Lake Wateree Sampling and Historic Water Quality – a Cooperative Exercise between Water Watch and USC

EXECUTIVE SUMMARY

This report documents the activities of the University of South Carolina in conjunction with the Water Watch group made up of members of the Wateree Homeowner's Association (WHOA) and the Lake Wateree Association (LWA). The recent collaboration between these groups began in early 2008; the first recordable sample set was collected on July 18, 2008 from the twenty sample sites on Lake Wateree. The report discusses the most recent results of the data-gathering exercise in six separate events since July 2008 but does so in the context of data gathered from May 1999 to October 2003 by WHOA (47 separate events), and also in the context of SCDHEC data available through the USEPA's online STORET system.

This document covers water quality with respect to two issues, namely human health and the effect of pollutants on aquatic life. With respect to human health from primary (e.g. swimming) and secondary (e.g. boating and fishing) contact, the concentrations of indicator bacteria on the lake are typically one to two orders of magnitude below the SCDHEC criteria for primary contact. The report concludes that human health risks from primary and secondary contact with the water are low. The water quality issue that occupies much of this document's content, however, deals with aquatic life, much of which involves lake eutrophication. Eutrophication is a natural process but can be accelerated by human activities that tend to increase the nutrient content of waters that feed the lake. In addition, the report tries to convey the theme that *water quality varies* over *space* (location and depth) and *time (*season and time of day).

The most significant, yet unsurprising, result of the Water Watch sampling exercises over the years is that water quality in Lake Wateree is not homogenous. To generalize, water quality in headwaters, embayments and the central channel tends to be different, and the degree and significance to which water quality varies depends on the parameter measured. For example, dissolved oxygen (DO) and turbidity (or the water's cloudiness) are typically *highest* in the headwaters and *lowest* in the channels, while specific conductivity (or the amount of salts in the water) are typically *lowest* in the headwaters and *highest* in the channels. Finally, pH levels (i.e., how acidic or basic the water is) tend to be *similar* in the headwaters and embayments, but *lower* in the channels. The specific reasons for these variations are discussed in the body of the report. *Individual* sample sites that appear to be of concern are Big Wateree Creek and Dutchman Creek (high turbidity) and Taylor and Singleton Creeks (high pH).

Monthly water quality data measured by SCDHEC in the headwaters (Station CW-231) and the forebay (i.e., near the Wateree dam wall at Station CL-089) typically show *significant* differences. For example, nutrient concentrations (phosphorus and nitrogen) in the headwaters are typically twice as high as those found in the forebay; turbidity and fecal coliform bacteria follow the same trend as nutrients. On the other hand chlorophyll-a concentration, a measure of the amount of algae in the water, is roughly *three times higher* in the forebay as it is in the headwaters. These trends are consistent and can be explained by nutrient uptake through plankton (plants and animals) and bacteria along the length of the lake. The data essentially show that the lake (like most reservoirs) tends to be a sink for organic and inorganic materials that enter it from the Catawba River and other streams. The

mechanisms that the lake tends to act as a sink for include physical (e.g., natural settling of solids), chemical (e.g., precipitation and transformation) and biological (e.g., bio-uptake) processes.

The Water Watch sampling data showed that water quality also varies with *depth*. For example, in a eutrophic lake like Lake Wateree, DO concentrations (which directly affect aquatic creatures) will *drop* with depth; the extent to which this happens is seasonal. The majority of samples where DO concentrations are below 2 mg/L (highly undesirable for aquatic creatures) are taken in the summer months at depths of 4 ft or below – the lowest concentrations for a given sample site will typically be at the interface between the lake sediment and the water. Lake stratification, a phenomenon where warmer waters tend to "float" on denser, cooler water, is most marked in summer seasons, and is a primary reason for a lack of mixing, hence the significant variance of water quality at different depths.

The Water Watch data shows significant amounts of seasonality. In summer, temperatures are *higher* (typically 30 °F), DO concentrations *lower* (typically 5 mg/L), pH *higher* (typically 1 pH unit), and turbidity *lower* (typically 25 NTU) than those found in winter.

As far as recent trends (since 2002) in water quality based on SCDHEC data are concerned, the most pertinent results show that turbidity, fecal coliform and phosphorus levels have shown a *downward* trend in Lake Wateree's headwaters - these signs are positive for the health of the lake. There is however, an *upward* trend in nitrogen concentrations, especially in nitrates and nitrites (soluble nitrogen). No increase or decrease in chlorophyll-a was detected over the period 2002-2007, although one excursion of chlorophyll-a above the SCDHEC criteria of 40 micrograms per liter occurred in the latter part of the period (2006).

The implications of the above findings in terms of the lake's health are that it will be vulnerable to water quality problems at different times and different locations. The most important vulnerabilities, in our opinion, would be as follows:

- Increased chlorophyll-a concentrations occur in the summer and are typically highest in the downstream portion of the lake. Increased chlorophyll-a concentrations (especially above 40 micrograms per liter) will cause discoloration of the lake waters and can, at times, be toxic to aquatic creatures. Algal blooms can result in low oxygen conditions, especially at night when no photosynthesis occurs and the algae itself requires oxygen to respire. Dead algae tends to settle at the bottom of the lake, and as it decays will use up oxygen. Algal blooms can also block out sunlight for rooted aquatic plants which may provide habitat for aquatic life.
- Low dissolved oxygen concentrations in the summer, especially in the embayments and channels and at depth, and especially at night when plants stop producing oxygen. Prolonged exposure to low DO concentrations (say below 4 mg/L) can suffocate aquatic creatures and will affect their growth and reproduction. Juveniles are typically more vulnerable to low DO concentrations.
- High pH in the summer during the day, especially in the downstream embayments and channel where most photosynthesis is expected to occur. As pH approaches 9, aquatic life will be vulnerable to ammonia toxicity.
- High turbidity in the rainy season (spring), especially in headwaters and embayments. Turbidity under these circumstances is an indicator of suspended solids. Suspended solids interfere with plant photosynthesis (especially in rooted aquatic vegetation), cause gill

abrasion in aquatic creatures and as sediments cover the lake bottom they reduce the amount of habitat available for successful fish spawning and benthic invertebrates.

As can be expected, there are still many questions about the lake's water quality. A table of questions, possible actions and required resources is provided in the conclusions of the report. The following three questions are included in the table:

- In 2008, why did we observe an *increase* in DO in the headwaters and a *decrease* in DO in the embayments?
- What are the causes of the recent high pH on the Singleton and Taylor Creek headwaters?
- Why is the Big Wateree Creek consistently more turbid than the other creeks coming into Lake Wateree?

The above questions are mentioned because our graduate student, Sara Powell, intends to tackle these questions as part of her Master's thesis in 2009 entitled "*Lake Wateree - getting out of the lake and into the watershed*".

Clearly, there is much work to be done. Water Watch will need to pay attention to watershed issues. Ideally, we would like all questions to be answered and all problems solved, but given limited resources (time and money), the Water Watch group will need to prioritize actions posed in the report. This process, although itself time-consuming, should contribute to the group's future strategy, growth and success.