/16/10 8:00	74.27	74.27	0
8/16/10 9:00	74.38	74.41	0.036
8/16/10 10:00	74.65	74.72	0.072
8/16/10 11:00	75.07	75.16	0.09
8/16/10 12:00	75.76	75.87	0.108
8/16/10 13:00	76.73	76.83	0.108
8/16/10 14:00	77.31	77.36	0.054
8/16/10 15:00	77.81	77.85	0.036
8/16/10 16:00	78.83	78.79	-0.036
8/16/10 17:00	79.23	79.19	-0.036
8/16/10 18:00	79.27	79.21	-0.054
8/16/10 19:00	79.58	79.52	-0.054
8/16/10 20:00	79.46	79.39	-0.072
8/16/10 21:00	78.96	78.89	-0.072
8/16/10 22:00	78.36	78.27	-0.09
8/16/10 23:00	77.64	77.54	-0.108
8/17/10 0:00	76.81	76.70	-0.108
8/17/10 1:00	75.88	75.76	-0.126
8/17/10 2:00	75.09	74.96	-0.126
8/17/10 3:00	74.47	74.34	-0.126
8/17/10 4:00	74.11	73.96	-0.144
8/17/10 5:00	73.99	73.83	-0.162
8/17/10 6:00	73.86	73.70	-0.162
8/17/10 7:00	73.76	73.59	-0.162
8/17/10 8:00	73.77	73.64	-0.126
8/17/10 9:00	74.04	73.95	-0.09
8/17/10 10:00	74.49	74.44	-0.054
8/17/10 11:00	75.27	75.25	-0.018
8/17/10 12:00	76.37	76.37	0
8/17/10 13:00	77.26	77.26	0
8/17/10 14:00	78.22	78.22	0
8/17/10 15:00	79.29	79.29	0
8/17/10 16:00	80.37	80.35	-0.018
8/17/10 17:00	80.96	80.89	-0.072
8/17/10 18:00	80.98	80.89	-0.09
8/17/10 19:00	80.70	80.61	-0.09
8/17/10 20:00	80.26	80.17	-0.09
8/17/10 21:00	79.67	79.56	-0.108
8/17/10 22:00	78.86	78.75	-0.108
8/17/10 23:00	77.95	77.84	-0.108
8/18/10 0:00	77.10	76.97	-0.126
8/18/10 1:00	76.37	76.24	-0.126

8/18/10 2:00	75.70	75.57	-0.126
8/18/10 3:00	75.02	74.89	-0.126
8/18/10 4:00	74.53	74.38	-0.144
8/18/10 5:00	74.26	74.12	-0.144
8/18/10 6:00	74.14	73.99	-0.144
8/18/10 7:00	73.92	73.77	-0.144
8/18/10 8:00	73.92	73.80	-0.126
8/18/10 9:00	74.12	74.05	-0.072
8/18/10 10:00	74.40	74.36	-0.036
8/18/10 11:00	75.10	75.11	0.018
8/18/10 12:00	75.96	76.03	0.072
8/18/10 13:00	76.60	76.69	0.09
8/18/10 14:00	76.98	77.10	0.126
8/18/10 15:00	77.50	77.62	0.126
8/18/10 16:00	77.85	77.97	0.126
8/18/10 17:00	78.07	78.18	0.108
8/18/10 18:00	78.22	78.31	0.09
8/18/10 19:00	78.13	78.21	0.072
8/18/10 20:00	77.75	77.80	0.054
8/18/10 21:00	77.07	77.09	0.018
8/18/10 22:00	76.42	76.42	0
8/18/10 23:00	75.79	75.75	-0.036
8/19/10 0:00	75.16	75.09	-0.072
8/19/10 1:00	74.61	74.53	-0.072
8/19/10 2:00	74.08	74.01	-0.072
8/19/10 3:00	73.69	73.58	-0.108
8/19/10 4:00	73.47	73.34	-0.126
8/19/10 5:00	73.18	73.08	-0.108
8/19/10 6:00	72.97	72.84	-0.126
8/19/10 7:00	72.86	72.73	-0.126
8/19/10 8:00	72.82	72.71	-0.108
8/19/10 9:00	72.96	72.91	-0.054
8/19/10 10:00	73.21	73.19	-0.018
8/19/10 11:00	73.98	74.02	0.036
8/19/10 12:00	75.34	75.42	0.072
8/19/10 13:00	76.66	76.71	0.054
8/19/10 14:00	77.99	78.08	0.09
8/19/10 15:00	79.36	79.36	0
8/19/10 16:00	80.54	80.52	-0.018
8/19/10 17:00	81.31	81.29	-0.018
8/19/10 18:00	81.63	81.59	-0.036
8/19/10 19:00	81.55	81.51	-0.036
8/19/10 20:00	81.12	81.09	-0.036
8/19/10 21:00	80.41	80.37	-0.036
8/19/10 22:00	79.49	79.43	-0.054
8/19/10 23:00	78.52	78.44	-0.072
8/20/10 0:00	77.63	77.55	-0.072
8/20/10 1:00	76.85	76.78	-0.072
8/20/10 2:00	76.04	75.95	-0.09
8/20/10 3:00	75.53	75.44	-0.09

8/20/10 4:00	75.21	75.10	-0.108
8/20/10 5:00	75.02	74.93	-0.09
8/20/10 6:00	74.87	74.76	-0.108
8/20/10 7:00	74.83	74.72	-0.108
8/20/10 8:00	74.82	74.75	-0.072
8/20/10 9:00	75.24	75.20	-0.036
8/20/10 10:00	75.70	75.70	0
8/20/10 11:00	76.56	76.60	0.036
8/20/10 12:00	77.60	77.62	0.018
8/20/10 13:00	78.78	78.76	-0.018
8/20/10 14:00	79.92	79.92	0
8/20/10 15:00	81.02	81.01	-0.018
8/20/10 16:00	82.07	82.05	-0.018
8/20/10 17:00	82.76	82.71	-0.054
8/20/10 18:00	82.95	82.88	-0.072
8/20/10 19:00	82.68	82.59	-0.09
8/20/10 20:00	82.04	81.95	-0.09
8/20/10 21:00	81.18	81.09	-0.09
8/20/10 22:00	80.20	80.10	-0.108
8/20/10 23:00	79.21	79.11	-0.108
8/21/10 0:00	78.10	77.98	-0.126
8/21/10 1:00	77.06	76.93	-0.126
8/21/10 2:00	76.08	75.93	-0.144
8/21/10 3:00	75.27	75.12	-0.144
8/21/10 4:00	74.76	74.62	-0.144
8/21/10 5:00	74.36	74.22	-0.144
8/21/10 6:00	74.03	73.89	-0.144
8/21/10 7:00	73.79	73.67	-0.126
8/21/10 8:00	73.66	73.55	-0.108
8/21/10 9:00	73.97	73.90	-0.072
8/21/10 10:00	74.48	74.48	0
8/21/10 11:00	75.07	75.10	0.036
8/21/10 12:00	75.86	75.95	0.09
8/21/10 13:00	76.81	76.94	0.126
8/21/10 14:00	77.81	77.93	0.126
8/21/10 15:00	78.68	78.85	0.162
8/21/10 16:00	79.30	79.41	0.108
8/21/10 17:00	79.66	79.76	0.108
8/21/10 18:00	79.77	79.88	0.108
8/21/10 19:00	79.62	79.71	0.09
8/21/10 20:00	79.27	79.33	0.054
8/21/10 21:00	78.84	78.87	0.036
8/21/10 22:00	78.38	78.41	0.036
8/21/10 23:00	77.89	77.89	0
8/22/10 0:00	77.36	77.34	-0.018
8/22/10 1:00	76.82	76.78	-0.036
8/22/10 2:00	76.24	76.20	-0.036
8/22/10 3:00	75.78	75.72	-0.054
8/22/10 4:00	75.48	75.44	-0.036
8/22/10 5:00	75.26	75.20	-0.054

8/22/10 6:00	75.20	75.14	-0.054
8/22/10 7:00	74.87	74.84	-0.036
8/22/10 8:00	74.68	74.66	-0.018
8/22/10 9:00	74.55	74.55	0
8/22/10 10:00	74.53	74.56	0.036
8/22/10 11:00	74.69	74.76	0.072
8/22/10 12:00	74.95	75.06	0.108
8/22/10 13:00	75.05	75.18	0.126
8/22/10 14:00	75.15	75.29	0.144
8/22/10 15:00	75.49	75.51	0.018
8/22/10 16:00	75.98	75.98	0
8/22/10 17:00	76.33	76.30	-0.036
8/22/10 18:00	76.46	76.40	-0.054
8/22/10 19:00	76.26	76.13	-0.126
8/22/10 20:00	76.03	75.92	-0.108
8/22/10 21:00	75.48	75.37	-0.108
8/22/10 22:00	74.63	74.52	-0.108
8/22/10 23:00	73.51	73.42	-0.09
8/23/10 0:00	72.55	72.44	-0.108
8/23/10 1:00	72.16	72.05	-0.108
8/23/10 2:00	71.99	71.88	-0.108
8/23/10 3:00	72.07	71.96	-0.108
8/23/10 4:00	71.98	71.87	-0.108
8/23/10 5:00	71.87	71.76	-0.108
8/23/10 6:00	71.71	71.59	-0.126
8/23/10 7:00	71.76	71.65	-0.108
8/23/10 8:00	71.57	71.48	-0.09
8/23/10 9:00	71.73	71.68	-0.054
8/23/10 10:00	72.03	72.03	0
8/23/10 11:00	72.24	72.28	0.036
8/23/10 12:00	72.54	72.61	0.072
8/23/10 13:00	72.94	73.01	0.072
8/23/10 14:00	73.72	73.82	0.108
8/23/10 15:00	73.75	73.84	0.09
8/23/10 16:00	73.77	73.84	0.072
8/23/10 17:00	74.09	74.09	0
8/23/10 18:00	73.64	73.63	-0.018
8/23/10 19:00	72.99	72.94	-0.054
8/23/10 20:00	72.57	72.50	-0.072
8/23/10 21:00	71.99	71.90	-0.09
8/23/10 22:00	71.54	71.43	-0.108
8/23/10 23:00	71.14	71.03	-0.108
8/24/10 0:00	71.06	70.95	-0.108
8/24/10 1:00	70.88	70.76	-0.126
8/24/10 2:00	70.74	70.61	-0.126
8/24/10 3:00	70.42	70.30	-0.126
8/24/10 4:00	70.29	70.14	-0.144
8/24/10 5:00	70.23	70.09	-0.144
8/24/10 6:00	70.04	69.89	-0.144
8/24/10 7:00	70.04	69.91	-0.126

8/24/10 8:00	70.18	70.07	-0.108
8/24/10 9:00	70.17	70.10	-0.072
8/24/10 10:00	70.40	70.36	-0.036
8/24/10 11:00	70.39	70.41	0.018
8/24/10 12:00	70.95	70.98	0.036
8/24/10 13:00	71.31	71.38	0.072
8/24/10 14:00	71.61	71.68	0.072
8/24/10 15:00	72.11	72.18	0.072
8/24/10 16:00	72.18	72.23	0.054
8/24/10 17:00	72.14	72.18	0.036
8/24/10 18:00	72.05	72.08	0.036
8/24/10 19:00	71.83	71.85	0.018
8/24/10 20:00	71.54	71.54	0
8/24/10 21:00	71.22	71.20	-0.018
8/24/10 22:00	70.89	70.85	-0.036
8/24/10 23:00	70.60	70.57	-0.036
8/25/10 0:00	70.61	70.58	-0.036
8/25/10 1:00	70.46	70.42	-0.036
8/25/10 2:00	70.34	70.29	-0.054
8/25/10 3:00	70.34	70.29	-0.054
8/25/10 4:00	70.37	70.30	-0.072
8/25/10 5:00	70.17	70.08	-0.09
8/25/10 6:00	70.08	69.99	-0.09
8/25/10 7:00	70.03	69.95	-0.072
8/25/10 8:00	70.01	69.96	-0.054
8/25/10 9:00	70.50	70.47	-0.036
8/25/10 10:00	70.80	70.80	0
8/25/10 11:00	70.87	70.91	0.036
8/25/10 12:00	71.09	71.15	0.054
8/25/10 13:00	71.55	71.62	0.072
8/25/10 14:00	71.71	71.78	0.072
8/25/10 15:00	71.68	71.75	0.072
8/25/10 16:00	71.68	71.75	0.072
8/25/10 17:00	71.61	71.67	0.054
8/25/10 18:00	71.53	71.56	0.036
8/25/10 19:00	71.24	71.26	0.018
8/25/10 20:00	70.74	70.74	0
8/25/10 21:00	70.36	70.38	0.018
8/25/10 22:00	70.20	70.20	0
8/25/10 23:00	70.07	70.05	-0.018
8/26/10 0:00	69.93	69.89	-0.036
8/26/10 1:00	69.85	69.81	-0.036
8/26/10 2:00	69.94	69.90	-0.036
8/26/10 3:00	70.06	69.98	-0.072
8/26/10 4:00	70.06	69.98	-0.072
8/26/10 5:00	70.07	70.00	-0.072
8/26/10 6:00	70.02	69.93	-0.09
8/26/10 7:00	70.01	69.92	-0.09
8/26/10 8:00	69.95	69.88	-0.072
8/26/10 9:00	69.99	69.94	-0.054

8/26/10 10:00	70.17	70.13	-0.036
8/26/10 11:00	70.52	70.52	0
8/26/10 12:00	71.02	71.06	0.036
8/26/10 13:00	71.52	71.56	0.036
8/26/10 14:00	71.87	71.89	0.018
8/26/10 15:00	72.28	72.26	-0.018
8/26/10 16:00	72.59	72.52	-0.072
8/26/10 17:00	72.74	72.67	-0.072
8/26/10 18:00	72.70	72.61	-0.09
8/26/10 19:00	72.45	72.36	-0.09
8/26/10 20:00	72.10	71.99	-0.108

***APPENDIX 5A. CHRONOLOGY OF OBSERVATIONS ON  
SMALLMOUTH BASS***

## ***APPENDIX 5. CHRONOLOGY OF OBSERVATIONS ON SMALLMOUTH BASS***

### ***SMALLMOUTH BASS SPAWNING***

A motorized kayak was used for the smallmouth bass (SMB) spawning surveys beginning in early May 2010. The first pre-spawning activity was observed along the east shoreline of Rocky island and Environmental Lab boat ramp (Figure 1) with subsequent nest building and fry emergence on May 20, 2010. The water temperature was 68°F. Although a survey of the areas near the Nescopeck Creek was performed, no pre-spawning activity was observed, most likely due a lack of backwater habitat suitable for smallmouth bass spawning. However, angling for smallmouth bass downriver from the Berwick Test Track boat ramp did produce three adults but their spawning locations could not be definitely ascertained.

It appears that smallmouth bass spawning occurred in late May at water temperature in the upper 60's °F. Larval smallmouth bass were observed swimming near a nest at the Rocky Island site located next to the river bank partially hidden by newly-emerged aquatic vegetation (Figure 1).

While angling for adult smallmouth bass near the Environmental Lab boat ramp, none were caught in deep water out from the shore, but, when casting within 20 feet of shore three adults (13-15 inches) were taken. These catches indicated that smallmouth bass pre-spawning activity was probably occurring in shallow water similar to what had been observed at Rocky Island on 5 May.





**Figure 1 Smallmouth bass spawning survey area on the Susquehanna River near Berwick, PA, 2010**

On May 26, 2010, several hours were spent on the river in the upper study area attempting to find spawning SMB even though the river was turbid (1-2 feet visibility). The river temperature along the shoreline was now consistently in the 70's °F. The first bass nest was found along the east shoreline of Rocky Island, where pre-spawning activity had been seen on May 5, 2010. The nest was a non-descript depression in the river gravel next to the bank guarded by an adult SMB. Upon closer examination, some larval SMB were seen that had emerged from the nest and were swimming adjacent to the river bank partially hidden by newly-emerged aquatic vegetation. These larvae were all colored jet black (Figure 2). This coloration made them easy to distinguish from the other larval fish in the immediate area that were more or less colored brown to light tan. Also, it was evident that as these larval SMB hatched from this nest, they would swim closer to shore for protection in the shoreline vegetation; likely seeking slower current. While motoring back upriver along the east shoreline of Goose Island, another SMB nest with newly-hatched SMB larvae was found. As they were just hatching and coming up through the nest gravel, and it was noted that they were not quite as black as the free swimming larvae from the nest at Rocky Island, but still noticeably darker than other larval fish in the area.

Three other schools of SMB larvae were observed on the west shoreline of Goose Island, but there was no sign of their nests. However, three of the larval SMB from the original nest were



collected. All three specimens were positively identified as SMB at the Environmental Laboratory by Dr. Brian P. Mangan, Environmental Lab, Inc.



**Figure 2 Newly-hatched smallmouth bass larvae colored jet black from the Susquehanna River, May 26, 2010**

A small school of SMB larvae and another larger school were observed about 200 yards upriver along the west bank along the Environmental Lab boat ramp on May 27, 2010. The shoreline water temperature was 78 °F. Across the river, in a cove at the upper end of the island immediately upriver from the mouth of Little Wapwallopen Creek, a very large school of several hundred SMB larvae was found.

Six dead adult SMB were also observed during May. Most were badly deteriorated, but it appeared that death may have been the result of post-spawning mortality. All of these fish were heavily infected with fungus.

A school of about 50 SMB larvae (fry) were seen at the Environmental Lab boat ramp in the vicinity of the SSES Intake Discharge Diffuser; the shoreline water temperature was 79 °F during this period. Across the river in the cove above the mouth of Little Wapwallopen Creek, some SMB fry were also observed, but they were more spread out compared to the previous week. The river level had dropped about one foot to a flow of 4,500 cfs, and several old abandoned SMB nests were observed that were not visible the previous week because of the deeper, turbid water. Several of these SMB fry were among thousands of American toad tadpoles (Figure 3). Re-crossing the river to the west bank under the power line about 200 yards upriver from the Lab ramp, a small school of SMB fry was found and several groups of two to six SMB fry were also observed along the river bank back downriver toward the Lab ramp.



From the ramp downriver to the Susquehanna SES Intake, several small groups of fry SMB fry were also observed, but, once again, not as concentrated in schools as observed in the previous week.



**Figure 3 American toad tadpoles and smallmouth bass fry in Little Wapwallopen Creek cove, 1 June 2010**

An extensive survey of the upper study area from the Environmental Lab boat ramp to the Nescopeck-Berwick Bridge was conducted. At the Lab ramp, the same school of about 50 SMB fry that were observed the prior day, were still present. Using a YSI 650 MDS equipped with a calibrated 600 XL Multi-Parameter Water Quality Monitor, measurements of the river water quality parameters were recorded inshore at the Lab ramp. The following information was ascertained: Temperature = 77 °F, Dissolved Oxygen = 8.89 mg/l, pH = 7.59; measurements in the river off-shore at the ramp were: Temperature = 76 °F, Conductivity = 354  $\mu$ mhos/cm, Dissolved Oxygen = 8.89 mg/l, pH = 8.1.

Along the west side at the head end of Goose Island, numerous SMB fry were observed in the emergent water willow plants. These plants partially blocked the view into the shallows along the shoreline so there may have been more fry here that were not observed. In the first backwater area along the west side, where during the previous week a large school of SMB fry were observed, several SMB fry were observed again, but not as many. These SMB fry had grown and were about twice as large as last week. In this backwater, measurements of the river water were recorded: Temperature = 79 °F, Conductivity = 365  $\mu$ mhos/cm, Dissolved Oxygen =



8.95 mg/l, pH = 8.3. On the east side of the head of Goose Island, SMB fry were observed along this shoreline, but more spread out compared to last week. The SMB nest where a large adult SMB was scared off last week was abandoned with only a few SMB fry in closer to shore. Several acres of gravel at the head end of Goose Island appear to be prime spawning habitat for SMB if the river level remains fairly constant during the spawning season (Figure 4).



**Figure 4 Smallmouth bass spawning habitat at the head end of Goose Island, Susquehanna River, June 2010**

Boating along the east shore of Rocky Island on June 2, 2010, some SMB fry were observed, but, once again, more dispersed compared to last week. Here, the river water measurements were: Temperature = 82 °F, Dissolved Oxygen = 9.2 mg/l, pH = 8.3. Farther down the east side of the island at an old SMB nest site near the tail end of the island, the river water measurements were: Temperature = 83 °F, Dissolved Oxygen = 8.9 mg/l, pH = 8.4. At this location, SMB fry had completely dispersed away from this nest site.

Along the east shore of Heron Island, some SMB fry were observed along with several abandoned nests. In a small backwater midway along the island, several SMB fry were found. Along the west side of Heron Island in a large backwater, 12 to 20 SMB fry were observed. Here, the river water measurements were: Temperature = 84 °F, Dissolved Oxygen = 9.1 mg/l, pH = 8.41.

Mid-river at the old bridge base (4<sup>th</sup> one over from the west bank) just upriver from the Nescopeck-Berwick Bridge, one SMB fry was found in the calm water on the downriver side;

there was fast current passing on both sides of this base. There also was an active beaver lodge on this base. Overall, this did not appear to be suitable spawning habitat, and the SMB fry found here was probably washed out from upriver spawning sites. At 1350 hours the river water measurements were: Temperature = 80 °F, Dissolved Oxygen = 10.1 mg/l, pH = 8.6.

The east side of the river along the Nescopeck bank appeared to be very good spawning habitat with a nice mix of small gravel, but SMB fry were not found here. It appears as if the SMB prefer to spawn around the islands in this reach of the river.

On June 11, 2010, another SMB fry survey of the study area was initiated at the Lab boat ramp at 1215 hours. Earlier in this week, extensive rainfall caused the river level to rise at least two feet, but it had now begun to recede. Turbidity, however, still limited visibility. At the Lab ramp, river water measurements were: Temperature = 77 °F, Dissolved Oxygen = 9.38 mg/l, pH = 8.0. The SMB fry observed at the ramp had grown up to 1 inch long, and they were very skittish compared to last week. This will undoubtedly make them more difficult to observe.

Across the river in Little Wapwallopen Creek cove, several small schools of SMB fry were observed, up to  $\frac{3}{4}$  inches long. It was encouraging to see that these fry survived the high water event early in the week. River water measurements in the cove at 1315 hours were: Temperature = 77 °F, Dissolved Oxygen = 8.50 mg/l, pH = 7.8. Farther into the cove, there was a larger school of at least 30 SMB fry, some up to 1 inch long. These fry scattered quickly from the surface where they were easily observed. Some appeared to be losing their black color. Along the west shore of the cove, a few SMB fry were observed. They were somewhat larger and better able to swim against the river current.

Farther downriver along the west shoreline, opposite Wapwallopen Creek mouth, a gravelly area in a water willow stand was inspected, but no SMB fry observed. On the east side of the river just below the mouth of Wapwallopen Creek in a backwater area, several SMB fry were observed. Fishermen curtailed further investigation here. At the west shoreline under the power line in the Bell Bend Pool, a few SMB fry were found next to shore.

Boating downriver on the west side of Goose Island and while walking through a stand of water willow, a few SMB fry up to 1 inch were observed. Several other larval fishes were also observed while wading downriver along this shoreline. As the water willow grows, it impedes observation. There were no SMB fry on the east side of Goose Island, but it was difficult to see into the water willow stands.

On the east shoreline of Rocky Island, some SMB fry were found. At 1430 hours, river water measurements were: Temperature = 77 °F, Dissolved Oxygen = 8.90 mg/l, pH = 8.4. The survey was discontinued here because of increasingly turbid water conditions.

Overall, SMB fry were becoming increasingly difficult to find as they sheltered in the growing vegetation, particularly water willow along the shoreline (Figure 5). Most observed SMB fry were now at least 1 inch in length. River water temperature was now consistently into the high 70's °F and low 80's °F, and daytime dissolved oxygen levels remained high. It appeared that



most of the SMB spawning was done for 2010 and future observations were limited to juvenile (YOY) SMB.



**Figure 5 Water willow stand along an island shoreline in the Susquehanna River, June 2010**

On July 7, 2010, another survey was conducted from 1100 hours to 1530 hours. The mid-river surface temperature was 86 °F and the shoreline temperature at the Lab ramp was even warmer (87 °F) as measured by a calibrated hand thermometer. Northeastern Pennsylvania was beginning to experience a summer drought that was causing low river levels and high water temperatures.

In the Little Wapwallopen Creek cove, one YOY SMB about 2 inches long, was observed in a school of YOY hog suckers. It was in about 1 foot of water with a water temperature of 86 °F. The backwater area of the cove had mostly dried up, although there is a small flow from the creek. Here, a small school of YOY suckers swam in the cooler stream flow at 66 °F, but no juvenile SMB had taken advantage of this cool water. On the west side of the island, an occasional juvenile SMB was observed while wading. They now appear to be moving into deeper water and away from the immediate shoreline. A river temperature of 84 °F was recorded near the center of the river out from the cove.



Downriver from the mouth of Wapwallopen Creek in the backwater with an extensive patch of submerged aquatic vegetation, there were several juvenile SMB, some up to 3 inches long. They were among various Cyprinids, but the SMB, now tan in color, were easily identified by the black, vertical stripe on an orange background on the end of their tails. And, they are more aggressive swimmers than most of the other Cyprinids. Water willows, that provided refuge for fry earlier this season, were now high and dry along the river bank. Submerged aquatic plants, which were not abundant earlier in May and June, had grown extensively and now provided cover for bass at this site. In other nearby areas where there are no aquatic plants, YOY SMB were observed taking advantage of stones and large gravel for cover in water up to 1.5 feet deep.

At the southern end of Goose Island, most of the water willow was now above the water line, but there was an abundance of submerged aquatic plants along with shallow gravelly bottom substrate with large stones and bed rock. In this area, the depth is uniform at about 1.5 feet even 100 yards from the island shoreline. This appeared to be suitable place for a juvenile SMB nursery and other juvenile fishes too.

#### ***MORTALITY OF SMALLMOUTH BASS***

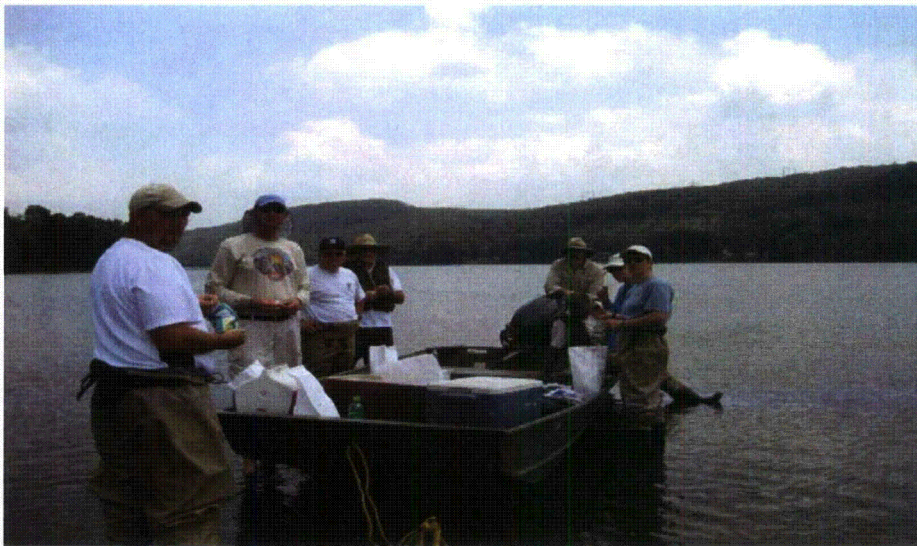
Dead smallmouth bass were first observed on July 14, 2010; three dead/dying SMB juvenile were found immediately upriver from the Environmental Lab boat ramp (Figure 6). These fish appeared to be infected with *Flavobacterium columnare*. Both shoreline and surface river temperatures had now reached or exceeded 86 °F as recorded with a hand thermometer.



**Figure 6 Dead/dying young-of-the-year smallmouth bass near the Environmental Lab boat ramp in the Susquehanna River, 14 July 2010**

Subsequently on July 21, 2010, during an Agency Tour of the study area (Figure 7), dead/dying juvenile smallmouth bass were also found (Figure 8). However, by this time, the population of Great Blue Heron had increased noticeably throughout the upper study area. They were seen daily hunting the shorelines, and there is little doubt that they were feeding extensively on stressed juvenile bass.





**Figure 7 Agency tour of study area, 21 July 2010**



**Figure 8 Dead young-of-the-year smallmouth bass near Goose Island in the Susquehanna River, 21 July 2010**

On a survey beginning at the Lab ramp on July 27, 2010, shoreline water temperature of 84 °F at 1410 hours was recorded. The river water was slightly turbid from two major rainfalls over the weekend upriver from the study area. The river level at this time was 4.2 feet which equaled a flow of about 3700 cfs. No stressed juvenile SMB were observed, but two Great Blue Herons were seen along the shoreline downriver and they appeared to be searching for stressed bass.



On the opposite shore in Little Wapwallopen Creek cove, the water temperature was 86 °F at 1420 hours. Upon arrival, a heron flew from the cove. A dying juvenile SMB was found which was easily caught by hand. River water was flooded back up into the water willow, but, by now it appeared that most SMB had moved out of this nursery area and into deeper river water.

On the west side of the river opposite Wapwallopen Creek, no juvenile SMB were observed. Also, there were no juvenile SMB in the backwater just downriver from Wapwallopen Creek.

No juvenile SMB were observed along the east edge of Goose Island. However, the river current was swift and the river level was rising. One dead juvenile SMB on the river bottom was found just upriver from the southeastern tip of Goose Island. Water temperature was 84 °F at 1500 hours recorded with a hand thermometer.

At the south end of Rocky Island the water temperature was 86 °F at 1525 hours. One juvenile SMB was observed with fungus on its back along the east side of this island.

On July 28, 2010, at 1550 hours, the river temperature was 84 °F at the Lab ramp. One stressed juvenile SMB was observed as it was attacked by a larger fish. It managed to get away and swam into shore very slowly.

Enclosure 2b

STUDY PLAN TO COLLECT SUPPLEMENTAL DATA TO ASSESS THE POTENTIAL  
EFFECTS OF THE BELL BEND PROJECT ON WATER QUALITY OF BACKWATER AREAS  
USED BY FRY AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS

STUDY PLAN TO COLLECT SUPPLEMENTAL DATA TO ASSESS  
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WATER QUALITY OF BACKWATER AREAS USED BY FRY AND  
YOUNG-OF-THE-YEAR SMALLMOUTH BASS

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FEBRUARY 2012

**(DRAFT FOR DISCUSSION)**

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# ABBREVIATIONS

Abbreviation	Meaning
°F or °C	Degrees Fahrenheit or Celsius (water temperature)
7Q10	Seven-day, consecutive low flow once on average every ten years.
ACOE	U.S. Army Corps of Engineers
ADCP	Acoustic Doppler Current Profiler, instrument to measure velocity at varying depths
ADF	Average Daily Flow computed on an annual basis
AMD	Abandoned Mine Drainage
BBNPP	Bell Bend Nuclear Power Plant
BBNPP ER	Bell Bend Nuclear Power Plant Environmental Report submitted to the Nuclear Regulatory Commission
cfs	Cubic feet per second; 1 cfs = 0.646 mgd
COLA	Combined Construction and Operating License Application
CORMIX	Cornell Mixing Zone Expert System, mixing zone model
DO	Dissolved oxygen
EFDC	Environmental Fluid Dynamics Code, 3-D hydrodynamic and water quality model
EMA	Eastern Middle Anthracite Fields
ERM	Environmental Resources Management, Inc.
GEMSS®	Generalized Environmental Modeling System for Surfacewater, 3-D hydrodynamic and water quality model
HSC	Habitat Suitability Curve, index used to indicate fish preferences for microhabitat variables (e.g., water velocity, depth, substrate/cover); expressed on a scale of 0 (least suitable) to 1 (optimum)
IFIM	Instream Flow Incremental Methodology, habitat-based methodology to estimate available aquatic habitat under changing flow conditions; based on the premise that stream-dwelling organisms prefer a certain range of microhabitats (velocity, depth, and substrate/cover)
mgd	Million gallons per day; 1 mgd = 1.55 cfs
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PADEP	Pennsylvania Department of Environmental Protection
PFBC	Pennsylvania Fish and Boat Commission
PHABSIM	Physical Habitat Simulation, model integrates outputs of hydraulic model(s) and species microhabitat preferences (depth, velocity, and substrate/cover)
PLS	Professional Land Surveyor
PPL BellBend	PPL Bell Bend, LLC; sponsor of the BBNPP project
RHABSIM	Customized version of PHABSIM
Sonde	Device that measures DO, temperature, pH and conductivity; French for "probe"
SRAFRFC	Susquehanna River Anadromous Fish Restoration Commission
SRBC	Susquehanna River Basin Commission
SSS	Susquehanna Steam Electric Station
TMDL	Total Maximum Daily Load
TRPA	Thomas R. Payne and Associates
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WUA	Weighted Usable Area, an index of available habitat

## **1. INTRODUCTION**

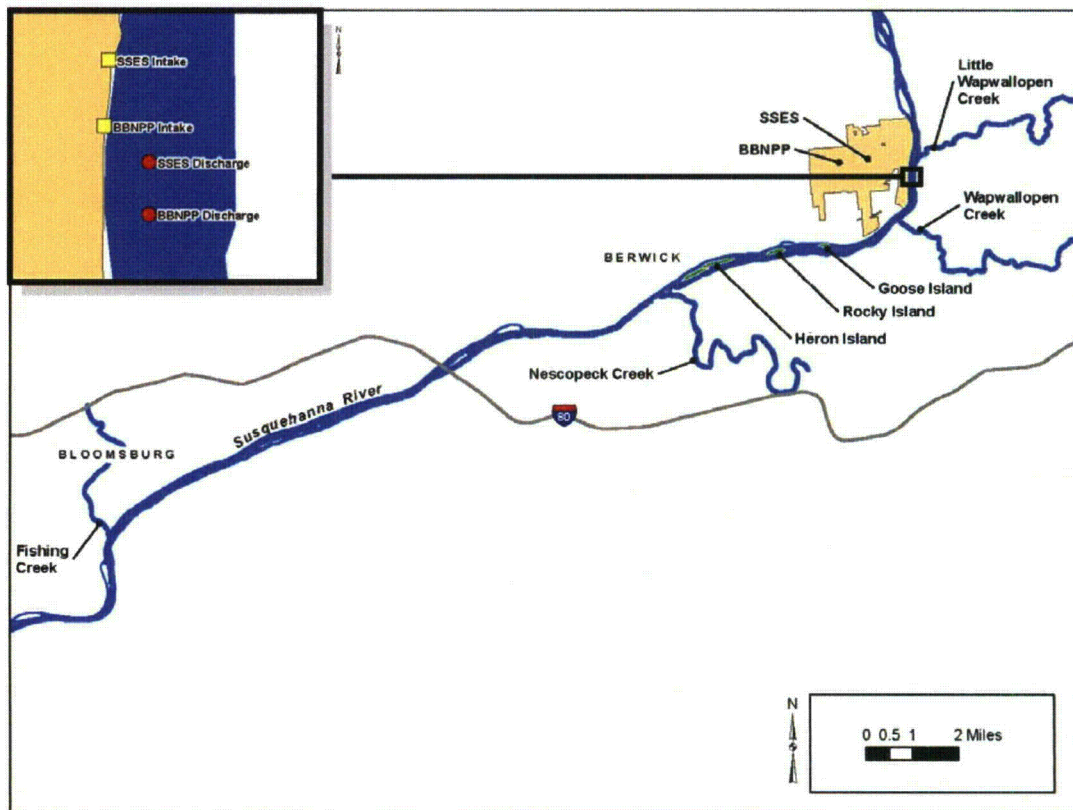
PPL submitted a report to the SRBC entitled, *"Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Users, Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania"*, dated June, 2011. Subsequent to the submittal of that report, SRBC provided comments in a letter dated December 21, 2011 to Mr. Michael J. Caverly, VP-Financial Nuclear Development. In that correspondence, SRBC provided a number of comments with the following primary concerns:

1. There is a need for additional sampling of backwater and shoreline areas for dissolved oxygen (DO) and water temperature where fry ( $\leq 25$  mm) and young smallmouth bass (YOY SMB) are known to occupy so that a more complete evaluation of the effects of consumptive use can be made.
2. Shallow inshore locations are critical habitats for YOY SMB and are of concern and should be the primary focus.
3. The study should determine the size and location of these areas at low flow conditions.
4. Since lowest DO levels were recorded at Sonde #1 at Goose Island, additional data are required to determine the extent and magnitude of the low DO levels.
5. Data are required from other backwater areas such as the backwater areas in the Rocky Island vicinity.

This study plan has been developed in light of these comments with a primary focus on obtaining additional water quality data from backwater and shoreline areas.

### **1.1. OBJECTIVE**

The objective of this study is to assess the potential impact associated with reduced river flow and stage due to BBNPP (Figure 1-1) consumptive use on dissolved oxygen (DO) and temperature, primarily focusing on backwater and shoreline areas that may be occupied by YOY SMB.



**Figure 1-1: Map showing intake and discharge locations for the proposed Bell Bend Nuclear Power Plant (BBNPP) on the Susquehanna River, Luzerne County, PA. Source: Normandeau Associates, et al. 2011.**

The 2012 data gathering and analysis will provide a comprehensive data base for a more complete evaluation of these areas. The study reach for this data collection is approximately 2.6 mi between the upper tip of Goose Island and the lower tip of Heron Island; the upper tip of Goose Island is approximately 2.5 mi downstream of the proposed BBNPP discharge location.

## **1.2. PLANNED FIELD WORK AND ANALYSIS**

The work will consist of collecting additional observations on SMB spawning activity (nesting, fry emergence, rearing, and nursery) DO, water temperature, pH, and depths data at six backwater and shoreline areas including the portion of the Susquehanna River near Rocky Island. Continuous depth measurements were not collected during 2010. The plan assumes that there is sufficient flexibility to respond to changing and/or prevailing hydrological and meteorological conditions.



The data collection is proposed to cover the period from mid-April to mid-August 2012. A temperature impact analysis will be conducted in a manner similar to that performed on the 2010 data. The 2010 temperature impact analysis was evaluated using a 0-dimension Temperature Calculation module of the Generalized Environmental Modeling System for Surface waters (GEMSS<sup>®</sup>) software package. This method uses hourly meteorological data to develop temperature change ( $\Delta T$ ) based on the maximum induced depth change as calculated by the flow analysis. The changes in temperature are then applied to the sonde data.

For the 2012 data analysis, the data will be assessed for event frequency and duration using the same methodology as the 2010 data. The thermal model will also be applied using the 2012 data and corresponding hourly meteorological data and  $\Delta T$ s reported on an hourly basis with the same diagnostics and summaries as with the 2010 data. In addition, the 2012 data collection will also include a depth transducer that will collect depth data on an hourly basis that corresponds to the water quality data. This will allow a direct comparison of depth, and thus flow variation and how temperature is statistically related to flow. Based again on diagnostics, a correlation or regression analysis can be completed to determine the existence of a statistically significant relationship and the strength of any relationship. It may also allow evaluation of the relationship on an hourly basis, again based on the data diagnostics. The hourly measurements are expected to provide a large sample size for these types of analyses.

PPL Bell Bend intends to submit a study report by the end of the 3<sup>rd</sup> quarter 2012. The sections below provide details of the study plan along with the specific objectives.

## 2. **RELEVANT DATA AND PRIOR STUDIES**

This section of the study plan summarizes relevant and readily available hydrologic and water quality data. Relevant data sources and reports are outlined in Table 2-1.

**Table 2-1 Summary of Relevant Prior Studies and Data**

Source	Reports and Data
Ecology III	Currently conducts quarterly water quality sampling at five sites; measures daily temperature and water surface elevation; performs electrofishing and seining. Macro-invertebrate, mussel, and impingement/entrainment investigations were also conducted. Annual reports are available beginning in 1971 with occasional special studies (e.g., thermal plume surveys) published separately. Reports include summary of water quality parameters (pH, DO, temperature, alkalinity, conductance, hardness, TDS, nutrients and metals).
EPA	Published two TMDL's (Susquehanna River and Nescopeck Creek) which summarize water quality data (pH, alkalinity and metals: aluminum, iron and manganese). Primary source of data are the sampling done in support of TMDL's (AMD-related TMDL for both Susquehanna River reach upstream of the BBNPP and Nescopeck Creek, and PCB-related TMDL for the Susquehanna River).
PPL Bell Bend	Published the BBNPP Environmental Report which is not a primary source, but contains a summary of available water quality parameters (pH, DO, temperature, alkalinity, conductance, hardness, TDS, nutrients and metals). Primary source of data are two SSES sampling locations used since 1968 and additional sampling performed during 2008.
USGS	Measures stage and discharge on various streams and the Susquehanna River itself. Several water quality parameters (pH, nutrients, metals, minerals, hydrocarbons and TDS) measured at USGS station near Hunlock Creek and Danville.
Normandeau Associates, et al., 2011	Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Users Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania

### 2.1. **HYDROLOGY**

This section presents background information on flows in the Susquehanna River relevant to this study.

#### 2.1.1. **USGS Gaging Sites and Records**

The USGS gaging sites of importance to this study are shown in Table 2-2, below.

**Table 2-2 USGS gaging sites**

Location	USGS No.	Drainage Area (sq. mi)	Period of Record
Susquehanna River at Wilkes-Barre	01536500	9,960	Daily discharge, 4/1899-present
Susquehanna River at Danville	01540500	11,220	Daily discharge, 4/1905-present
Nescopeck Creek at Nescopeck	01538600	171	Periodic measurements since 1949

The Wilkes-Barre river gage is the nearest river gage upstream from the study reach; the study reach encompasses an area between the upper tip of Goose Island and the lower tip of Heron

Island. River flow data from this gaging site were used for all previous calculations of habitat flow relationships (Normandeau Associates, *et al.* 2011).

The drainage area at SSES/BBNPP is 2.8% greater than at the Wilkes-Barre gage. Wapwallopen Creek at Wapwallopen is the only active gage on a stream entering the river between the Wilkes-Barre gage and SSES/BBNPP; the Wapwallopen Creek gage has a drainage area of only 43.8 square miles. For the purposes of this supplemental data collection study, river flow as measured and recorded at the Wilkes-Barre gage will be considered to represent the flow in the study reach. Recorded daily river flows at Wilkes-Barre for the period April 1899 (beginning of record) through March 2011 will be used to evaluate the occurrence of the potential impacts of BBNPP consumptive water use<sup>1</sup>. Table 2-3 presents selected statistics of the daily river flow at Wilkes-Barre from April 1899 through March 2011.

**Table 2-3 Selected daily river flow statistics at Wilkes-Barre (USGS gage # 01536500), April 1899- March 2011**

Month/season <sup>2</sup>	Daily flow (cfs)			
	Minimum	Median	Average (mean)	Maximum
Jan	1,010	9,100	14,500	210,000
Feb	1,060	8,800	14,900	179,000
Mar	2,100	22,100	30,400	229,000
Apr	5,210	24,000	31,000	206,000
May	2,000	12,000	16,300	206,000
Jun	1,350	5,775	9,400	329,000
Jul	787	3,480	5,600	142,000
Aug	716	2,440	4,200	95,300
Sep	532	2,290	4,600	244,000
Oct	658	3,360	7,200	151,000
Nov	627	7,540	11,500	123,000
Dec	860	10,200	14,500	184,000
Annual	532	7,400	13,700	329,000
Jan-Mar	1,010	12,100	20,100	229,000
Apr-Jun	1,350	13,000	18,900	329,000
Jul-Sep	532	2,670	4,800	244,000
Aug-Oct <sup>3</sup>	532	2,570	5,400	244,000
Oct-Dec	627	6,720	11,100	184,000

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<sup>1</sup>SRBC has requested that daily river flows for the entire period of record be used for this study. (Pers. Communication with A. Dehoff.)

<sup>2</sup>Other "seasons" (e.g., May-June) may be appropriate for evaluation of potential habitat loss for certain species-life stage combinations.

## **2.2.      *WATER QUALITY***

This section of the study plan describes the water quality of the Susquehanna River in the vicinity of the BBNPP.

### **2.2.1.      *Susquehanna River Water Quality***

Susquehanna River water quality has been monitored by the Susquehanna SES Environmental Laboratory from 1971 through the present, with modifications to the program over the years. Table 2-4 summarizes the sampling periods, frequency, locations, and programs.

**Table 2-4 Ecology III Susquehanna River water quality monitoring program**

Year	Sample period	Sample frequency	Sample locations	Programs
1971	Aug-Dec	Twice a month	6-9 locations Falls, PA to Berwick, PA	
1972	Apr-Dec	Daily	SSES	Various analyses
		Monthly	SSES	Diurnal
		Semimonthly	Falls to Berwick	River Run
		Quarterly	SSES to Columbia	Extended River Run
1973	Jan-Dec	Daily	SSES	Various analyses
		Monthly	SSES	Diurnal
		Semimonthly	Falls to Berwick	River Run
		Quarterly	SSES to Columbia	Extended River Run
1974	Jan-Dec	Semi-weekly	SSES, Bell Bend	Various analyses
		Mar, May, Jul, Sep	SSES	Diurnal
		Feb, May, Jul, Sep, Dec	Falls to Berwick	River Run
1975	Jan-Dec	Weekly (Jan-Feb)	SSES, SSES-A <sup>4</sup>	Various analyses
		Weekly (Mar-Dec)	SSES-A	Various analyses
		Apr, May, Jun, Jul, Aug, Sep	SSES-A	Diurnal
1976	Mar, Oct-Dec	Semimonthly	SSES-A	Various analyses
	Apr-Jun	Semiweekly		
	Jul-Sep	Weekly		
1977	Apr-Sep	Semiweekly	SSES-A	Various analyses
	Jan-Mar, Oct-Dec	Semimonthly		
1978-1985	Apr-Sep	Semiweekly	SSES**, Bell Bend	Various analyses
	Jan-Mar, Oct-Dec	Weekly		
1986-2004	Apr-Sep	Weekly	SSES, Bell Bend, Bell Bend I	Various analyses
	Jan-Mar, Oct-Dec	Semimonthly		
2005-present		Quarterly	SSES, Bell Bend	Various analyses
1974-present	Constant monitor for river level and river temperature			

Ecology III has measured water temperatures 1,620 feet upstream of the SSES intake structure on the west bank of the Susquehanna River daily since 1974 (Ecology III, Inc. 2008). A maximum water temperature of 86.5°F was recorded on 15 Aug 1988 and on 4 Aug 2007. A minimum water temperature of 32.0°F was recorded numerous times in January. Other statistical summaries, for example, monthly mean and maximum temperatures, can be developed from this daily record. The Susquehanna River adjacent to the BBNPP is designated as a Warm Water Fishery (WWF). Specific water quality criteria (Pa. Code, Chapter 93. Water Quality Standards, § 93.7. Specific water quality criteria) for DO and pH are as follows:

“DO<sub>2</sub> (applicable to WWF): Minimum daily average 5.0 mg/l; minimum instantaneous 4.0 mg/l.”

<sup>4</sup>Same sampling location from 1975 to present. SSES-A was renamed SSES.

“pH (applicable to WWF): range between 6.0 and 9.0 inclusive”

Pennsylvania provides the following criteria for temperature (Pa. Code, Chapter 93. Water Quality Standards, § 93.7. Specific water quality criteria):

“Maximum temperatures in the receiving water body resulting from heated waste sources are regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. Additionally, these wastes may not result in a change by more than 2°F during a 1-hour period.”

Table 2-5 summarizes the temperature limits by “critical use period” applicable to WWF streams. These values represent the maximum allowable water temperatures (cross-sectional average) at an unspecified distance downstream of the discharge where fully-mixed conditions occur.

**Table 2-5 Temperature limits applicable to Warm Water Fishery streams**

Source: Pa Code, Chapter 93, § 93.7

Critical Use Period:	Temperature (°F)
January1-31	40
February1-29	40
March1-31	46
April1-15	52
April16-30	58
May1-15	64*
May16-31	72*
June1-15	80*
June16-30	84*
July1-31	87*
August1-15	87**
August16-30	87**
September1-15	84
September16-30	78
October1-15	72
October16-31	66
November1-15	58
November16-30	50
December1-31	42

\* Critical Period for Fry per Chaplin (2009)

\*\*Additional Period to be evaluated by this Study

A search of USGS records for recent dissolved oxygen measurements in Susquehanna River shows that Hunlock Creek (USGS No. 01537700) is the nearest water quality station upstream of SSES and that Danville (USGS No. 01540500) is the nearest water quality station downstream of SSES. There were 76 samples taken at Danville and 15 samples at Hunlock Creek since January 2001. DO values for all samples were within the range of 7 mg/l to 15 mg/l. The DO values were consistently above the applicable DO criterion (DO<sub>2</sub>). The pH values ranged from 6.4 to 8.9. The pH values were consistently within the required standard.

The water quality of the Susquehanna River upstream of the BBNPP has also been studied as part of two TMDL investigations. The first TMDL study (PADEP 1999; USEPA, 1999) focused on polychlorinated biphenyls (PCBs). The second TMDL (PADEP 2009; USEPA 2009) focused on mine drainage-affected segments for metals (iron, aluminum, and manganese), pH, and alkalinity. These Susquehanna River TMDL studies provide measured water quality parameters (pH, alkalinity and metals: iron, aluminum, and manganese).



**3. WATER QUALITY ASSESSMENT OF BACKWATER AREAS USED BY FRY ( $\leq 25$  MM LONG) AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS (YOY SMB)**

“Diseased” YOY SMB have been observed by Ecology III staff biologists in the river during the summers of 2005 and 2010, periods of low river flow and high water temperature (Brian Mangan, personal communication). The summer of 2005 was also the period when the Pennsylvania Fish & Boat Commission biologists first observed mortality of young YOY SMB with lesions but apparently not in the area near the BBNPP site. A recent report by Chaplin *et al.* (2009) postulated that sub-optimal dissolved oxygen (DO), particularly during the nighttime and in combination with relatively warm temperatures in habitats of YOY SMB, may have played a role in predisposing the fish to the bacterial infections. The bacterium (*Flavobacterium columnare*) is common in soil and water and causes secondary infections in stressed fish (PFBC 2005).

Microhabitats in which such sub-optimal DO and warm temperatures may occur are typically in side channels or backwaters and are characterized by relatively low velocities ( $<0.1$  ft./sec) and shallow depths ( $<2$  ft.) compared to the main river channel. These microhabitats, occupied by YOY SMB, can be subject to wide fluctuations in DO and elevated water temperature. For illustrative purposes, an example photo of a backwater area from the southeast shore of Goose Island on the Susquehanna River with abundant aquatic vegetation is provided as Figure 3-1; it shows a shallow, low velocity area away from the main river channel.



**Figure 3-1 Example of backwater habitat at Southeast shore of Goose Island on the Susquehanna River with abundant aquatic vegetation. Photo taken in July 2010.**

Shallow areas are more susceptible to heating by solar radiation than the main channel of the Susquehanna River and also may show larger fluctuations in DO over a 24-hour period. Backwaters are relatively calm, shallow areas or channels around islands that are cut off from the dominant flow of a river, particularly in late spring and summer as seasonal low flow approaches. This period may coincide with fish rearing and nursery activities. YOY SMB utilizing these habitats during a sustained extreme low river flow may be subject to potentially stressful, low DO concentrations at night and elevated water temperature during the day.

### **3.1. FIELD DATA COLLECTION**

A program of continuous monitoring of DO, pH, water temperature, and depth in off-channel habitats, combined with visual observations (hydrological conditions permitting) of potential SMB spawning areas along the shore lines will be conducted. Six sondes will be deployed in the vicinity of Goose and Rocky Islands for 17 weeks from 15 April through 15 August, meteorological and hydrological conditions permitting. Two back-up sondes will be available in case of any malfunctions with the field units. If spawning activity is observed or emerging (black) fry are noted, the frequency of depth measurements and visual observations will be increased in these areas. These observations may also be used to adjust the locations of the continuous monitoring locations described below. Also, water quality and depth data will be

collected at various locations within the SRBC designated study reach (between the upper tip of Goose Island and lower tip of Heron Island) when conditions deem necessary. In addition, observations of potential areas where mussels may be vulnerable to exposure will also be recorded.

To supplement the above data, periodic electrofishing surveys<sup>5</sup> will be conducted primarily to examine YOY SMB for symptoms of disease (e.g., lesions, open wounds/injury, etc.), particularly in August when the bacterial disease has been reported to be most prevalent.

Continuous monitoring of DO, water temperature, depth, and pH in backwater areas near Rocky Island (Figure 3-2) and Goose Island will be conducted during a period likely to coincide with high water temperature and low nighttime DO values and recommended by SRBC. All these locations are at least 2.5 mi downstream of the proposed BBNPP discharge and cover both shorelines. This period would also coincide with the SMB spawning, rearing, and nursery in backwater areas. This monitoring program will document whether stressful water quality conditions occur during the critical nursery and rearing times of fry and YOY SMB and the extent of these conditions.

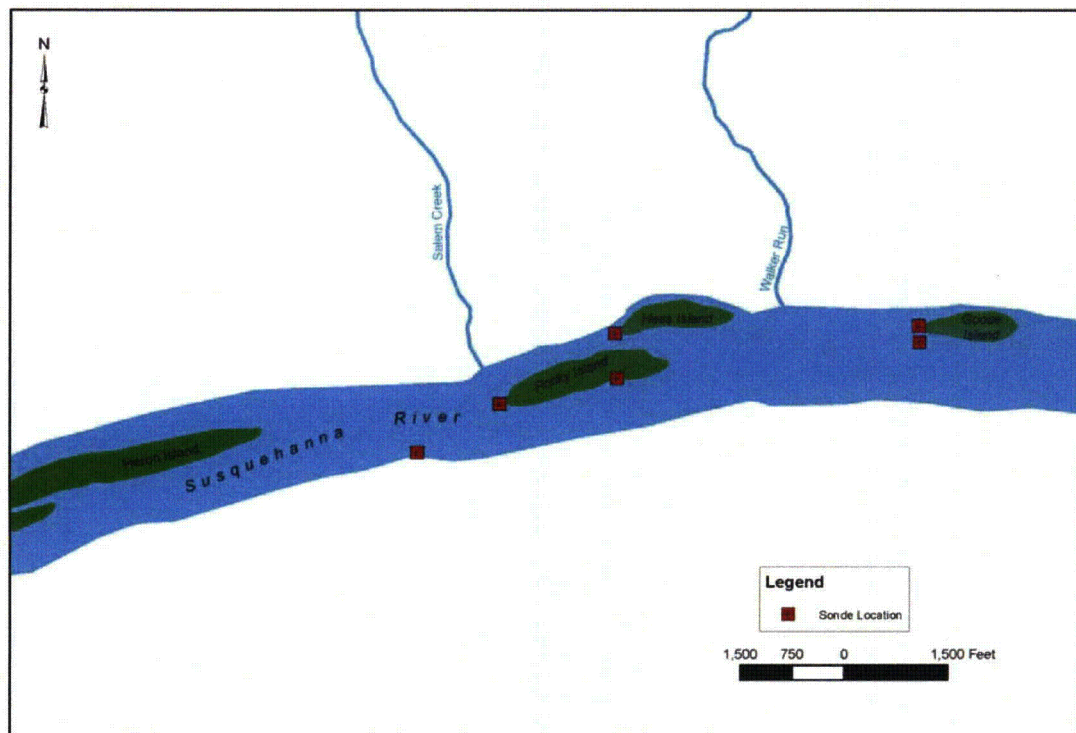
The locations were selected for accessibility, ease of servicing, and representativeness of potential backwater habitat and a main channel location near Goose Island. The proposed sampling scheme utilizes a total of six locations to be monitored. Five of the six field sondes will be positioned near-shoreline and backwater locations at and around the two islands. These locations will provide data in areas with the potential of having stressful water quality conditions for YOY SMB. One backwater location is a repeat at Goose Island backwater area and another within the vicinity of Goose Island in the main channel to be used as a reference site (Figure 3.2). The third location will be near the downstream end of Rocky Island and the fourth location will be at a suitable microhabitat within the riffle area located near Rocky Island. The last two locations will be along the east and/or west shoreline where YOY SMB frequently inhabit.

Unlike the Chaplin *et al.* (2009) and Normandeau Associates *et al* (2011) studies where paired sondes were deployed in both a backwater area and a corresponding main channel location to monitor DO and water temperature, this proposed study is designed to sample water quality parameters (water temperature, DO, pH, and depth) at five low velocity and/or backwater areas and one main channel habitat near Goose Island (Figure 3-2); the latter will be used as a reference location. Again these locations, particularly low velocity areas, are selected based on where YOY SMB occur and can become susceptible to the bacterium (*Flavobacterium columnare*) within the SRBC designated study reach.

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<sup>5</sup>PFBC has offered to coordinate with PPL Bell Bend to perform YOY SMB electrofishing in the study area in August in order to determine the incidence of disease.





**Figure 3-2** Proposed sampling locations of backwater temperature and DO in the study area. One (lower) of the two sondes at Goose Island is positioned in the main channel to serve as a reference location.

### 3.2. *QA/QC OF SONDE PERFORMANCE*

Personnel will utilize boat(s) to service the sondes and calibration will be done either in the field or at the Susquehanna SES Environmental Laboratory, approximately 4 miles upriver from the islands. Meteorological and hydrological conditions permitting, the sondes will be serviced once a week during the monitoring period to allow corrective action in a timely fashion. Should some continuous data collection be interrupted, manual measurements will be taken, particularly during nighttime low DO periods.

Continuous water quality data will be collected at continuous monitoring locations with a HACH Hydrolab DS5X data sonde equipped with sensors to measure temperature, DO, pH, and depth. The temperature sensors are set at the factory and all other parameter sensors will be calibrated per manufacturer's requirements on a weekly basis. The DO sensor will employ the luminescence dissolved oxygen (LDO) technology which uses blue and red light-emitting diodes (LEDs) to measure DO in water. The LDO sensor was chosen over traditional techniques out of

concern that passive fouling (*e.g.*, algae growth on sensor) could occur. The LDO sensor does not consume oxygen so passive fouling will not affect DO readings. The luminescence dissolved oxygen (LDO) technology is specifically designed for long term continuous monitoring; any incidental algae or biological growth on the meter will not affect the accuracy of the sensor. The continuous monitor probes will be visually inspected for biological growth weekly and cleaned as necessary.

QA/QC measures will include regular (weekly) downloads and calibration of the continuous monitors per manufacturer's instructions. The LDO sensor will be equipped with a self-cleaning wiper to decrease the potential for fouling by debris or algae. Calibration records for the continuous monitors will be kept and provided in the report. Performance of the sondes will be checked against a calibrated field DO and temperature meter according to the procedures developed by Ecology III.

As in the Chaplin *et al.* (2009) study, freshly calibrated water quality meters will be positioned with the deployed sonde to collect side-by-side measurements of DO and water temperature. The deployed sonde will be cleaned and returned to the river and a second set of side-by-side readings will be recorded. Following these checks, the deployed sondes will be retrieved and the data downloaded to a field data logger. The recorded sonde measurements will be adjusted for any drifts between the two side-by-side readings. Dissolved oxygen (DO), water temperature, pH, and depth data averaged for hourly parameter values) will be collected for 17 weeks (15 April-15 August), meteorological and hydrological conditions permitting.

The LDO, pH, and depth sensors on the continuous monitors will be calibrated prior to deployment, per manufacturer's specifications and on a weekly basis thereafter. In-river DO, water temperature, and pH will be checked against the continuous monitor using calibrated portable instruments; these values will be recorded on data sheets as performance check measurements. Once the continuous data is retrieved, the performance check measurements will be compared to the continuous monitor data set for accuracy. The raw data collected from the continuous monitor will be reviewed and approved by field scientists prior to reporting. Spurious and other data that is considered inconsistent or unreasonable based on observed trends will be highlighted for exclusion from further analysis.

### **3.3. *SMALLMOUTH BASS (SMB) SPAWNING ACTIVITY, FRY ( $\leq 25$ MM LONG), AND YOUNG OF THE YEAR (YOY) MONITORING***

Observations on initiation of smallmouth bass spawning activity and emergence of fry with subsequent development into YOY life stage will begin in mid-April 2012 or earlier if the river water temperature warms to 50 F. An attempt will be made to document the time and location of pre-spawning activity as was observed in early spring of 2010. For 2012, an approximation of the size of the area where spawning activity is observed will also be documented. This shore-line schooling behavior of adult SMB gives a good indication of where spawning will actually occur. These observations will be centered where sondes have been deployed in the vicinity of Goose and Rocky Islands and on the eastern shoreline (Figure 3-2). Once spawning begins

around the first week in May, weekly observations will be made to try to locate nests and subsequent schools of SMB fry. In 2010, SMB fry were seen hatching from nests and swimming directly into the shoreline to seek cover from the river current.

A portable sonde will be used to record river water temperature; DO, pH, and depth at the location of fry schools, particularly if they are not near a sonde. These instantaneous measurements will not take the place of the continuous sonde data, but they should provide some information about habitat preference. As fry grow into YOY, their location and habitat will also be noted weekly. Photographs will be taken to document the habitat of both fry and YOY SMB along with depth and current measurements. Some backpack electrofishing and seining is planned in July, provided river conditions are suitable, to document possible habitat changes of YOY SMB (see footnote 5 on page 11).

### **3.4. DATA ANALYSIS**

The water quality analysis will focus on the relationship among flow, depth, temperature, dissolved oxygen (DO) and possibly pH. The previous 2010 data were limited by time frame since the deployment of the sondes occurred in late June, so actual data from the beginning of the SRBC period of interest beginning May 1, were not available. The sonde data did, however, capture the highest temperature period of the year and we are confident that it captured all events above the 84°F thermal threshold. The 2012 data collection season is scheduled to begin mid-April and continue to mid-August, fully capturing the pre-spawning, fry and juvenile activity periods.

#### **3.4.1. Smallmouth Bass Prespawning and Fry Period 2012**

When field observations indicate that the fry period is over, the collected 2012 data will be analyzed. Initially, the data will be assessed for event frequency and duration similar to the 2010 data.

Unlike the 2010 data collection, the 2012 data collection will also include a depth transducer that will gather depth data on an hourly basis with corresponding water quality data. This will allow a direct comparison of depth, and thus flow variation and if temperature is statistically related to flow. Based again on diagnostics, a correlation or regression analysis will be completed to determine the existence of a statistically significant relationship and the strength of any relationship. It may also allow evaluation of the relationship on an hourly basis, again based on the data diagnostics. If the depth analysis is inconclusive we will then apply the thermal model used for the 2010 data analysis using the 2012 data and corresponding hourly meteorological data and  $\Delta T$ s reported on an hourly basis with the same diagnostics and summaries as with the 2010 data.

#### **3.4.2. YOY SMB Period 2012**

Once the full data collection event is complete, all the data will be assessed using the same procedural outline as for the pre-spawning and fry period described above. At this time, the data will also be assessed to determine if any other, particularly statistical analysis, will be useful to a

comprehensive understanding of the data and incremental effects. The scope and nature of those assessments cannot be determined until all the data are available and have been mined.

The final data analysis will also, to the extent mathematically justified, place the data and analyses in context of flow statistics to capture more extreme low flow events than 7Q10, however, the nature of historical flow data will limit this to daily averages.

#### 3.4.3. *Dissolved Oxygen and pH 2012*

Since thermal changes can affect dissolved oxygen, we will then extend the analysis to the dissolved oxygen data and assess dissolved oxygen concentration effects based on a threshold concentration of 4.0 mg/l. All the analyses will be based on hourly data and hourly increment analysis, consistent with the time step used in data collection and will include frequency and duration of events below 4 mg/l. This will be a complex analysis and the nature of the data will dictate the details and direction of the analysis. The main reason this analysis is so complex lies primarily in the strong diurnal signal that is dominated by photosynthetic activity, which drives DO into high super-saturation conditions into the mid- to late afternoon with corresponding nighttime lows in dissolved oxygen. As part of weekly observations, the type of aquatic vegetation will be visually identified and its density estimated.

The analyses will be presented in various tabular and graphical forms to demonstrate frequency, intensity and duration and describe the diurnal patterns and the oxygen dynamics that drive the patterns.

Chaplin et al 2009 as well as other references on *Flavobacterium columnare* discuss other factors such as pH on the virulence of the bacteria. We will complete parallel assessments of other parameters and to the extent that sonde data are available, compare incremental effects of flow reduction on those parameters. This portion of the analysis will have certain limitations based on the time step available for historical flow data (daily averages) which we will attempt to reconcile with the hourly sonde and meteorological data.

#### **4. REPORTING AND SCHEDULE**

The fry period data analysis will be complete by the end of July or early August 2012, depending on when the end of fry activity is noted in the field. The final comprehensive analysis will be completed approximately 2 weeks after the end of data collection, and compiled in the study report at the end of the first week of September 2012.

An electronic database will accompany the report. This database will provide all data sources used in the analysis, photographs from site visits, documentation of sampled locations with time and dates, and computer model inputs and outputs.

Table 4-1 below describes the planned schedule for this project. The tasks shown are those that relate directly to deliverables to agencies and the expected review cycles on work products.

**Table 4-1 Proposed Schedule**

Submit to SRBC for Review	Fri 4/6/12
Hold Agency Meeting	Wed 4/11/12
Finalize Scope	Wed 4/18/12
Undertake Additional Data Collection as Needed	Thu 9/6/12
Prepare and Submit Report	Thu 9/6/12*
* Assumes no additional data collection is necessary.	



### ***LITERATURE CITED***

Chaplin, J.J., J.K. Crawford, and R.A. Brightbill. 2009. Water quality monitoring in 2008 in response to young-of-the-year smallmouth bass (*Micropterus dolomieu*) mortality in the Susquehanna River and major tributaries, Pennsylvania, U.S. Geological Survey, Reston, VA.

Ecology III, Inc. 2008. Environmental studies in the vicinity of the Susquehanna Steam Electric Station. Annual Report prepared for PPL LLC, Allentown, PA.

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Normandeau Associates Inc., Ecology III, and T. R. Payne Associates. 2011. Potential effects of the Bell Bend Project on aquatic resources and downstream users. Proposed Bell Bend Nuclear Plant Site, Luzerne County, Pennsylvania. Draft for agency review. Prepared for PPL Bell Bend, LLC, Allentown, PA.

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USGS 2010. Stream Stats online at <http://water.usgs.gov/osw/streamstats/pennsylvania.html>



REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT, U.S. ARMY CORPS OF ENGINEERS  
P.O. BOX 1715  
BALTIMORE, MD 21203-1715

Operations Division

April 16, 2012

PPL Bell Bend LLC  
Attn: Mr. Terry Harpster  
VP – Bell Bend Project Development  
38 Bomboy Lane, Suite 2  
Berwick, Pennsylvania 18603

RECEIVED APR 19 2012

Dear Mr. Harpster:

This is in reference to your application for a Department of the Army permit, identified by this office as CENAB-OP-RPA-2008-01401-P13 (Bell Bend Nuclear Power Plant), to construct a new nuclear power plant, located on lands to the west and southwest of the existing PPL Power Plant, approximately five miles northeast of Berwick, in Salem Township, Luzerne County, Pennsylvania.

Enclosed, please find comments this office received in response to our Public Notice #PN-12-07, which expired on March 22, 2012. Please review the comments provided and provide a written response for each letter to the attention of Mrs. Amy Elliott, U.S. Army Corps of Engineers, State College Field Office, 1631 South Atherton Street, Suite 101, State College, Pennsylvania, 16801. Please also furnish a copy of your response to each respective agency and/or commenter.

Copies of this letter, with enclosures, are being provided to the U.S. Nuclear Regulatory Commission, the PA Department of Environmental Protection – Northeast Regional Office, and to the Luzerne County Conservation District, for informational purposes.

If you have any questions concerning this matter, please call Mrs. Amy Elliott, of this office, at (814) 234-0573.

Sincerely,

  
Wade B. Chandler  
Chief, Pennsylvania Section

Enclosures

RECEIVED MAR 28 2012



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029**

MAR 22 2012

Ms. Beth Bachur  
Acting Chief, Baltimore District  
U.S. Army Corps of Engineers  
PO BOX 1715  
Baltimore MD 21203-1715

Re: Public Notice NAB-2008-01401-P13 Bell Bend Nuclear Power Plant

Dear Ms. Bachur:

The U.S. Environmental Protection Agency (EPA) has reviewed the public notice (PN) for Pennsylvania Power and Light Bell Bend LLC (PPL or applicant), Bell Bend Nuclear Power Plant (BBNPP), located in Salem Township, Luzerne County, Pennsylvania. EPA's review and comments, provided herein, are based upon the Public Notice issued January 23, 2012, the joint permit application (JPA) prepared for this project, and technical comments provided by the Susquehanna River Basin Commission (SRBC).

EPA's review is intended to ensure that the proposed project meets the requirements of Section 404 of the Clean Water Act (CWA). The CWA Section 404(b)(1) Guidelines (40 C.F.R. Part 230) (Guidelines) provide the substantive environmental criteria against which this application must be evaluated. Fundamental to the Guidelines is the premise that no discharge of dredged or fill material may be permitted if: (1) it causes or contributes, after consideration of disposal, site dilution and dispersion, to violations of any applicable state water quality standard; (2) a practicable alternative to the proposed discharge exists that would have a less adverse impact on the aquatic environment; or (3) the discharge would cause or contribute to significant degradation of the waters of the United States. See 40 C.F.R. § 230.10.

The proposed project is undergoing review by many different agencies responsible for issuing authorizations for the construction of the BBNPP, including the Nuclear Regulatory Commission (NRC), the SRBC, the Pennsylvania Department of Environmental Protection (PADEP), and the U.S. Army Corps of Engineers (Corps). There remains outstanding and necessary document submittals and studies, including studies related to the proposed water withdrawals and water storage facilities that have not yet been completed. An Environmental Impact Statement (EIS) is being developed in accordance with NRC's compliance with the National Environmental Policy Act (NEPA). It would appear that significant data that would inform the Corps' Section 404(b)(1) Guidelines analysis is absent from the record at this time.

The purpose of the project as described in the Public Notice is to provide 1,600 megawatts of additional nuclear baseload electrical power to the northeast portion of the Pennsylvania, New Jersey and Maryland Regional Transmission Organizational grid. PPL proposes to construct a new nuclear power plant at a site adjacent to the existing Susquehanna



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Steam Electric Station. The project site boundary consists of approximately 2,055 acres, of which 687 would be altered to support construction and operation of the facility. Waterways on the site include the North Branch Susquehanna River, Lake Took-a-While, unnamed tributary to Lake Took-a-While, North Branch Canal, Walker Run and Eastern tributary to Walker Run plus associated wetland systems.

These aquatic resources are all tributaries to the Susquehanna River. Approximately fifty percent (50%) of the freshwater flow to the Chesapeake Bay (the Bay) originates from the Susquehanna River. The river was designated in 1997 as an American Heritage River. The Chesapeake Bay is North America's largest estuary and the third largest estuary in the world. Its watershed is home to approximately 17 million people and contributes significantly to the surrounding local and states economies; the Chesapeake Bay Foundation reported that the Bay is valued at over \$1 trillion. In 2009, President Obama signed Executive Order 13508 recognizing the Chesapeake Bay as a national treasure and called on the federal agencies to work to protect and restore the Chesapeake Bay watershed. American Rivers identified the Susquehanna River as No. 1 on its list of America's Most Endangered Rivers for 2011.

According to the applicant, construction of the BBNPP facility would result in approximately 13.14 acres of impacts to jurisdictional wetlands and approximately 1.25 acres of impacts to jurisdictional rivers and streams. Additionally, water intake from the North Branch Susquehanna River would be necessary for plant operation and safety purposes. It is estimated that the BBNPP circulating water system and the raw water supply would withdraw 37 million gallons of water a day (MGD) on average from the North Branch Susquehanna River. PPL has made applications to the SRBC to withdraw up to 42 MGD from the North Branch of the Susquehanna River, and a withdrawal of 1 MGD from groundwater resources in the area. The proposed surface water withdraw represents approximately 5 percent of the 7Q10 of the river. The potential effects of this water withdrawal are still being studied and are yet to be determined. These effects could include impacts on water use and water quality, effects on aquatic communities and their habitat, and effects to duration and flow of perennial and intermittent streams. In addition, consideration of effects to the aquatic ecosystem as a result of other reasonably foreseeable future water withdrawal should be made.

EPA appreciates the applicant's significant efforts undertaken to date to avoid direct impacts to aquatic resources on-site. During the initial planning process and early engagement with the resources agencies, including EPA, the site designs included potential impacts to wetlands and streams totaling over 100 acres. Currently, the applicant is seeking approval to impact 13.14 acres of wetlands and 1.25 acres of river and stream. Continued evaluation should be made of design alternatives that may be available to minimize any identified adverse effects to the local aquatic resources and to the downstream receiving systems, including the Bay. Of the 13.14 acres of impacts to wetlands 2.96 acres of impacts are to be temporary, 1.25 acres of impacts are permanent and 8.93 acres are permanent conversion from forested wetlands to emergent or shrub scrub wetlands. The proposed mitigation includes enhancing 6.80 acres of wetlands, creating 8.23 acres of wetlands, enhancing 853 linear feet of stream channel and the re-establishment of 1,360 linear feet of stream channel. To ensure that adequate compensation is achieved, a thorough assessment of the current condition of the resources proposed to be impacted should be made using appropriate and acceptable assessment methods to identify the



functional replacement needs of the streams and wetlands on-site. Any approved mitigation plan should include observable and measureable success criteria to which the success of the mitigation projects can be measured, along with an adaptive management plan to adjust any problems that arise post mitigation construction.

The Public Notice states that "the impacts caused by the consumptive use of the North Branch of the Susquehanna River are regulated by the SRBC. Any approval by the SRBC as well as Water Quality Certification, by the PADEP, will address the affects of this impact including water quantity and stream flow, water quality, aquatic habitat and provisions for low flow conditions and consumptive use mitigation." EPA agrees that SRBC is the primary regulator for water withdrawals (including groundwater withdrawals) within the Susquehanna River Basin. Nevertheless, the Section 404(b)(1) Guidelines direct the Corps to consider these impacts. See 40 C.F.R. § 230.11(h). Moreover, EPA understands that numerous studies necessary for the SRBC application have not yet been completed, including a 2-D analysis of the Instream Flow Incremental Methodology, a mussel study to be conducted in 2012, and temperature and dissolved oxygen studies for water quality in the backwater areas. EPA is providing technical comments on several studies that have been provided in the JPA for review and are included in the enclosure to this letter. In addition, technical comments provided by SRBC regarding the aquatic and water quality assessments and studies reports included in the JPA remain outstanding. Many of these studies would seem likely to provide the type of information that would assist the Corps in its public interest review and its review of the project pursuant to the Section 404(b)(1) Guidelines.

As stated above, it is our understanding that while SRBC's review of the project is underway, the applicant has not yet completed the application process, including the completion of additional aquatic studies and outstanding technical comments that must be addressed. Since the SRBC has not yet made a determination regarding the necessary approvals for the project, it is unknown at this time whether such approvals would be granted and, if so, what conditions the SRBC might consider and/or impose. Any conditions imposed by the SRBC could alter the Corps' Section 404(b)(1) Guidelines determination. For example, the applicant has not yet formally requested the SRBC to approve its pooled asset approach to meeting its consumptive use mitigation requirements. This approach is anticipated to require significant water storage capacity that may not yet have been fully identified. While SRBC has indicated that appropriate mitigation for water consumption of the magnitude and at the location associated with this project will require compensatory water or discontinuance under certain conditions, no final decision has been made. Accordingly, it is unknown at this time whether the applicant will be required to provide compensatory water and, if so, whether construction of additional facilities and further encroachment on jurisdictional waters may be required. In addition, SRBC continues to review the groundwater withdrawal application and has noted a potential concern for impacts to wetlands that would not be impacted by direct fill (i.e., loss of hydrology).

The Public Notice states that a second PN will be issued upon the completion of the draft Environmental Impact Statement (EIS). The EIS is being prepared by NRC in their compliance with NEPA. As the studies undertaken for the EIS are not yet complete, including assessment of direct, indirect and cumulative impacts to aquatic and terrestrial resources, air quality, cultural and historic resources, and communities, EPA believes this PN (NAB-2008-01401-P13) is






premature. Significant information regarding the impacts of this proposed project and other project alternatives are still being developed. It is the goal of an EIS, among other things, to consider a range of alternatives which could meet the needs identified, in the case of the project, for the energy needs of a defined area. In this instance, issuance of a Section 404 PN proposing a specific project for comment at this time gives the appearance of premature decision-making and diminishes the benefit that the detailed analysis of alternatives and impacts provides to selection of a preferred alternative. Additionally, there is the appearance that consideration of alternatives in the NEPA process would not be genuine. Though EPA understands that there may be obligations to the NRC process which prompt the timing of the application and the Corps' determination that it has a complete application for purposes of publishing the PN, EPA believes that EIS data collection and analysis has not been used to fully inform the alternative selection. It is our hope and expectation that after completion of the EIS studies, changes will be made to the selected alternative if analyses identify additional options to avoid and minimize impacts. This could include changes to location, timing or design of a preferred alternative, or selection of a no action alternative.

The additional information that has not yet been provided should be considered in making a determination under the Section 404(b)(1) Guidelines. Given the importance of the aquatic resources at stake, the complexity of the project, the magnitude of potential impacts, and the type of information that remains outstanding, EPA is concerned that the Bell Bend project, as proposed and in the absence of additional information, may result in substantial and unacceptable impacts to aquatic resources of national importance as covered in Part IV, paragraph 3(a), of the 1992 CWA Section 404(q) Memorandum of Agreement (MOA) between EPA and the Department of the Army. While EPA appreciates the applicant's efforts to work with the regulatory agencies and their significant efforts to avoid impacts to on-site aquatic resources, we believe it is premature to consider the potential direct and secondary impacts until all necessary studies and information gathering, including but not limited to the NEPA analysis has been completed.

EPA is committed to continuing to work with you and the applicant to assure that the proposed impacts resulting from this project are the least environmentally damaging practicable alternative, consistent with the CWA Section 404(b)(1) Guidelines and that significant degradation to the North Branch of the Susquehanna River is prevented. Our project-specific comments and questions are enclosed.

Thank you for the opportunity to review and provide comment on the Public Notice for the Bell Bend Nuclear Power Plant. If you have questions, please do not hesitate to contact Mrs. Jamie Davis, the staff contact for this project, at [davis.jamie@epa.gov](mailto:davis.jamie@epa.gov) or at 570-842-1044.

Sincerely,



John R. Pomponio, Director  
Environmental Assessment & Innovation Division

Enclosure



**Enclosure**  
**Detailed EPA Technical Comments- Bell Bend Nuclear Power Plant**

EPA has reviewed the below listed Supplemental Environmental Reports provided in the JPA and are providing the following technical comments.

Section 1. A Field Survey of Fish and Aquatic Macroinvertebrates at the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, PA; Normaneau Associates, Inc., November 2010.  
Section 4. Impingement and Entrainment Sampling for the Proposed Bell Bend Nuclear Power plant at the SSES Circulating Water Supply System Intake Structure, Luzerne County, PA; Normaneau Associates, Inc., June 2010.  
Section 5. Mussel Survey in the Susquehanna River in the Vicinity of the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, PA; Normaneau Associates, Inc., July 2010.  
Section 7. Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Uses, Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, PA; Normaneau Associates, Inc., June 2011.

**Section 1. -** The objective of this section of the report was to provide a field survey of fish and aquatic macroinvertebrates at the proposed Bell Bend Nuclear Power Plant site.

- As stated in the report, 'the biological sampling effort focused on water bodies that occurred in the potential areas of disturbance, although a selection of water bodies outside of this area were sampled to account for potential downstream impacts.' EPA is concerned that the North Branch of the Susquehanna River, the primary receiving stream, was not assessed for potential downstream impacts. Please provide the rationale why this river resource was not assessed.
- Please provide clarification and rationale on the selection of the sampling methods used during the assessment.
- Additional details and rationale needs to be provided regarding the sampling of the ponds.
- Please describe the methods used during the electrofishing surveys that have been completed. Were they conducted during daylight or night-time? The PADEP and others recommend a minimum of a 100 m reach for fish surveys. None of the sample reaches assessed for this study were 100 m in length. Please provide a rationale for the reach lengths selected for this study.
- Please provide clarification regarding the stream assessments and sampling methods used for both the streams and the ponds. Were the methods followed using either the Susquehanna River Basin Commission or the PADEP protocols used for these surveys? If these protocols were not used, please describe how the method used compares with SRBC and PADEP methods and why the method was utilized for sampling and assessment.

**Section 4.**

- Please provide clarification as to whether the current and proposed plants are a closed cycle facility.



- The entrainment samples were collected during one of the two diurnal periods. This is a reasonable approach; however, because different fish species will swim-up at different times, it would have been better to randomly alternate the sampling times between the daylight and night time diurnal periods. It would have also been beneficial if the study provided documentation for the entrainment values for the months of February/March and September to confirm that no spawning activity occurred during these months.
- It would have benefited the study if transect sampling of the river reach would have occurred to document what was actually available (eggs & larvae) in the river reach that by-passed the facility intake. The study could have calculated a percent entrainment score from this information.
- Please clarify whether the 2008 and 2009 entrainment results are a normal expectation for entrainment studies and how this was established.
- Please identify if there any concerns with no eggs collected during the 2008 surveys and only one egg collected during the entire 5 week sampling period in 2009.
- Generally the fish community of this river reach is known, were all of the expected fish collected during the impingement surveys that were expected?

#### Section 5.

- The qualitative mussel survey completed five years ago in 2007 did not collect the green floater, *Lasmigona subviridis* in the sampling effort; however, a single specimen was collected in the area of the proposed Bell Bend Nuclear Power Plant site during the supplemental benthic macroinvertebrate sampling survey. This species is classified as imperiled throughout much of its historic range and is considered imperiled by the Pennsylvania Natural Heritage Program plus the USFWS will be reviewing the species for candidate listing under the Endangered Species Act, we recommend that quantitative freshwater mollusk surveys using appropriate methods be completed on the Susquehanna River reach within the associated impact area of the proposed facility.

#### Section 7.

- Technical review comments from the Pennsylvania Fish & Boat Commission, Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission should be addressed.
- In addition, the section should review and address the recommendations of the Susquehanna River Ecosystem Flows Study as related to the proposed facility and its effects on the Susquehanna River ecosystem. Details of the study can be found at <http://www.nature.org/media/pa/tnc-final-susquehanna-river-ecosystem-flows-study-report.pdf>.
- The study should address the fish health issues currently occurring within the Susquehanna River watershed, how the proposed facility may or may not affect these populations, and whether mitigative efforts could be undertaken to minimize these effects.





REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT, U.S. ARMY CORPS OF ENGINEERS  
P.O. BOX 1715  
BALTIMORE, MD 21203-1715

RECEIVED MAY 24 2012

Operations Division

May 21, 2012

Mr. Michael J. Caverly  
Vice President – Nuclear Project Development  
PPL Nuclear Development, LLC  
38 Bomboy Lane, Suite 2  
Berwick, Pennsylvania 18603

Dear Mr. Caverly:

This is in reference to your application for a Department of the Army permit, identified by this office as CENAB-OP-RPA-2008-01401-P13 (Bell Bend Nuclear Power Plant), to construct a new nuclear power plant, on lands located to the west and southwest of the existing PPL Power Plant, approximately five miles northeast of Berwick, in Salem Township, Luzerne County, Pennsylvania.

In response to our Public Notice #PN-12-07, we received several comments letters which we previously forwarded to you in a letter dated April 16, 2012. Please find enclosed a second comment letter from the U.S. Environmental Protection Agency (USEPA) which should be included in your review of comments received. Please review the USEPA comments provided and provide a written response to the attention of Mrs. Amy Elliott, at U.S. Army Corps of Engineers, State College Field Office, 1631 South Atherton Street, Suite 101, State College, Pennsylvania 16801. Please also furnish a copy of your response to the commenting USEPA office.

Copies of this letter, with the enclosure, are being provided to the U.S. Nuclear Regulatory Commission, the Pennsylvania Department of Environmental Protection – Northeast Regional Office, and to the Luzerne County Conservation District, for informational purposes.

If you have any questions concerning this matter, please call Mrs. Amy Elliott, of this office, at (814) 234-0573.

Sincerely,

Wade B. Chandler  
Chief, Pennsylvania Section

Enclosure

UNITED STATES  
ENVIRONMENTAL PROTECTION AGENCY

REGION III  
1650 ARCH STREET  
MAIL CODE 3EAB  
PHILADELPHIA, PA 19103-2029

OFFICIAL BUSINESS  
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Colonel David E. Anderson  
U.S. Army Corps of Engineers  
Baltimore District  
P.O. Box 1715  
Baltimore, Maryland 21203-1715



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APR 23 2012

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029

APR 16 2012

Colonel David E. Anderson  
U.S. Army Corps of Engineers  
Baltimore District  
P.O. Box 1715  
Baltimore, Maryland 21203-1715

Dear Colonel Anderson:

On March 22, 2012, the U.S. Environmental Protection Agency (EPA) provided comments in response to the Public Notice NAB-2008-01401-P13 issued for Pennsylvania Power and Light Bell Bend LLC (PPL or applicant), Bell Bend Nuclear Power Plant (BBNPP), located in Salem Township, Luzerne County, Pennsylvania. Our letter referenced Part IV, paragraph 3(a), of the 1992 Clean Water Act (CWA) Section 404(q) Memorandum of Agreement (MOA) between EPA and the Department of the Army. The letter expressed EPA's concern that this project may adversely affect water quality and result in significant degradation of the aquatic ecosystem, and that efforts should be considered to address such impacts. EPA's March 22, 2012 comments are incorporated herein by reference (copy enclosed).

The purpose of the project as described in the Public Notice is to provide 1,600 megawatts of additional nuclear baseload electrical power to the northeast portion of the Pennsylvania, New Jersey and Maryland Regional Transmission Organizational grid. PPL proposes to construct a new nuclear power plant, at a site adjacent to the existing Susquehanna Steam Electric Station. The project site boundary consists of approximately 2,055 acres, of which 687 would be altered to support construction and operation of the facility. Waterways on the site include Lake Took-a-While, an unnamed tributary to Lake Took-a-While, North Branch Canal, Walker Run, Eastern tributary to Walker Run, and the North Branch of the Susquehanna River plus associated wetland systems. These aquatic resources are all tributaries to the Susquehanna River.

According to the applicant, construction of the BBNPP facility would result in approximately 13.14 acres of impacts to jurisdictional wetlands and approximately 1.25 acres of impacts to jurisdictional rivers and streams. Additionally, water intake from the North Branch of the Susquehanna River would be necessary for plant operation and safety purposes. It is estimated that the BBNPP circulating water system and raw water supply would withdraw 37 million gallons of water a day (MGD) on average from the North Branch of the Susquehanna River. PPL has made applications to the Susquehanna River Basin Commission to withdraw up to 42 MGD from the North Branch of the Susquehanna River, and a withdrawal of 1 MGD from groundwater resources in the area.



Additional information has not been provided to address the concerns raised in our March 22 letter. EPA appreciates the applicant's efforts undertaken to date to engage the resource agencies in the planning process for this project. We realize that additional environmental studies will be undertaken, including an Environmental Impact Statement which is being prepared by the Nuclear Regulatory Commission in their compliance with the National Environmental Policy Act, to close data gaps and better clarify the potential environmental uncertainties that this proposed project raises. These additional studies may bring to light significant information that would assist the resource agencies in their review including the U.S. Army Corps of Engineers in its public interest review and its review of the project pursuant to the CWA Section 404(b)(1) Guidelines.

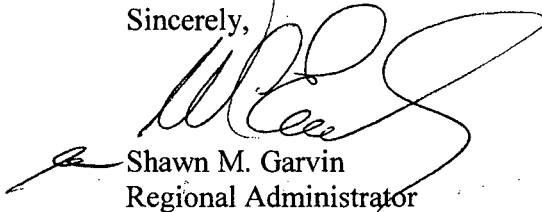
However, EPA continues to be concerned, based on the existing available information, that this project, as currently proposed, does not satisfy the CWA 404(b)(1) Guidelines, 40 C.F.R. Part 230. EPA believes that additional avoidance and minimization efforts should be considered, that the anticipated impacts are likely to cause or contribute to significant degradation of waters of the United States, and that the direct and cumulative impacts of this project, when combined with other past, present, and reasonably foreseeable future projects will adversely affect aquatic ecosystems.

Consistent with Part IV, paragraph 3(b), of the 1992 CWA 404(q) MOA between EPA and the Department of the Army, EPA believes that the project, as described in the information provided to EPA, will result in substantial and unacceptable impacts to aquatic resources of national importance. As explained in our March 22, 2012 letter, this project would result in significant direct impacts to the North Branch of the Susquehanna River, which is an important component of the Chesapeake Bay aquatic ecosystem.

EPA reaffirms our commitment made in the March 22, 2012 letter to continue to work with the applicant and you to assure that the proposed impacts resulting from this project are the least environmentally damaging practicable alternative, consistent with the CWA Section 404(b)(1) Guidelines and that significant degradation to the North Branch of the Susquehanna River is prevented. We look forward to working with you to discuss and resolve these important issues.

If you have any questions, please do not hesitate to contact me or have your staff contact Mr. John R. Pomponio, Director of EPA Region III's Environmental Assessment & Innovation Division, at 215-814-2702.

Sincerely,



Shawn M. Garvin  
Regional Administrator

Enclosure

RECEIVED APR 30 2012  
RECEIVED APR 30 2012



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029**

MAR 22 2012

Ms. Beth Bachur  
Acting Chief, Baltimore District  
U.S. Army Corps of Engineers  
PO BOX 1715  
Baltimore MD 21203-1715

Re: Public Notice NAB-2008-01401-P13 Bell Bend Nuclear Power Plant

Dear Ms. Bachur:

The U.S. Environmental Protection Agency (EPA) has reviewed the public notice (PN) for Pennsylvania Power and Light Bell Bend LLC (PPL or applicant), Bell Bend Nuclear Power Plant (BBNPP), located in Salem Township, Luzerne County, Pennsylvania. EPA's review and comments, provided herein, are based upon the Public Notice issued January 23, 2012, the joint permit application (JPA) prepared for this project, and technical comments provided by the Susquehanna River Basin Commission (SRBC).

EPA's review is intended to ensure that the proposed project meets the requirements of Section 404 of the Clean Water Act (CWA). The CWA Section 404(b)(1) Guidelines (40 C.F.R. Part 230) (Guidelines) provide the substantive environmental criteria against which this application must be evaluated. Fundamental to the Guidelines is the premise that no discharge of dredged or fill material may be permitted if: (1) it causes or contributes, after consideration of disposal, site dilution and dispersion, to violations of any applicable state water quality standard; (2) a practicable alternative to the proposed discharge exists that would have a less adverse impact on the aquatic environment; or (3) the discharge would cause or contribute to significant degradation of the waters of the United States. See 40 C.F.R. § 230.10.

The proposed project is undergoing review by many different agencies responsible for issuing authorizations for the construction of the BBNPP, including the Nuclear Regulatory Commission (NRC), the SRBC, the Pennsylvania Department of Environmental Protection (PADEP), and the U.S. Army Corps of Engineers (Corps). There remains outstanding and necessary document submittals and studies, including studies related to the proposed water withdrawals and water storage facilities that have not yet been completed. An Environmental Impact Statement (EIS) is being developed in accordance with NRC's compliance with the National Environmental Policy Act (NEPA). It would appear that significant data that would inform the Corps' Section 404(b)(1) Guidelines analysis is absent from the record at this time.

The purpose of the project as described in the Public Notice is to provide 1,600 megawatts of additional nuclear baseload electrical power to the northeast portion of the Pennsylvania, New Jersey and Maryland Regional Transmission Organizational grid. PPL proposes to construct a new nuclear power plant at a site adjacent to the existing Susquehanna



Steam Electric Station. The project site boundary consists of approximately 2,055 acres, of which 687 would be altered to support construction and operation of the facility. Waterways on the site include the North Branch Susquehanna River, Lake Took-a-While, unnamed tributary to Lake Took-a-While, North Branch Canal, Walker Run and Eastern tributary to Walker Run plus associated wetland systems.

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EPA appreciates the applicant's significant efforts undertaken to date to avoid direct impacts to aquatic resources on-site. During the initial planning process and early engagement with the resources agencies, including EPA, the site designs included potential impacts to wetlands and streams totaling over 100 acres. Currently, the applicant is seeking approval to impact 13.14 acres of wetlands and 1.25 acres of river and stream. Continued evaluation should be made of design alternatives that may be available to minimize any identified adverse effects to the local aquatic resources and to the downstream receiving systems, including the Bay. Of the 13.14 acres of impacts to wetlands 2.96 acres of impacts are to be temporary, 1.25 acres of impacts are permanent and 8.93 acres are permanent conversion from forested wetlands to emergent or shrub scrub wetlands. The proposed mitigation includes enhancing 6.80 acres of wetlands, creating 8.23 acres of wetlands, enhancing 853 linear feet of stream channel and the re-establishment of 1,360 linear feet of stream channel. To ensure that adequate compensation is achieved, a thorough assessment of the current condition of the resources proposed to be impacted should be made using appropriate and acceptable assessment methods to identify the



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As stated above, it is our understanding that while SRBC's review of the project is underway, the applicant has not yet completed the application process, including the completion of additional aquatic studies and outstanding technical comments that must be addressed. Since the SRBC has not yet made a determination regarding the necessary approvals for the project, it is unknown at this time whether such approvals would be granted and, if so, what conditions the SRBC might consider and/or impose. Any conditions imposed by the SRBC could alter the Corps' Section 404(b)(1) Guidelines determination. For example, the applicant has not yet formally requested the SRBC to approve its pooled asset approach to meeting its consumptive use mitigation requirements. This approach is anticipated to require significant water storage capacity that may not yet have been fully identified. While SRBC has indicated that appropriate mitigation for water consumption of the magnitude and at the location associated with this project will require compensatory water or discontinuance under certain conditions, no final decision has been made. Accordingly, it is unknown at this time whether the applicant will be required to provide compensatory water and, if so, whether construction of additional facilities and further encroachment on jurisdictional waters may be required. In addition, SRBC continues to review the groundwater withdrawal application and has noted a potential concern for impacts to wetlands that would not be impacted by direct fill (i.e., loss of hydrology).

The Public Notice states that a second PN will be issued upon the completion of the draft Environmental Impact Statement (EIS). The EIS is being prepared by NRC in their compliance with NEPA. As the studies undertaken for the EIS are not yet complete, including assessment of direct, indirect and cumulative impacts to aquatic and terrestrial resources, air quality, cultural and historic resources, and communities, EPA believes this PN (NAB-2008-01401-P13) is

premature. Significant information regarding the impacts of this proposed project and other project alternatives are still being developed. It is the goal of an EIS, among other things, to consider a range of alternatives which could meet the needs identified, in the case of the project, for the energy needs of a defined area. In this instance, issuance of a Section 404 PN proposing a specific project for comment at this time gives the appearance of premature decision-making and diminishes the benefit that the detailed analysis of alternatives and impacts provides to selection of a preferred alternative. Additionally, there is the appearance that consideration of alternatives in the NEPA process would not be genuine. Though EPA understands that there may be obligations to the NRC process which prompt the timing of the application and the Corps' determination that it has a complete application for purposes of publishing the PN, EPA believes that EIS data collection and analysis has not been used to fully inform the alternative selection. It is our hope and expectation that after completion of the EIS studies, changes will be made to the selected alternative if analyses identify additional options to avoid and minimize impacts. This could include changes to location, timing or design of a preferred alternative, or selection of a no action alternative.

The additional information that has not yet been provided should be considered in making a determination under the Section 404(b)(1) Guidelines. Given the importance of the aquatic resources at stake, the complexity of the project, the magnitude of potential impacts, and the type of information that remains outstanding, EPA is concerned that the Bell Bend project, as proposed and in the absence of additional information, may result in substantial and unacceptable impacts to aquatic resources of national importance as covered in Part IV, paragraph 3(a), of the 1992 CWA Section 404(q) Memorandum of Agreement (MOA) between EPA and the Department of the Army. While EPA appreciates the applicant's efforts to work with the regulatory agencies and their significant efforts to avoid impacts to on-site aquatic resources, we believe it is premature to consider the potential direct and secondary impacts until all necessary studies and information gathering, including but not limited to the NEPA analysis has been completed.

EPA is committed to continuing to work with you and the applicant to assure that the proposed impacts resulting from this project are the least environmentally damaging practicable alternative, consistent with the CWA Section 404(b)(1) Guidelines and that significant degradation to the North Branch of the Susquehanna River is prevented. Our project-specific comments and questions are enclosed.

Thank you for the opportunity to review and provide comment on the Public Notice for the Bell Bend Nuclear Power Plant. If you have questions, please do not hesitate to contact Mrs. Jamie Davis, the staff contact for this project, at [davis.jamie@epa.gov](mailto:davis.jamie@epa.gov) or at 570-842-1044.

Sincerely,

  
John R. Pomponio, Director  
Environmental Assessment & Innovation Division

Enclosure



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Customer Service Hotline: 1-800-438-2474

**Enclosure**

**Detailed EPA Technical Comments- Bell Bend Nuclear Power Plant**

EPA has reviewed the below listed Supplemental Environmental Reports provided in the JPA and are providing the following technical comments.

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Section 7. Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Uses, Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, PA; Normaneau Associates, Inc., June 2011.

**Section 1. -** The objective of this section of the report was to provide a field survey of fish and aquatic macroinvertebrates at the proposed Bell Bend Nuclear Power Plant site.

- As stated in the report, 'the biological sampling effort focused on water bodies that occurred in the potential areas of disturbance, although a selection of water bodies outside of this area were sampled to account for potential downstream impacts.' EPA is concerned that the North Branch of the Susquehanna River, the primary receiving stream, was not assessed for potential downstream impacts. Please provide the rationale why this river resource was not assessed.
- Please provide clarification and rationale on the selection of the sampling methods used during the assessment.
- Additional details and rationale needs to be provided regarding the sampling of the ponds.
- Please describe the methods used during the electrofishing surveys that have been completed. Were they conducted during daylight or night-time? The PADEP and others recommend a minimum of a 100 m reach for fish surveys. None of the sample reaches assessed for this study were 100 m in length. Please provide a rationale for the reach lengths selected for this study.
- Please provide clarification regarding the stream assessments and sampling methods used for both the streams and the ponds. Were the methods followed using either the Susquehanna River Basin Commission or the PADEP protocols used for these surveys? If these protocols were not used, please describe how the method used compares with SRBC and PADEP methods and why the method was utilized for sampling and assessment.

**Section 4.**

- Please provide clarification as to whether the current and proposed plants are a closed cycle facility.

- The entrainment samples were collected during one of the two diurnal periods. This is a reasonable approach; however, because different fish species will swim-up at different times, it would have been better to randomly alternate the sampling times between the daylight and night time diurnal periods. It would have also been beneficial if the study provided documentation for the entrainment values for the months of February/March and September to confirm that no spawning activity occurred during these months.
- It would have benefited the study if transect sampling of the river reach would have occurred to document what was actually available (eggs & larvae) in the river reach that by-passed the facility intake. The study could have calculated a percent entrainment score from this information.
- Please clarify whether the 2008 and 2009 entrainment results are a normal expectation for entrainment studies and how this was established.
- Please identify if there are any concerns with no eggs collected during the 2008 surveys and only one egg collected during the entire 5 week sampling period in 2009.
- Generally the fish community of this river reach is known, were all of the expected fish collected during the impingement surveys that were expected?

#### Section 5.

- The qualitative mussel survey completed five years ago in 2007 did not collect the green floater, *Lasmigona subviridis* in the sampling effort; however, a single specimen was collected in the area of the proposed Bell Bend Nuclear Power Plant site during the supplemental benthic macroinvertebrate sampling survey. This species is classified as imperiled throughout much of its historic range and is considered imperiled by the Pennsylvania Natural Heritage Program plus the USFWS will be reviewing the species for candidate listing under the Endangered Species Act, we recommend that quantitative freshwater mollusk surveys using appropriate methods be completed on the Susquehanna River reach within the associated impact area of the proposed facility.

#### Section 7.

- Technical review comments from the Pennsylvania Fish & Boat Commission, Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission should be addressed.
- In addition, the section should review and address the recommendations of the Susquehanna River Ecosystem Flows Study as related to the proposed facility and its effects on the Susquehanna River ecosystem. Details of the study can be found at <http://www.nature.org/media/pa/tnc-final-susquehanna-river-ecosystem-flows-study-report.pdf>.
- The study should address the fish health issues currently occurring within the Susquehanna River watershed, how the proposed facility may or may not affect these populations, and whether mitigative efforts could be undertaken to minimize these effects.

