APPENDIX E.2.1

TECHNICAL MEMORANDUM FOR WATER AND SEDIMENT QUALITY STUDY

APPENDIX E.2.2

TEMPERATURE ANALYSES SUMMARY

The purpose of this summary is to provide a condensed explanation of how the temperature monitoring results were analyzed to (1) address compliance with water quality standards, and (2) answer questions submitted on the Draft License Application.

What was our approach to water temperature in the Study Plan?

Collect sufficient data on temperature and related parameters to support different analyses, and base the analyses on the need to address uncertainties with water quality compliance. For example, concurrent water temperature and meteorological data were collected in 2006 that could support temperature modeling, if modeling was determined necessary to address uncertainties with compliance. The following text summarizes how compliance with water temperature standards has been demonstrated without using a numerical temperature model.

What did the data show?

- There were no exceedances of water temperature standards. The 17.5 °C criterion was exceeded at all monitoring locations, including upstream from the project area. However, between the upper and lower reservoir pool, the 7-DADMax temperature did not increase more than 0.3 °C at any time.

- During the low flows in August, temperatures decreased through the reservoir, and the temperature in the forebay peaked after midnight. These monitoring results are evidence that warm inflows moving slowly through the reservoir, hours after the afternoon peak temperature is reached in the river upstream, are a greater determinant of forebay temperatures than localized heat gain and loss from solar radiation and advection. If localized heat gain was more important then the forebay temperatures would have peaked in the late afternoon.

- As shown by plotting temperature measurements to illustrate that higher daily peaks were experienced in the upper reservoir compared to the lower reservoir, the reservoir was shown to moderate peak temperatures, a conclusion also reached during the previous Enloe license application study.

- Daily mean temperatures also did not increase more than 0.3 °C between the upper and lower reservoir locations in July and August, and more often decreased.

Will crest gate operations cause warming in the reservoir?

The crest gates will sustain a small increase in surface area (less than 12%) and larger increases in average depth (20%) and volume (21%). The small increase in surface area will increase heating from direct sunshine and also result in more heat loss through advection (e.g. wind-driven evaporative cooling). Because deeper waters will have less penetration of solar radiation and because larger water volumes require more heat input to effect a change in temperature, net incremental increase in heat gain, if any, is not expected to raise water temperatures. More importantly, the increased hydraulic residence time will provide for more mixing of warm and cool inflows and likely extend the period when peak temperatures are moderated.

Did river temperatures naturally cool through the reservoir reach even more before the dam was built?

As seen on aerial photographs of the river from Shankers Bend upstream toward Nighthawk, the river has a relatively uniform width and a valley form similar to the reservoir reach. Most likely the average water depth was only a few feet during low flows and much less than the existing mean depth of 8.4 feet in the reservoir, and the river was about half as wide as the current impoundment. As discussed above, because the water was much shallower, solar radiation likely had a greater warming effect on water in the pre-dam reservoir reach. Hydraulic residence time in this reach before the dam was never long enough to provide the mixing of cool overnight inflows with warm afternoon inflows. Topographic shade modeling performed by Entrix showed that the maximum difference in duration of direct solar radiation through the reservoir reach is not much different than the reach upstream, so the cooling effect that was seen in monitoring data cannot be explained by more shade. Finally, a comparison of average temperatures above and below the dam indicate that there is no consistent cooling that might indicate a substantial groundwater influx that would also have been present pre-dam. All together, these factors indicate that the river was probably more subject to warming in the reservoir reach before the dam was constructed.