

# EVALUATION AND COMPARISON OF REUSE WATER AS APPLIED TO GOLF COURSE GREENS IN THE PIEDMONT REGION OF NORTH CAROLINA

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## History

The City of Raleigh developed a Reclaimed Water Master Plan in January of 2007. There had been several iterations of a master plan prior to 2007 however the atmosphere surrounding reclaimed water in North Carolina was changing rapidly. In 2006 the piedmont region of North Carolina along with much of the Southeast began to experience a drought. By 2007 and into 2008 this drought reached severe status and water resources became scarce. The City of Raleigh imposed water restrictions which became more stringent the longer the drought lasted. At this time it was decided to move forward with the reclaimed water system.

Our current system has been built in several segments since 2007. When the last segment in this phase is finished next year our system will cover approximately 20 miles with one 0.75 million gallon tank. The permitted usage for this system is 3.3 million gallons per day however pumping capacity is approximately 6 million gallons per day. Currently, there are two golf courses on City of Raleigh reclaimed water. A third golf course will come on line and be at the distal end of our system next year. By moving to reclaimed water the golf courses are enjoying the benefits of lower rates and not being subjected to water restrictions.

Due to historical data and past research many golf course superintendents are leery of using reclaimed water on greens due to the high sodium and salinity content. However, much of this data and research has come from areas that do not receive the normal rainfall allocation that the piedmont region of North Carolina does. In some instances this has been a deterrent for golf course personnel to make the choice to begin irrigation with reclaimed water. In the winter of 2011 it was determined that a research area would be constructed to study the effects of reclaimed water on turf grasses used in golf course and athletic field industry at the Neuse River WWTP.

Three sites have been and will continue to be evaluated. They include the Neuse River WWTP Turf Grass Research area, Raleigh Country Club, and River Ridge Country Club. River Ridge does not currently collect tissue samples on a regular basis as they irrigate their greens with water from the Neuse River.

## Overview

### *Neuse River WWTP Research Area*

In 2011 the Land Management staff at Neuse River WWTP took on the task of building two golf course greens. This was completed with the assistance of Michael Shoun at Raleigh Country Club. The turf grass research area is made up of two greens complexes that area approximately 1300 square feet and constructed to United States Golf Associations specifications. Underground drainage and materials

installed under greens surfaces were designed to match drainage rates of greens at golf courses in our immediate area. We have five different turf grasses that we use in dedicated sections of the research area. Our tee box is Tifton 419 Bermuda, the fairway is Majestic Bermuda, the approach and collar are Tiff-sport Bermuda, one green is Bent grass, and the second is Champion Bermuda. We decided on the different grasses because these are the grasses used on the golf courses in this area. We irrigate both green complexes an average of twice a day. During the winter months we have no irrigation events, but during the hot and dry summers of North Carolina we may irrigate the green complexes up to six times a day. All other areas are irrigated on an average of once a day. Our mowing schedule is set up to simulate the stresses of everyday mowing at a golf course. We mow both green complexes once a day during the growing season. Because of the two different grasses the growing seasons are much different. We mow the Bent grass green daily from March thru early November. The Champion Bermuda is mowed once a day from late April thru early October. The tee box and fairway are mowed as needed on an average of once a week. The approach and collar areas are mowed twice a week. Our sampling schedule for both greens complexes is equal to our mowing schedule. We try to take tissue samples for analyses when mowing occurs. For the collar/approach areas, the fairway, and the tee box we try to take tissue samples once a week. The entire research site is 0.75 acres.

### ***Raleigh Country Club***

Raleigh Country Club is located in the downtown area of Raleigh. It was designed by Donald Ross and is considered one of the premier golf course clubs in central North Carolina. Irrigation was supplied with potable water until early 2011. It became evident in 2007 and 2008 that Raleigh Country Club needed an alternate water supply for irrigation. Due to the fact that it is located in downtown Raleigh there are no available natural water ways to be accessed for irrigation. It has two large storm water impoundments located on site that are used as water features for the course. However, this water comes off of area strip mall parking lots and is of such poor quality that it would be detrimental to the turf grasses if it was applied to it. The City of Raleigh approached Raleigh Country Club to see if they would be interested in utilizing reclaimed water. This would be mutually beneficial since they would be a major user in the pipeline corridor. One decision that had to be made was whether or not the bent grass greens would be irrigated with reclaimed water. There was no way to separate the greens from the fairways in the irrigation system without considerable expense. The management at Raleigh Country Club made the decision to irrigate the entire course with reclaimed water due to the availability and cost. This is the only premier golf course in central North Carolina to irrigate bent grass greens with reclaimed water.

### ***River Ridge Country Club***

The City of Raleigh and River Ridge Country Club began discussing the use of reclaimed water on the golf course about ten years ago. At that time their sole source of water for irrigation was pumped from the Neuse River. The course is located very close to the Neuse River WWTP and the use of reclaimed water is beneficial to both parties. However permitting with the NC Division of Water Quality became difficult due to buffer restrictions and was put on hold until 2009. The reclaimed water line was already available to River Ridge. It was put in as a part of a larger sewer project twelve years ago. In 2009 private consultants, City of Raleigh engineers, and NC DWQ came to an agreement as to how reclaimed water could be used at this course. River Ridge does not use reclaimed water on their greens or in buffer areas that are close to water ways or private dwellings. They have the ability to pump reclaimed water and water from the Neuse River with the same pumping system through a series of valves and controllers. NC DWQ agreed to and permitted a system that allowed reclaimed water to be used in areas of the course (mainly fairways) where buffers were not a problem. After the reclaimed water cycle there

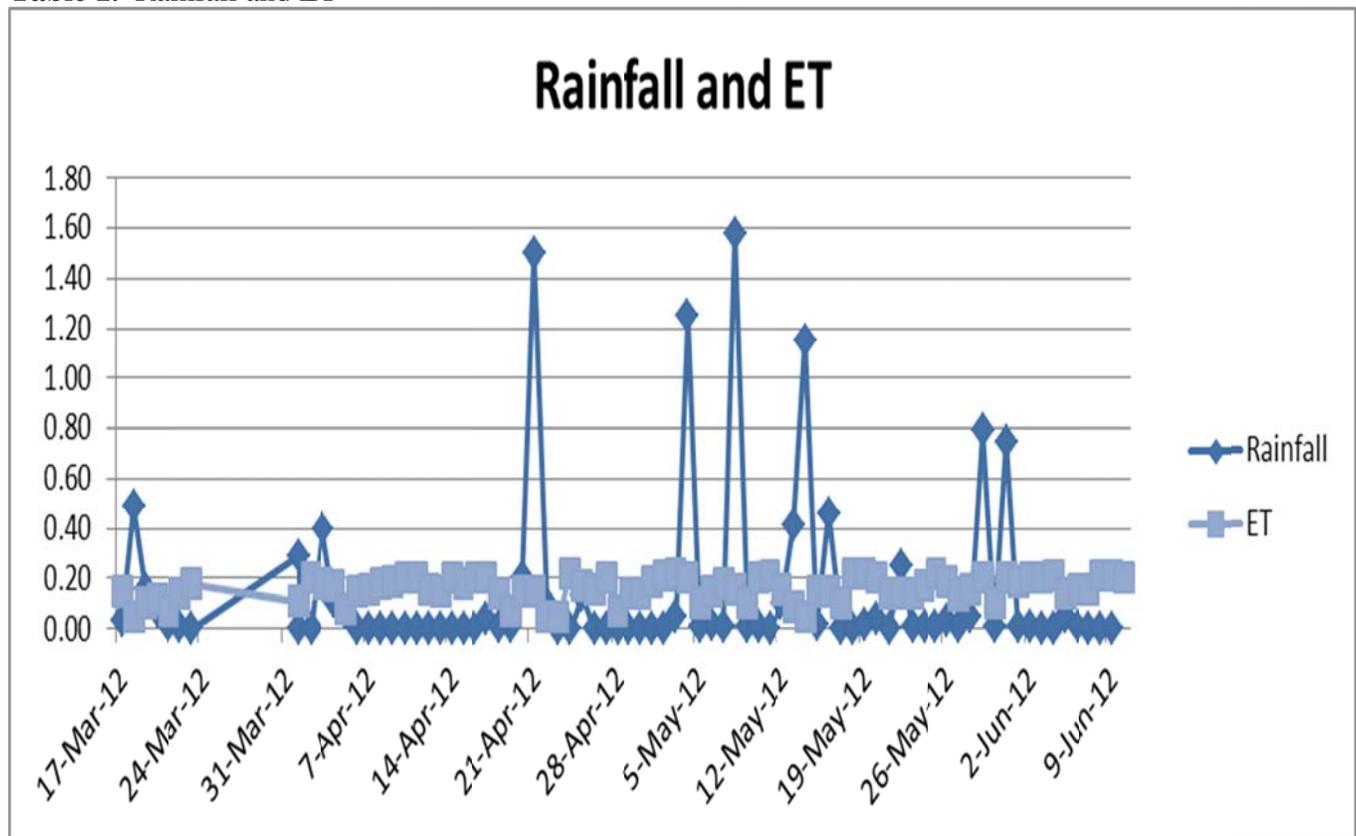
is a flush through of river water that irrigates all of the reclaimed water out of the system so that no reclaimed water is irrigated in buffer areas or on the greens.

### Supporting Data

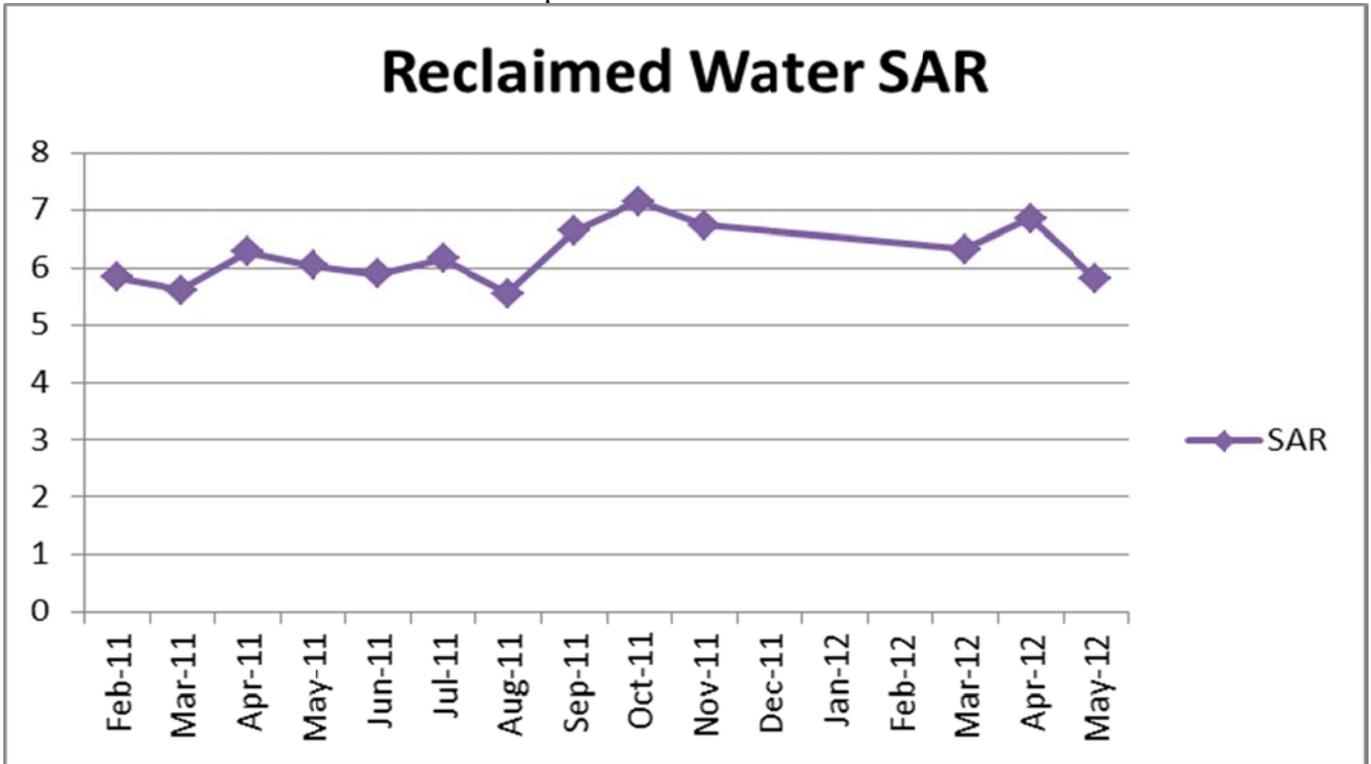
#### *Neuse River WWTP Research Area*

Consistent data collection began in March 2012 for this site. An initial analysis of the greens was performed in October 2011. The Sodium Absorption Ratio for the Bent Grass at this time was 7.38 and for the Champion Bermuda 7.35. The average salinity for our reclaimed water is 113.58 ppm. Rainfall and ET data has also been collected. Gypsum was applied to the Bent Grass green in March 2012. It is evident in the tables below that applying Gypsum reduces the amount of sodium that is taken up by the plant. Approximately 0.88 inches per acre is applied to the 0.75 acre site monthly. During the warm, dry periods approximately 50 gallons per irrigation event is applied to each green. The average Sodium Absorption Ratio of the reclaimed water is 6.23. In general it is recommended that the SAR of the water source be less than 9 (Gross, 2008).

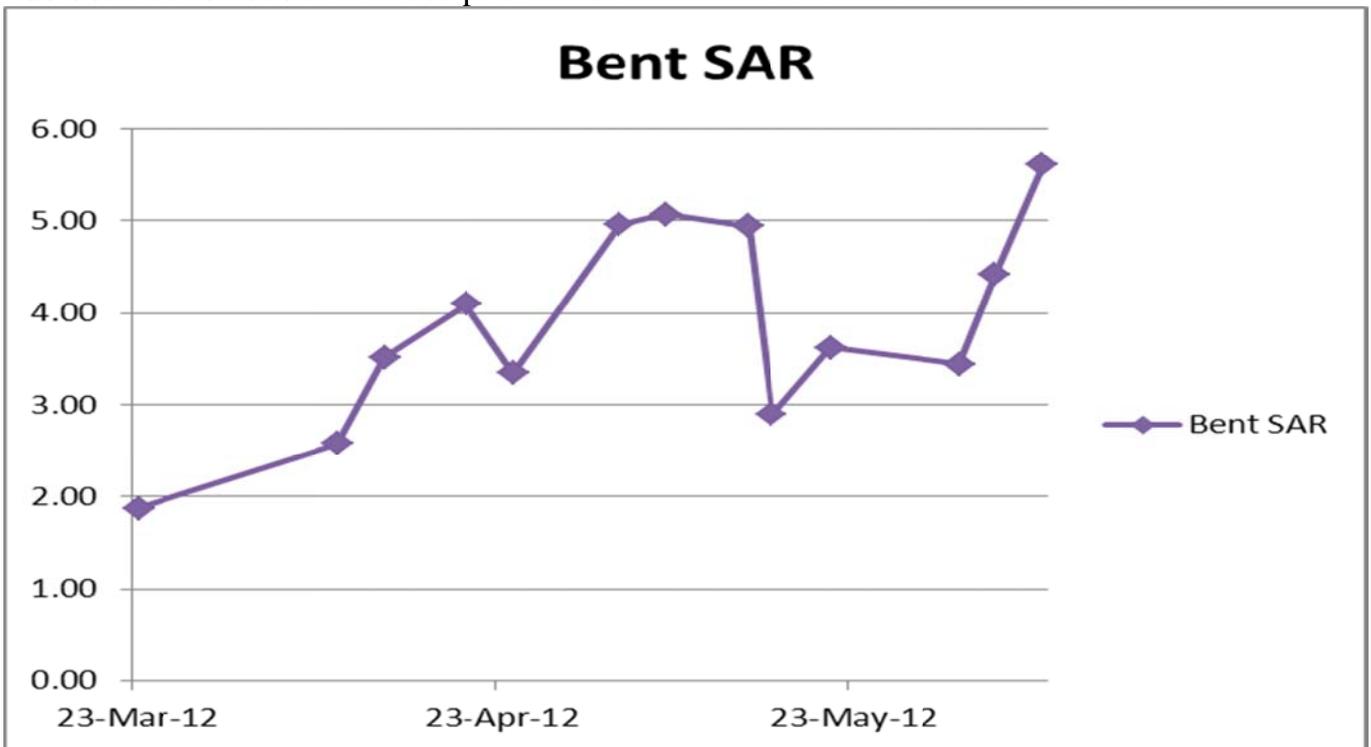
**Table 1.** Rainfall and ET



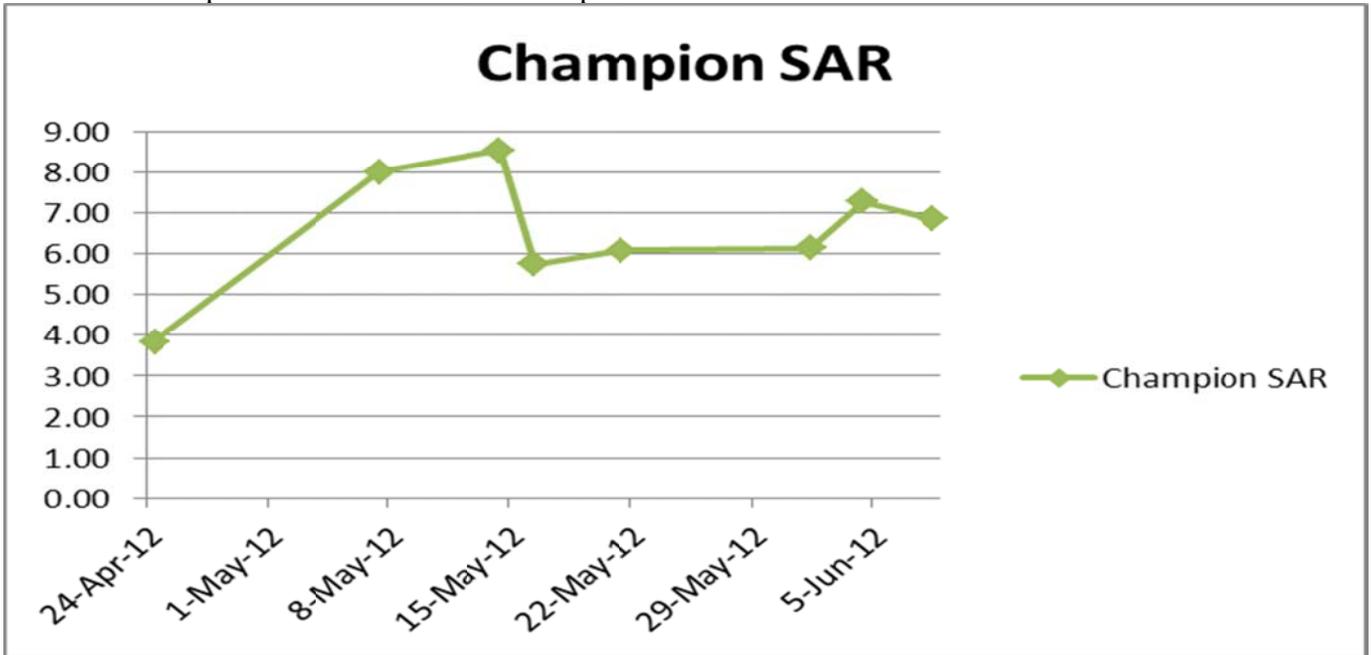
**Table 2.** Reclaimed Water Sodium Absorption Ratio



**Table 3.** Bent Grass Sodium Absorption Ratio



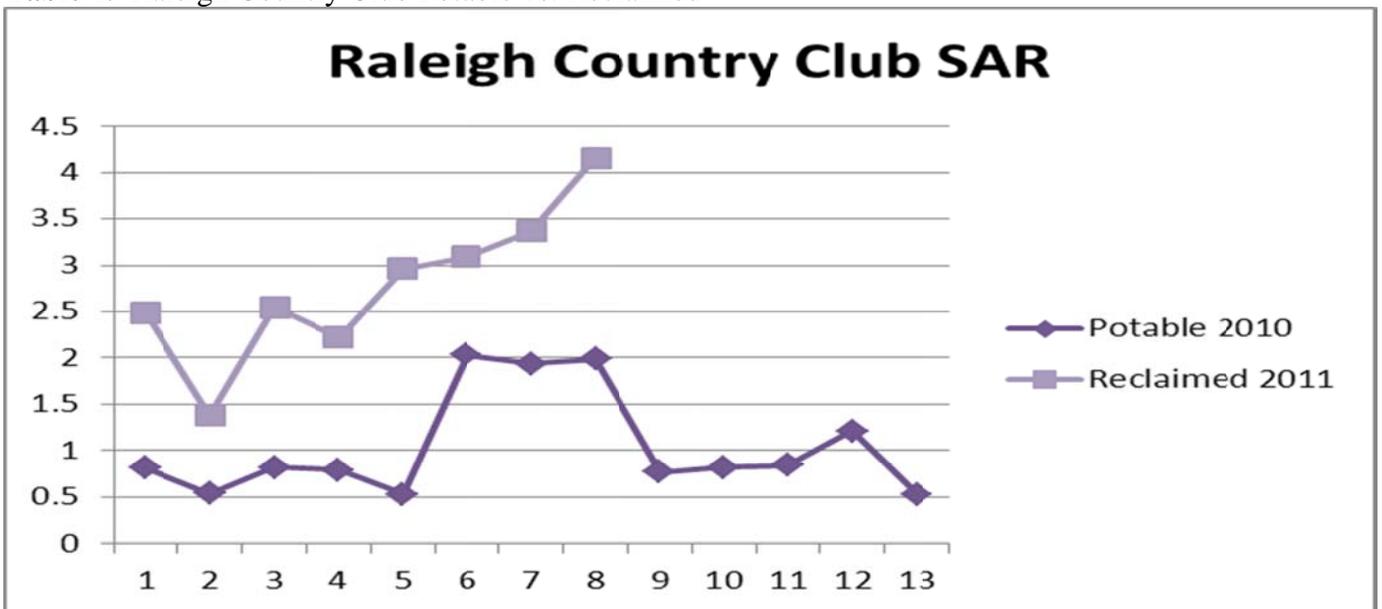
**Table 4.** Champion Bermuda Sodium Absorption Ratio



**Raleigh Country Club**

While Raleigh Country Club was irrigating with potable water the SAR of the Bent grass greens averaged 1.05. Even with potable water irrigation the SAR increased to 2.0 in the hot months when more irrigation occurs and rainfall is not as frequent in a widespread manner. The Sodium Absorption Ratio doubled when Raleigh Country Club began irrigating their greens with reclaimed water. The course changed from potable to reclaimed water in March 2011. Gypsum and Calcium are added to the greens at prescribed intervals to mitigate the effects of Sodium in reclaimed water. In April 2012 several soil samples were analyzed. The soils report indicated that Sodium was elevated in the root zone of the greens. These greens are about 1% higher in Sodium than the target.

**Table 4.** Raleigh Country Club Potable vs. Reclaimed



## Conclusion

It appears that sandy soils such as those in constructed golf course greens are not as susceptible to structure and permeability problems associated with elevated Sodium Absorption Ratio values. However, the stress of daily mowing may allow the sodium accumulation to make up a large portion of the small remaining quantity of leaf tissue (Harivandi, 1999). This could result in the presence of phytotoxicity in sensitive bent grass greens. Raleigh Country Club experienced phytotoxicity on a few greens in 2011 however it was easily mitigated with Gypsum and/or Calcium applications and aeration. The City of Raleigh Turf Grass Area has seen no evidence of phytotoxicity thus far.

Currently, it appears that with the amount of rainfall located in the Piedmont region of North Carolina the Sodium is flushed through the green structures before it can become detrimental to the turf. The data supports that when there is adequate rainfall the Sodium is flushed through the sandy soil structure of the green. As seen in the graphs above in April and May when rainfall occurred the SAR of both greens dropped in direct correlation with the event. Evaluation of these sites will continue and it will be interesting to see how the SAR values react in the hot, potentially dry summers in the Piedmont region of North Carolina.

## References

Gross, Peter. A Step-By-Step Guide for Using Recycled Water. Green Section Record, USGA. 2008.

Harivandi, Ali. Interpreting Turfgrass Irrigation Water Test Results. University of California Division of Agriculture and Natural Resources. 1999.

Landschoot, Peter. Irrigation Water Quality Guidelines for Turfgrass Sites. Penn State College of Agriculture Science. 2012.