Roanoke River Success Story

In 1996, approximately 6 miles of the Roanoke River below the Kerr Reservoir Dam were identified as polluted because it was not meeting water quality standards with dissolved oxygen concentrations frequently falling below the numeric criteria of 4 mg/L. Over the next six years, the Virginia Department of Environmental Quality (DEQ) collected additional data to characterize the extent of the problem. As a result, the affected area expanded to a total of about 11 river miles, which included upper portions of Lake Gaston. Throughout this period, DEQ sought to identify the cause of this low dissolved oxygen.

> Dissolved oxygen is the amount of oxygen present in water. It is typically measured in milligrams per liter (mg/L)

> Eutrophication can occur in reservoirs where excess nutrients result in the growth of excess algae. Algae will then decompose and use up the oxygen in the water.

Algal growth due to nutrients was first investigated as the reason for the low oxygen levels in the River. However, none of the data collected suggested that the nutrient levels or algae were high enough to cause the problem. After further investigation, it was determined that the water discharged from the Kerr Reservoir dam was resulting in the low oxygen concentrations in the Roanoke River downstream of the dam.

> Stratification occurs because cold water is denser than warm water, and the cold water that is not heated by the summer sun remains on the bottom of the reservoir.

The low dissolved oxygen concentrations were observed during summer months when the Kerr Reservoir waters were **stratified**. The Kerr Reservoir dam releases water to generate electricity from the bottom of the reservoir. Reservoirs are good at capturing material behind the dam, and organic matter such as decaying vegetation, organisms, and animal waste fall to the bottom of the reservoir and use up the dissolved oxygen as they decompose. During the summer months when the Kerr Reservoir becomes stratified**,** the decaying organic matter uses up the oxygen. This low oxygen bottom water was discharging into the Roanoke River.

In 2007, after concluding that the Kerr Reservoir Dam discharge was causing the low dissolved oxygen concentrations in the Roanoke River, DEQ contacted the Army Corps of Engineers to discuss the problem. In 2000, aware of dissolved oxygen issues, the Army Corps of Engineers installed baffles to aerate the water passing through the turbines of the dam. That resulted in some water quality improvements, but more work was necessary. In 2007 after DEQ contacted the Army Corps of Engineers, the Corps volunteered to make enhancements to address this problem as part of upgrades that were already underway. Accordingly, the Army Corps of Engineers planned to install a Permanent Dissolved Oxygen System, which includes generator units that oxygenate the water on 3 of the 6 turbines. The schedule for dam improvements outlined that the first turbine would be retrofitted and back in service by January 2008 with the additional units being replaced by 2010. DEQ worked with the Army Corps of Engineers to design a sampling plan to monitor the effectiveness of the permanent Dissolved Oxygen System. As a result of these voluntary efforts and effectiveness monitoring plans, DEQ moved this polluted section of the river from a category 5 listing on the 303(d) impaired waters list to a category 4B. This means that a Total Maximum Daily Load (TMDL) was not required to restore the Roanoke River since the dam improvement efforts were underway and expected to restore the Roanoke River to healthy Dissolved Oxygen levels. The 4B justification document and its EPA approval letter can be found here.

Figure 1. Kerr Reservoir Dam

As soon as the dam improvements began to be implemented, the oxygen levels in the Roanoke River began to improve. **Figure 2** below shows dissolved oxygen measurements through time near the dam discharge (18.04 miles from the North Carolina border), and **Figure 3** shows dissolved oxygen measurements through time a few miles downstream (12.08 miles from the North Carolina border). In both **Figure 2** and **Figure 3** the purple box represents the time period when the baffles were installed to aerate water in 2000, whereas the green box represents the time period when the 3 new aerating turbines were installed.

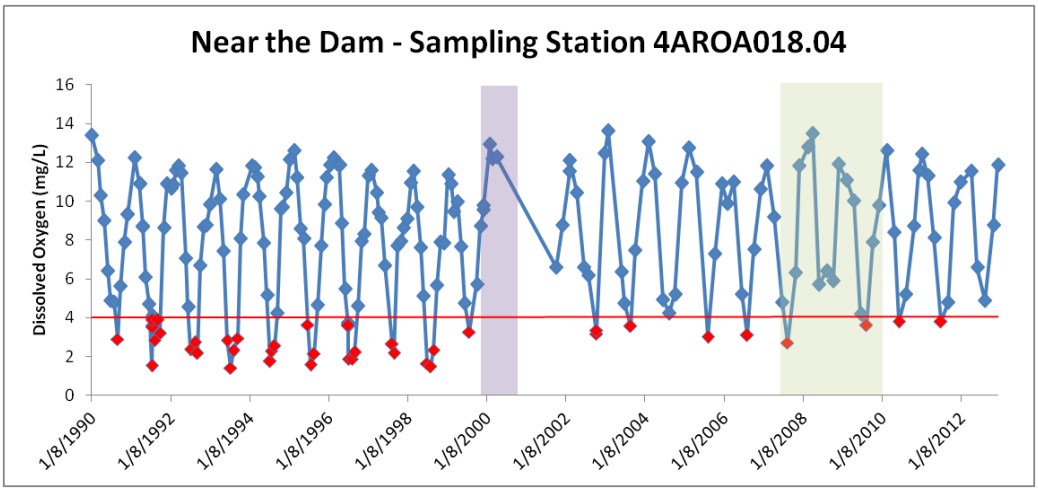

Figure 2. Dissolved Oxygen measurements at sampling station 4AROA018.04, which is just downstream of the Kerr Reservoir Dam.

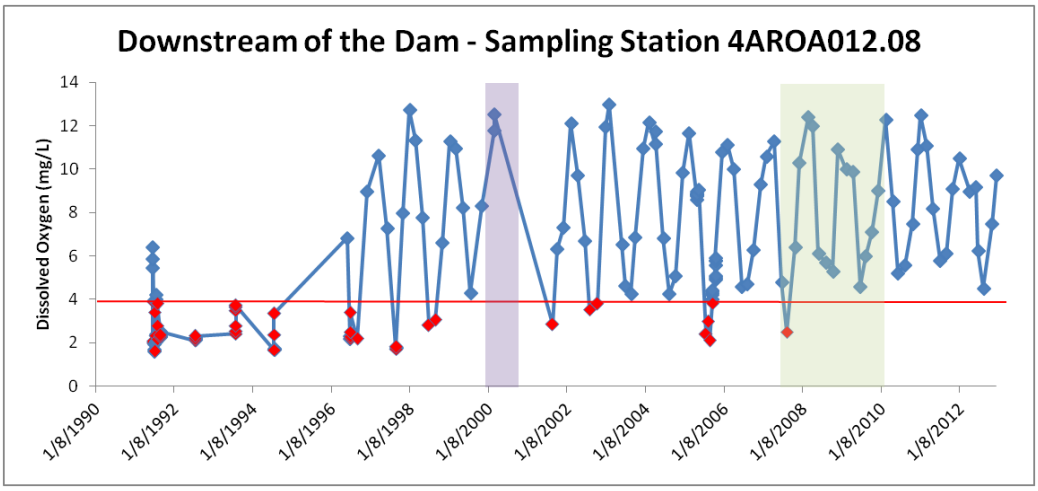

Figure 3. Dissolved Oxygen measurements at sampling station 4AROA012.08, which is a few miles downstream of the Kerr Reservoir Dam.

Looking at **Figure 2** and **Figure 3**, it is apparent that the initial baffle installation in 2000 improved the quality of the water some but not enough. However, following the installation of the Permanent Dissolved Oxygen System in 2007-2009, the water quality improved much more, especially in the downstream portion of the Roanoke River. While there were still some violations of the water quality standard of 4 mg/L of dissolved oxygen following the installation of the Permanent Dissolved Oxygen System, the trend is positive and the number of violations fall below 10%. As a result, DEQ removed all 11 miles (including the upper portions of Lake Gaston) from the 303(d) impaired waters list after documenting this water quality restoration to EPA in a document found here. Thanks to the work of DEQ staff in identifying the problem and the voluntary efforts of the Army Corps of Engineers to retrofit the Kerr Reservoir dam, the Roanoke River is no longer plagued with low dissolved oxygen in the summer months!