Chattahoochee River Temperature TMDL

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U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:

Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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Executive Summary

The Georgia Environmental Protection Division (EPD) identified a 9.5 mile stretch of the Chattahoochee River near Atlanta, from Peachtree Creek downstream to Utoy Creek, as 'not supporting its designated use' with respect to water temperature and included this segment in the *Georgia 2002 305(b)/303(d) List of Waters*.

Section 391-3-6-.03 of Georgia's *Rules and Regulations for Water Quality Control* classifies the Chattahoochee River from Peachtree Creek to Cedar Creek as 'Fishing' and defines the following water temperature standards:

- Not to exceed 90 degrees F (Fahrenheit).
- At no time is the temperature of the receiving waters to be increased more than 5 degrees F above intake temperature.

'Intake temperature' is defined as the natural or background temperature unaffected by any man-made discharge or thermal input. In addition, *Rules and Regulations* states that these temperature standards "apply at all times when the river flow measured at a point immediately upstream from Peachtree Creek equals or exceeds 750 cubic feet per second (cfs)."

Five point sources discharge effluent to this segment with temperatures higher than the upstream or background temperature of the River. These sources include two conventional power plants owned and operated by Georgia Power Company, Plants Atkinson and McDonough, and three municipal wastewater facilities, R. L. Sutton, R. M. Clayton, and South Cobb.

Four conclusions were drawn from this investigation. First, violations of Georgia's temperature standard have occurred in the listed segment of the Chattahoochee River from Peachtree Creek to Utoy Creek. Second, waste heat discharged from two conventional power plants, Plants Atkinson and McDonough, were the major cause. Third, a 100% reduction of the waste heat discharged from these two facilities will solve the problem and eliminate the standards violation. Fourth, the three municipal wastewater facilities, R. L. Sutton, R. M. Clayton, and South Cobb, also discharge heat to the listed segment. However, with the elimination of the heat load from the power plants, the combined heat from these three plants does not violate Georgia's temperature standard and no heat reductions from these plants are necessary.

These conclusions lead to two essential recommendations: 1) remove the power plant heat loads from the river; and 2) in the future, the method presented in this report can be used to determine maximum allowable wastewater temperatures when and if increases in permit limits for the remaining wastewater facilities are requested.

1.0 INTRODUCTION

1.1 Background

The Georgia Environmental Protection Division (EPD) is required to develop Total Maximum Daily Loads (TMDLs) for waters of the State not meeting water quality standards as required by Section 303(d) of the *Clean Water Act* and the US Environmental Protection Agency (EPA) *Water Quality Planning and Management Regulations* (40 CFR Part 130). Accordingly, EPD identified a stretch of the Chattahoochee River downstream of Atlanta as 'not supporting its designated use' with respect to water temperature and included this River segment in the *Georgia 2002 305(b)/303(d) List of Waters*.

This report contains a problem assessment and develops the TMDL. The following sections will describe the listed segment, examine existing temperature data, identify and quantify sources of excess heat load to the segment, present a method for determining allowable wastewater temperatures, and specify reductions needed to protect the applicable temperature standard.

1.2 Segment Description

Figure 1 locates the listed segment which spans 9.5 miles of the Chattahoochee River from Peachtree Creek downstream to Utoy Creek. The segment is bounded on the west by Cobb County and on the east by Fulton County, both a part of the greater Atlanta metropolitan area.

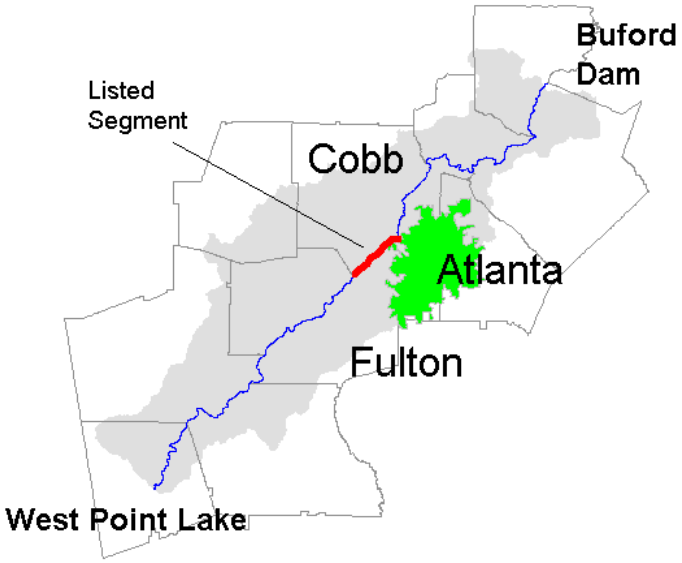


Figure 1. Location of Listed Segment

Streamflows in this segment are dynamic and highly variable. They are dominated and fully regulated by power generation at Buford Dam 50 miles upstream. The long-term mean annual flow at Paces Ferry Road, 2 miles upstream of Peachtree Creek, is approximately 2500 cubic feet per second (cfs). However, during power generation, flows from the Dam can range from 600 cfs to 10,000 cfs over the course of a single day, producing dynamic flow conditions downstream all the way to West Point Lake over 100 miles away.

The total drainage area from the Chattahoochee headwaters in Union County to Peachtree Creek is approximately 1600 square miles. By comparison, the local drainage area contributing directly to the segment is only 60 square miles (3 to 4 percent of this total) and is comprised of three watersheds: Proctor Creek, Nickajack Creek, and Sandy Creek. Therefore, streamflows in the listed segment, especially during low flow critical conditions, depend primarily on flows from Buford Dam and other watersheds upstream of Peachtree Creek.

1.3 Water Quality Standards

Georgia's *Rules and Regulations for Water Quality Control* (DNR, 2001) provide use classifications and quality standards for all surface waters of the State. Section 391-3-6-.03 classifies the Chattahoochee River from Peachtree Creek to Cedar Creek as 'Fishing' and defines the following standards for water temperature:

- Not to exceed 90 degrees F (Fahrenheit).
- At no time is the temperature of the receiving waters to be increased more than 5 degrees F above intake temperature.

Where, 'intake temperature' is defined as the natural or background temperature unaffected by any man-made discharge or thermal input.

Rules and Regulations also states that these temperature standards "apply at all times when the river flow measured at a point immediately upstream from Peachtree Creek equals or exceeds 750 cfs." This unique minimum flow provision controls the application of temperature and dissolved oxygen standards for the Chattahoochee River between Buford Dam and West Point Lake and will likewise play a central role in the development of maximum allowable effluent temperatures for the listed segment.

2.0 WATER QUALITY ASSESSMENT

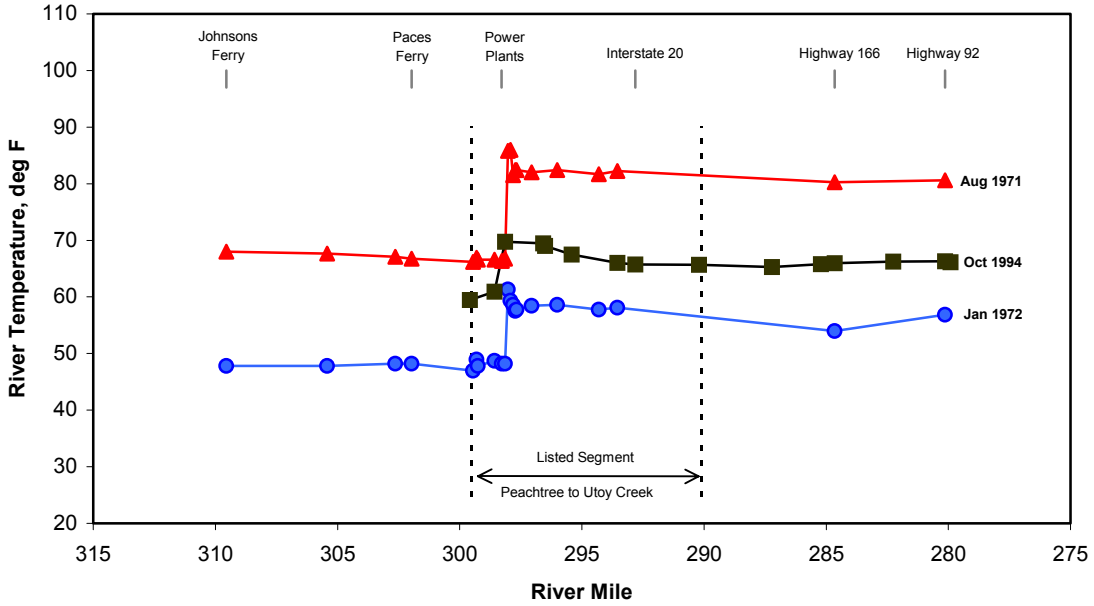
This section presents some Chattahoochee River temperature data to illustrate how the temperature standard was applied, and to justify inclusion of the segment from Peachtree Creek to Utoy Creek in the *Georgia 2002 305(b)/303(d) List of Waters*.

For this TMDL, the controlling standard is the one that states, "At no time is the temperature of the receiving water to be increased more than 5 degrees F". In technical shorthand, a temperature **change** in the River is commonly referred to as **'delta T'**. Therefore, to protect the temperature standard, the delta T in the River should not exceed 5 degrees F. If field data indicate that the River delta T is larger than 5 degrees F, then the standard may not be protected, and the segment becomes a candidate for the *305(b)/303(d) List*.

Longitudinal profiles of river temperature provide the best way to examine the Chattahoochee River delta T. Longitudinal profiles are a graph of field measurements taken at roughly the same time, usually on the same day, over a length of river both upstream and downstream of a point source discharge of waste heat. Longitudinal profile graphs make it easy to see the river delta T and to compare it to the limiting delta T of 5 degrees F.

Figure 2 shows three longitudinal temperature profiles covering a 30-mile stretch of the Chattahoochee River bracketing the listed segment both upstream and downstream. Measurements begin 10 miles upstream of Peachtree Creek at Johnsons Ferry Road and end 10 miles downstream of Utoy Creek at Highway 92. The plots contain data from August 1971, January 1972, and October 1994 representing two different decades and three distinct seasons of the year.

Figure 2. Temperature Increases in the Listed Segment



Notice that the line segments upstream of Peachtree Creek and downstream of Utoy Creek are flat without any noticeable temperature increases. By comparison, inside the listed segment there are abrupt temperature increases, each greater than 5 degrees F. Based on these observations and other similar data sets, the segment from Peachtree Creek to Utoy Creek was flagged for a delta T violation and subsequently added to the *305(b)/303(d) List*.

3.0 SOURCE ASSESSMENT

The longitudinal temperature profiles in Figure 2 indicate that River temperatures do not increase in the zones either upstream or downstream of the listed segment. However, there is a sharp increase in River temperature (an excessive delta T) that occurs within the listed segment. Five point sources, with a collective potential to raise River temperatures, discharge directly into the listed segment. Table 1 summarizes the relevant current permit information.

Table 1. Permitted Intakes and Discharges in the Listed Segment

Permit Number	Permit Holder	Facility Name	Type	Permit Limit	Expiration Date
GA0026140	Cobb County	R. L. Sutton	Municipal wastewater	40 mgd	Feb 26, 2003
GA0021482	City of Atlanta	R. M. Clayton	Municipal wastewater	96 mgd	Oct 9, 2002
033-1291-01	Georgia Power Co.	Plant Atkinson	Cooling water intake	432 mgd	Jun 20, 2009
033-1291-03	Georgia Power Co.	Plant McDonough	Cooling water intake	394 mgd	Jun 20, 2009
GA0001431	Georgia Power Co.	Plant Atkinson	Cooling water discharge	(none)	July 31, 2002
GA0001431	Georgia Power Co.	Plant McDonough	Cooling water discharge	(none)	July 31, 2002
GA0026158	Cobb County	South Cobb	Municipal wastewater	40 mgd	Jun 14, 2006

Plant Atkinson and Plant McDonough, owned and operated by Georgia Power Company, withdraw water from the Chattahoochee River for once-through condenser cooling and discharge waste heat to the segment. The three municipal wastewater facilities, R. L. Sutton, R. M. Clayton, and South Cobb, also discharge effluent to the segment with temperatures usually higher than the background River temperature. The effluent temperatures from these wastewater treatment facilities derive from flow through the sewer system and the waste treatment process, not from industrial cooling.

Figure 3 contains time series graphs of 1995 temperature data for the Chattahoochee River directly upstream of Peachtree Creek, and the effluents from Plant McDonough and R. M. Clayton. Note that at all times, effluent temperatures are higher than the background River temperature. This creates the potential for temperature increases in the River, the delta T of concern. If effluent temperatures were always lower than or equal to background River temperatures, then there would be no potential for temperature increases no matter how large the effluent flows might be. But Figure 3 shows that point source temperatures are typically higher than River temperatures and therefore discharge 'excess heat' into the receiving waters. The following equation can be used to calculate the excess heat load for each point source:

$$HE = (Te - Tr) \times Qe \times 8.34$$

Where:

HE = Excess heat load, Million-British Thermal Units per day (M-Btu/day)
Te = Effluent temperature, degrees F (Fahrenheit)
Tr = River temperature, degrees F (Fahrenheit)
Qe = Effluent flow, million gallons per day (mgd)

Figure 3. 1995 Chattahoochee River and Facility Discharge Temperatures

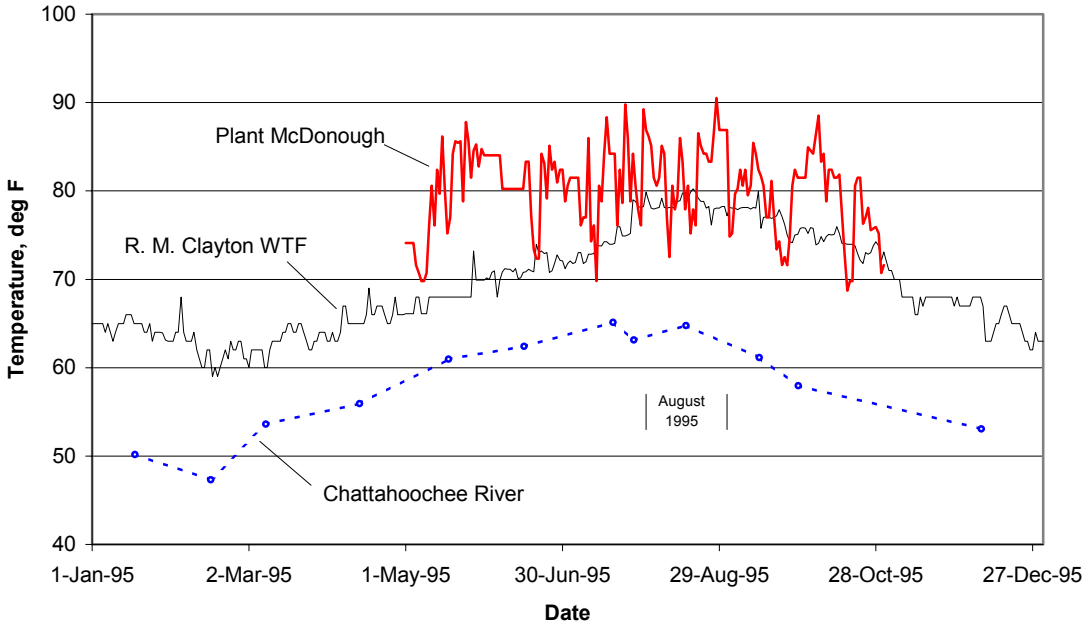


Table 2 summarizes the excess heat loads from each point source during the critical month of August 1995. From Figure 3, the River temperature upstream of Peachtree Creek peaked out at around 65 degrees F in August 1995. The excess heat loads in Table 2 are accordingly based on the degrees of effluent temperature above this background or baseline temperature as an illustration.

Table 2. 'Excess' Heat Loads -- August 1995

Facility	Flow mgd	Temperature degrees F	Excess Heat Load M-Btu/day	Percent of Total
R. L. Sutton	32.1	78.6	8895	9
R. M. Clayton	78.6	78.6	3637	4
South Cobb	19.8	78.6	2230	2
Plant Atkinson	324.0	82.6	43384	45
Plant McDonough	295.9	79.4	38944	40

Note: All entries are averages of daily values for August 1995

In August 1995, the excess heat load from all five point sources totaled about 97,000 million Btu per day. The three municipal wastewater facilities contributed approximately 15,000 million Btu per day, or about 15% of the total. The two power plants accounted for around 82,000 million Btu per day, or about 85% of the total.

4.0 HEAT BALANCE APPROACH

The familiar mass balance equation can also be used to determine the final temperature of a mixture of waters. When wastewater is mixed with river water, the resulting temperature of the mixture is not simply the average of the two temperatures but, instead, is a flow-weighted combination described by the mass balance equation below:

$$(T_{mixture}) \times (Q_{mixture}) = (T_{river}) \times (Q_{river}) + (T_{waste}) \times (Q_{waste})$$

Where:

T = Temperature, degrees F (Fahrenheit)
Q = Flow, millions of gallons per day (mgd)

We also know that the total flow of the mixture is simply the sum of the river flow and the wastewater flow, or:

$$Q_{mixture} = Q_{river} + Q_{waste}$$

Rearranging the first equation and substituting ($Q_{mixture} - Q_{waste}$) for Q_{river}, produces the following equation for calculating maximum allowable waste temperature:

$$T_{waste} = T_{river} + (T_{mixture} - T_{river}) \times (Q_{river} + Q_{waste}) / Q_{waste}$$

The key part of this equation is the term: ($T_{mixture} - T_{river}$). This is the difference between the background temperature of the river and the resulting temperature of the mixture, or the river **delta T.** Since the maximum allowable River delta T in this case equals 5 degrees F. The equation above becomes:

$$T_{waste} = T_{river} + (5 \text{ degrees F}) \times (Q_{river} + Q_{waste}) / Q_{waste}$$

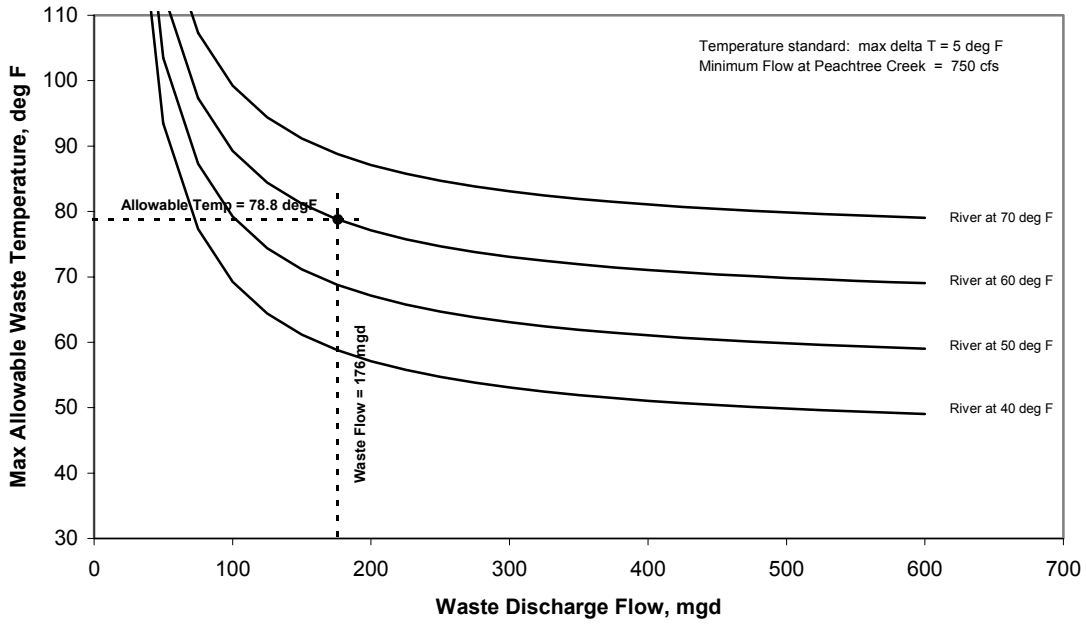
This equation can be further simplified for the listed segment since we know the minimum flow established for the Chattahoochee River at Peachtree Creek is 750 cfs. This minimum flow provision defines the regulatory critical condition for the River and is applicable for both temperature and dissolved oxygen standards. Since 750 cfs equals 484.7 mgd, the required minimum River flow can be substituted for the Q_{river} term in the equation to yield:

$$T_{waste} = T_{river} + (5 \text{ degrees F}) \times (484.7 \text{ mgd} + Q_{waste}) / Q_{waste}$$

Therefore, if we know the background critical temperature of the River (T_{river}) and the waste flow (Q_{waste}), this equation can be used to calculate the maximum allowable waste temperature (T_{waste}) that will protect the River temperature standard, the delta T of concern. This type of equation is well suited for manipulation in a spreadsheet to provide a family of curves that will allow a quick determination of the maximum allowable waste temperature for a given waste flow and critical River temperature.

Figure 4 shows these curves representing the listed segment from Peachtree Creek to Utoy Creek. Data from 1995 (Figure 3) indicate that background River temperatures can vary between 45 and 65 degrees F. Accordingly, curves are provided to represent a range of background temperatures from 40 to 70 degrees F.

Figure 4. Max Allowable Waste Temperature into the Listed Segment



As an example, suppose the background River temperature is 60 degrees F. The combined currently permitted flow for R. L. Sutton, R. M. Clayton, and South Cobb wastewater facilities equals 176 mgd (Table 1). If these temperature and flow values are plugged into the equation on the previous page, the calculated maximum allowable waste temperature would equal 78.8 degrees F to protect the River maximum delta T of 5 degrees F. This result is plotted in Figure 4 as an illustration.

5.0 MAXIMUM ALLOWABLE WASTE TEMPERATURE

The water quality standard (the river delta T) is only concerned with 'excess heat' or the temperature of the effluent that is higher than background river temperature. The following analysis, therefore, focuses on the amount of excess heat to be eliminated from the point source discharges so that the temperature standard is met.

Results presented in Table 2 indicate that the majority of the excess point source heat load (85%) can be attributed to waste heat discharged from the two power plants. Accordingly, one might initially address these two heat sources as a solution to the problem. Indeed, this is the approach that has been taken. Georgia Power Company has committed to remove their heat loads from the river. When the discharge permits for Plants Atkinson and McDonough are renewed in 2003, EPD will include a schedule for total heat load removal.

Three municipal wastewater facilities are also sources of excess heat discharged to the segment. Using the heat balance equation (repeated below) the remaining wastewater discharges will be examined to see if they, by themselves, have the potential for exceeding the allowable river delta T.

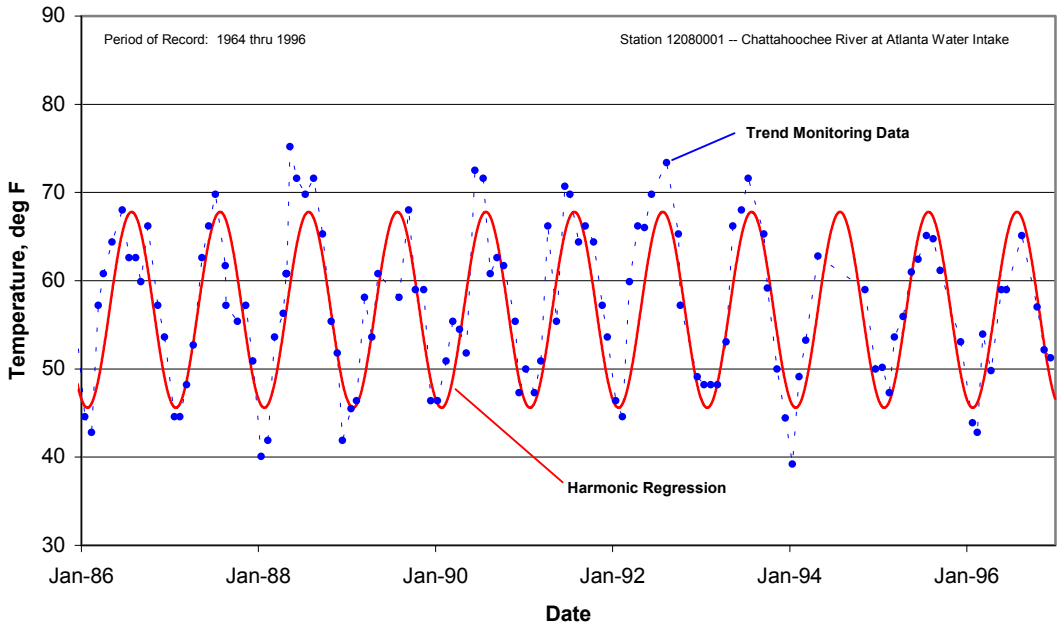
$$T_{waste} = T_{river} + (5 \text{ degrees F}) \times (484.7 \text{ mgd} + Q_{waste}) / Q_{waste}$$

To calculate a maximum allowable waste temperature (T_{waste}) the equation requires values for the waste flow into the segment (Q_{waste}) and the upstream or background river temperature (T_{river}). For proper application of water quality standards, the background river temperature must reflect regulatory 'critical conditions'. This is complicated by the fact that river temperatures vary in response to climatic conditions that change by season over the course of a year. The following section will define and develop the critical background river temperatures required for calculating maximum allowable waste temperatures for this particular segment.

5.1 Critical Conditions

More than 30 years of historic trend monitoring data are available for the Chattahoochee River immediately upstream of Peachtree Creek. This sampling station is designated as 12080001, Chattahoochee River at the Atlanta Water Intake. Figure 5 plots temperature data from this station for the period from 1986 to1996, along with the annual harmonic regression line that represents the best mathematical fit to the complete 30 years of historic temperatures.

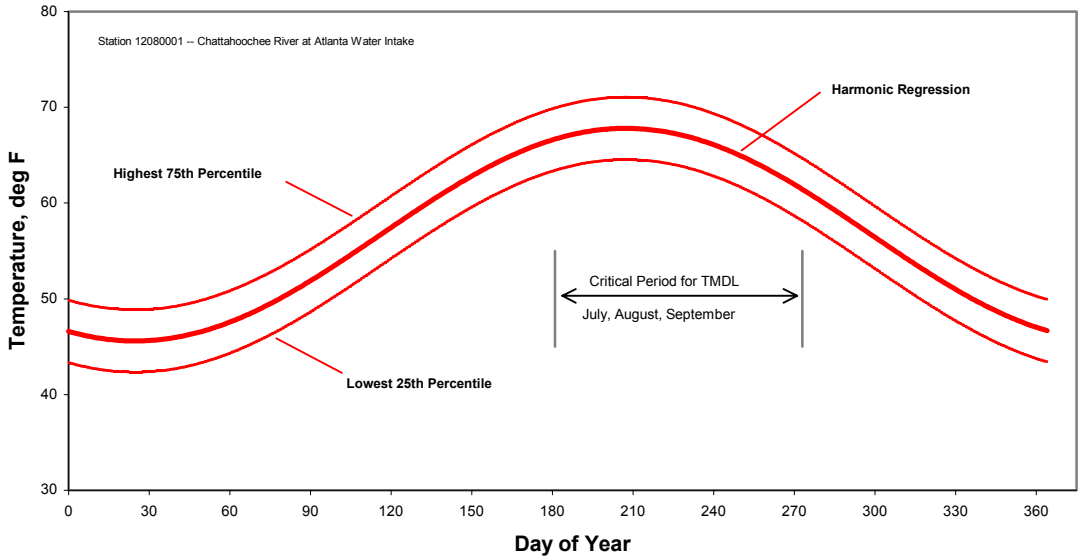
Figure 5. Chattahoochee River Historic Temperature Data



The harmonic regression line can be used to predict daily temperatures for any given critical time period. The regression, however, represents mean temperatures and not necessarily critical temperatures to be used for regulatory purposes. In this situation, it's common practice to use for critical conditions 'the outer edge of the interquartile range' of possible conditions (Butcher, 1998). Translated this means, instead of using average temperatures for critical conditions, one should use either the 25th or 75th percentile temperatures or those exceeded, or less than, 25 percent of the time.

Figure 6 shows how the highest 75th percentile and lowest 25th percentile River temperatures compare to the daily mean temperature (the harmonic regression) for the trend monitoring station at the Atlanta Water Intake. The figure also indicates that the critical months for this TMDL are July, August, and September. In summer months, river temperatures tend to be higher and dissolved oxygen concentrations tend to be lower than during cooler seasons of the year. The greatest stress with respect to protection of aquatic life can occur during these periods. This can occur during a summer heat wave when the flow at Peachtree Creek drops to 750 cfs, the minimum specified in *Rules and Regulations*, and dissolved oxygen concentrations begin to drop.

Figure 6. Critical Temperatures for the TMDL



5.2 Margin of Safety

Critical conditions for the Chattahoochee are typically based on high River temperatures when dissolved oxygen concentrations are the lowest, thereby posing the greatest threat to aquatic life. High River temperatures are always used as critical conditions for determining NPDES Permit limits for oxygen demanding substances like BOD and ammonia. Therefore, for consistency, the highest 75th percentile background temperature would normally be used as the critical condition.

Following this approach, wastewater temperatures would have to be higher than the highest 75th percentile background River temperature to raise the temperature of the River to create a delta T of concern. As a 'Margin of Safety' for this TMDL, instead of using the highest 75th percentile for background River temperatures, which would be consistent with conventional critical conditions, the lowest 25th percentile will be used. Under the lowest 25th percentile criterion, which is a very conservative approach, wastewater temperatures would have to be lower than otherwise allowed providing the required Margin of Safety. Therefore, if the existing wastewater facilities, currently discharging into the listed segment, pass the lowest 25th percentile test, we can be confident that the delta T temperature standard is protected.

5.3 Allowable Wastewater Temperatures

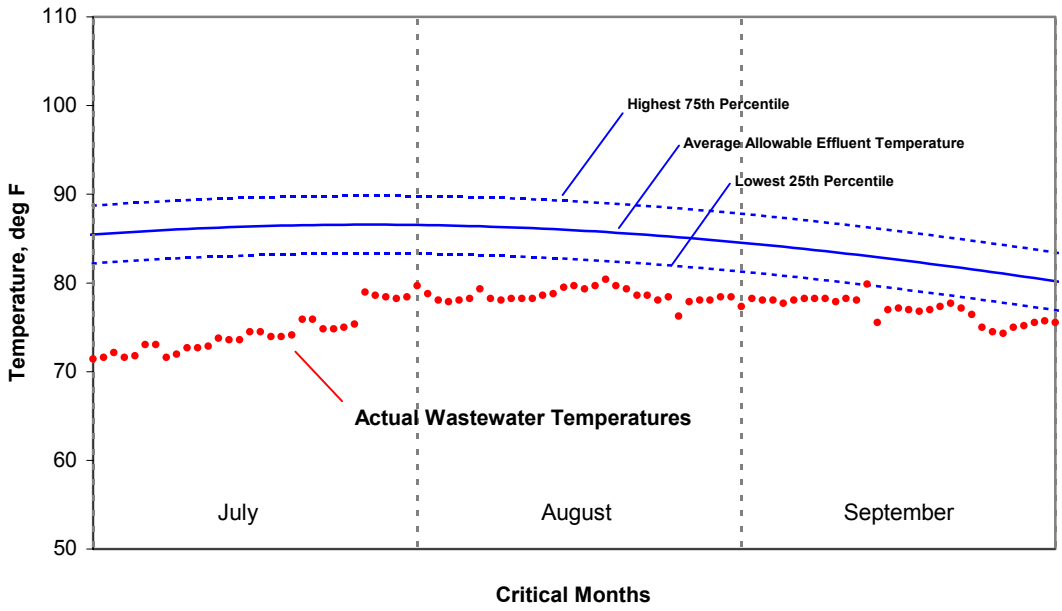
Allowable wastewater temperatures will be calculated using the heat balance equation derived earlier:

$$T_{waste} = T_{river} + (5 \text{ degrees F}) \times (484.7 \text{ mgd} + Q_{waste}) / Q_{waste}$$

The total wastewater discharged to the segment (Q_{waste}) equals 176 mgd, the currently permitted flow from three wastewater facilities: R. L. Sutton, R. M. Clayton, and South Cobb (see Table 1). The critical background River temperature (T_{river}) would be the lowest 25th percentile temperature line for the three critical months shown in Figure 6: July, August, and September.

Results are shown in Figure 7 which plots the calculated allowable temperatures along with actual wastewater temperatures for comparison. The top three lines represent maximum allowable wastewater temperatures calculated from the critical river temperatures shown in Figure 6. The lowest 25th percentile line will be used as the maximum allowable limit on wastewater temperatures. (The highest 75th percentile and the average background values are included only for comparison).

Figure 7. Actual and Allowable Waste Temperatures for the Listed Segment



Actual wastewater temperatures are daily values taken from 1995 monthly Operation Monitoring Reports (OMR) for the R. M. Clayton wastewater facility. Daily temperatures were not available for the R. L. Sutton and South Cobb plants for this time period. Their temperatures were assumed to be equal to those from Clayton.

Figure 7 shows that existing wastewater temperatures during the critical months of July, August, and September do not equal or exceed the maximum allowable temperatures calculated using the heat balance equation. This means that the three wastewater treatment facilities, in the absence of the two power plants, do not threaten the temperature standard under current permit conditions. Accordingly, no temperature reductions are needed for these remaining discharges. In the future, if increases are requested for these permitted flows, the heat balance method outlined in this TMDL can be used to determine maximum allowable wastewater temperatures.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following four conclusions can be drawn from this investigation:

1. Violations of Georgia's temperature standard have occurred in the listed segment of the Chattahoochee River from Peachtree Creek to Utoy Creek.

2. Waste heat discharged from two conventional power plants, Plants Atkinson and McDonough, are the major cause of the standards violation.

3. A 100% reduction of the waste heat discharged from these two facilities will solve the problem and eliminate the standards violation.

4. Three municipal wastewater facilities, R. L. Sutton, R. M. Clayton, and South Cobb, also discharge heat to the listed segment. However, with the elimination of the heat load from the power plants, the combined heat from these three plants does not violate Georgia's temperature standard and no further heat reductions are necessary.

These conclusions lead to two essential recommendations:

1. Remove the power plant heat loads from the River.

2. In the future, the heat balance method presented in this report can be used to determine maximum allowable wastewater temperatures when and if increases in Permit limits for the remaining wastewater facilities are requested.

7.0 REFERENCES

Butcher, Jonathan B. "Review of South Carolina Dynamic Modeling Applications for Dissolved Oxygen," *EPA SWAT Team Modeling Assistance*, Tetra Tech, Inc., May 1998.

DNR. *Rules and Regulations for Water Quality Control*, Chapter 391-3-6, Georgia Department of Natural Resources, Environmental Protection Division, Atlanta, Georgia, Revised - October 2001.