Richard B. Russell
Oxygen Diffuser System Replacement

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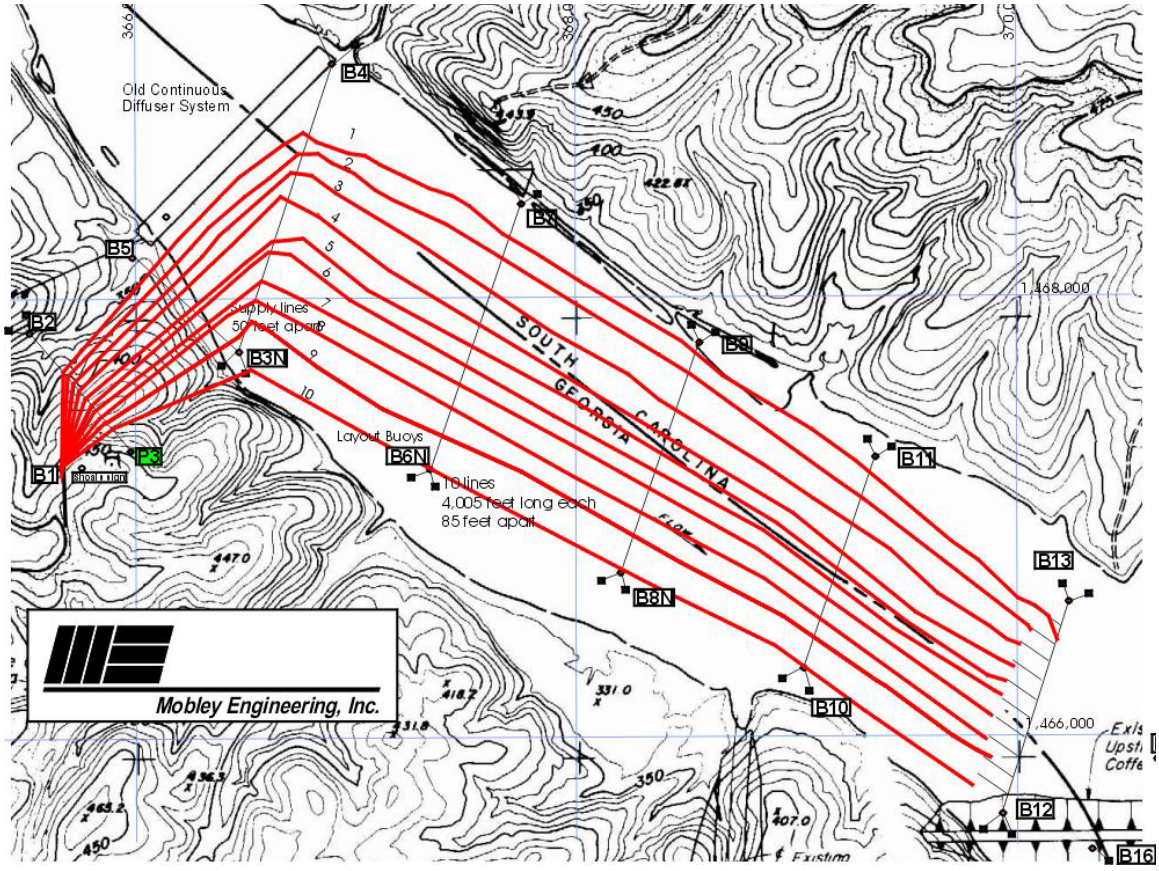
Introduction:

Since 1985, the Richard B. Russell hydro project on the Savannah River near Calhoun Falls, South Carolina has used pure oxygen distributed in the reservoir to meet water quality requirements in the hydropower releases. The project uses up to $1M worth of oxygen each year to maintain dissolved oxygen levels. The original oxygen diffuser system included diffuser lines immediately upstream of the dam to operate with turbine use and 2,000 feet of diffuser approximately one mile upstream of the dam to operate continuously. All of these diffusers were originally equipped with ceramic diffuser heads that required chemical cleaning, and frequent maintenance. Over the years, the use of the diffusers immediately upstream of the dam was discontinued. About one half of the ceramic diffuser heads on the continuous diffuser were replaced with membrane diffusers to reduce clogging. Nevertheless, leaks and uneven oxygen distribution continued to be a problem.

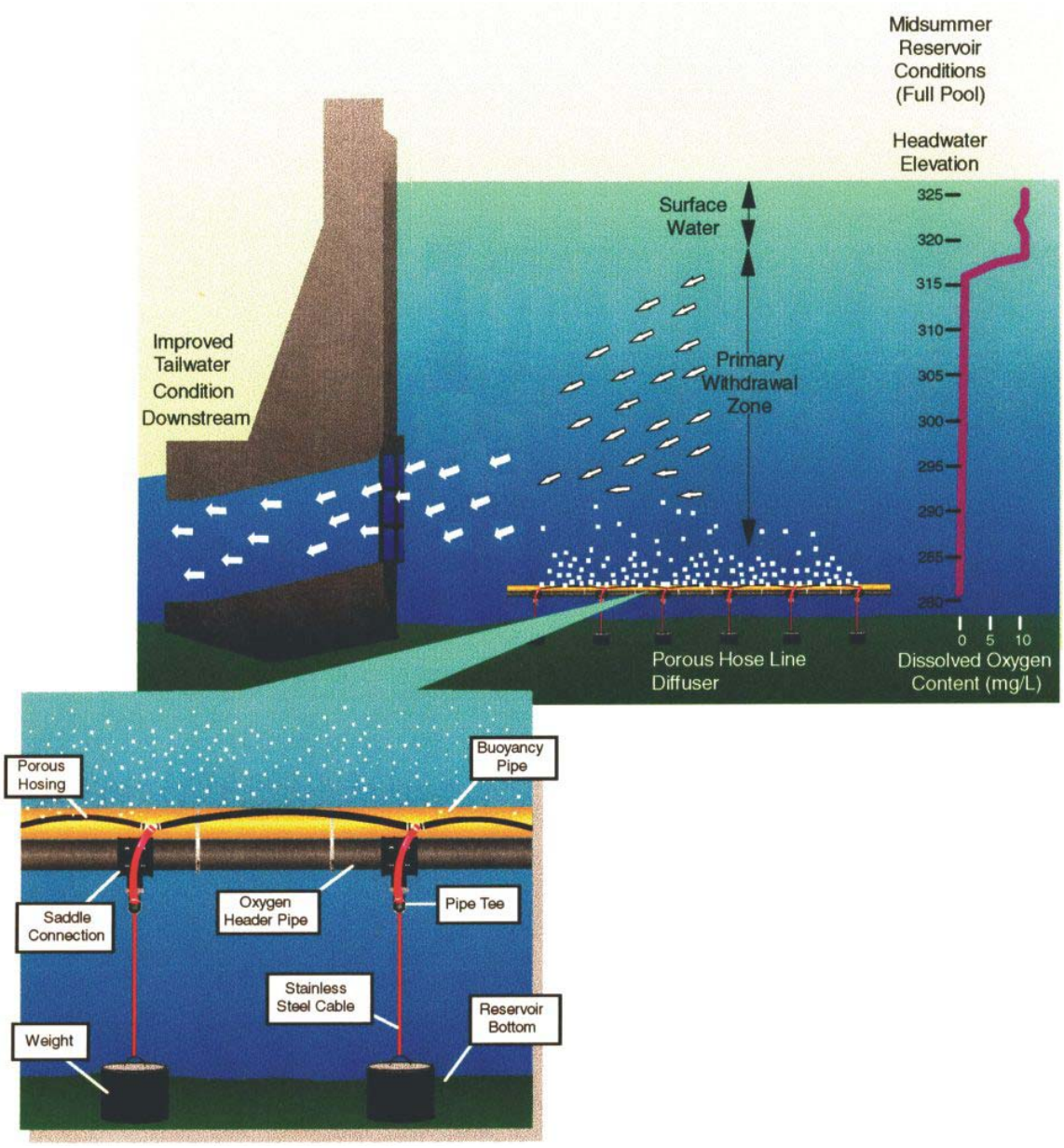
Line Diffuser:

In 2001, the original continuous diffuser was replaced with a porous hose line diffuser design that has ten lines, each 4,000 feet long extending along the old river channel upstream of the Richard B. Russell dam. The oxygen is distributed along the full length of each of these lines during operation, thus spreading the oxygen over a large area to achieve high oxygen transfer efficiencies and reduce oxygen expenditures.



Richard B Russell Oxygen Diffuser Layout

Individual supply lines to each diffuser were installed in a ½ mile trench from the existing oxygen supply facility along a peninsula near the diffuser locations. The diffuser installation in the reservoir was conducted from the surface without divers. The diffusers were assembled from a temporarily closed boat ramp and floated into final position in the reservoir in sections. Floating over a mile of diffuser piping at a time across a popular reservoir required seven workboats, deep anchor points, long rope spans and a patrol boat to warn public boaters. The workboats and anchor points were used to maintain the diffuser location despite changing wind conditions. Once the diffuser was satisfactorily floating above the final location, a buoyancy pipe chamber was pumped full of water to sink the diffuser in a controlled manner to the bottom. This process can be reversed to retrieve the diffuser for maintenance or repositioning.



Line Diffuser Schematic

Initial Operation:

The diffuser installation was completed with some preliminary testing in September 2001. Results indicated some disparity in the individual diffuser line flows and difficulty in obtaining full system design flow during test conditions that included temporary piping and flow control.

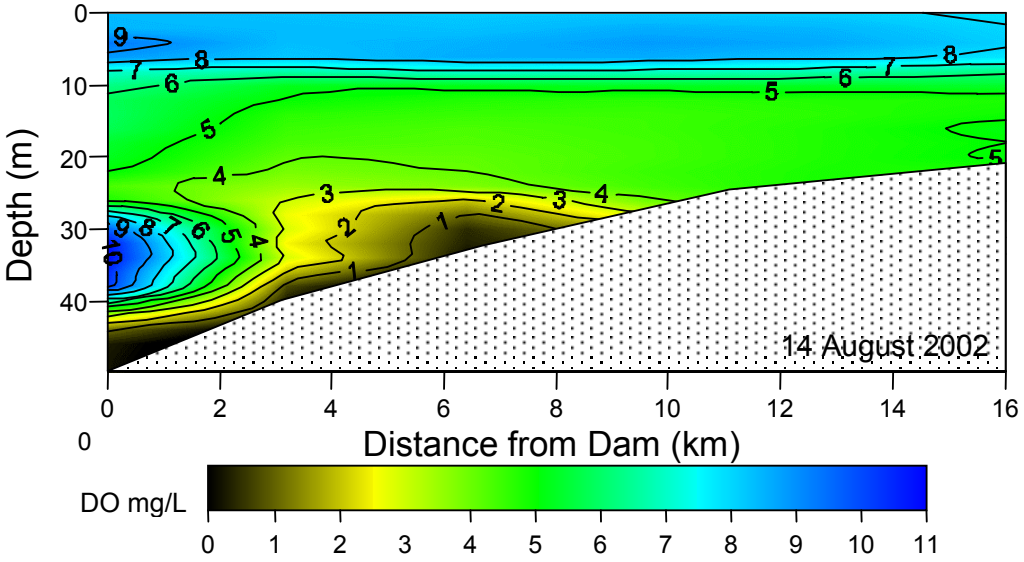
Oxygen Supply Facility Modifications

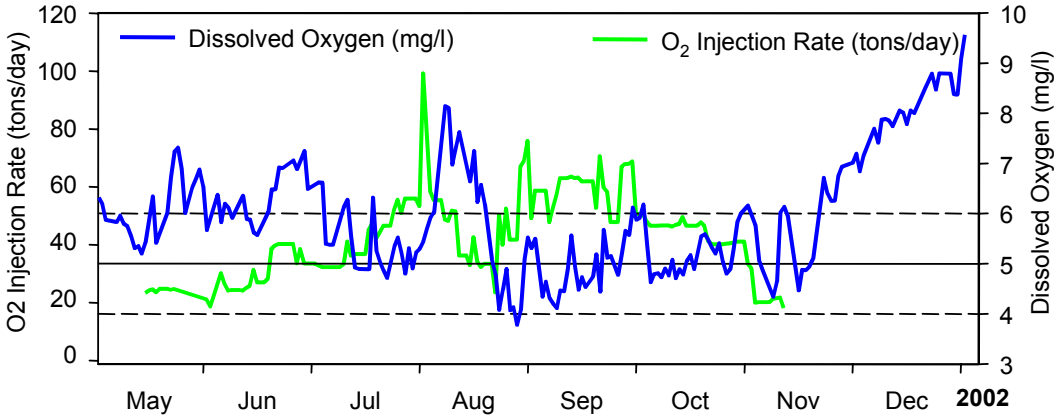
During 2002, the existing liquid oxygen supply facility was modified to reliably achieve the maximum design flow capacity, a new oxygen flow control system was completed, and several diffuser lines were modified to provide better flow capacity. The WaterView® performance monitoring system was installed to monitor operation of the oxygen system, provide annunciation of system alarms, and provide remote control from the powerhouse of the valves that control individual line flows. Startup testing was completed in August 2002 including operation of the system at over 200 tons of oxygen per day.

Richard B Russell Oxygen Distribution and Flow Control Manifold

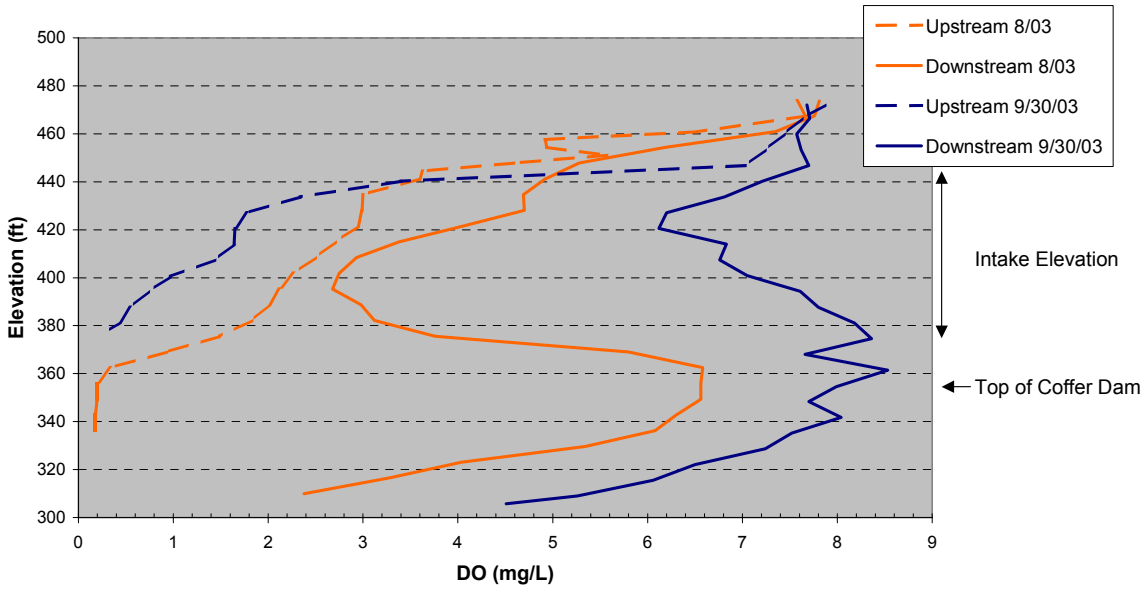
Results:

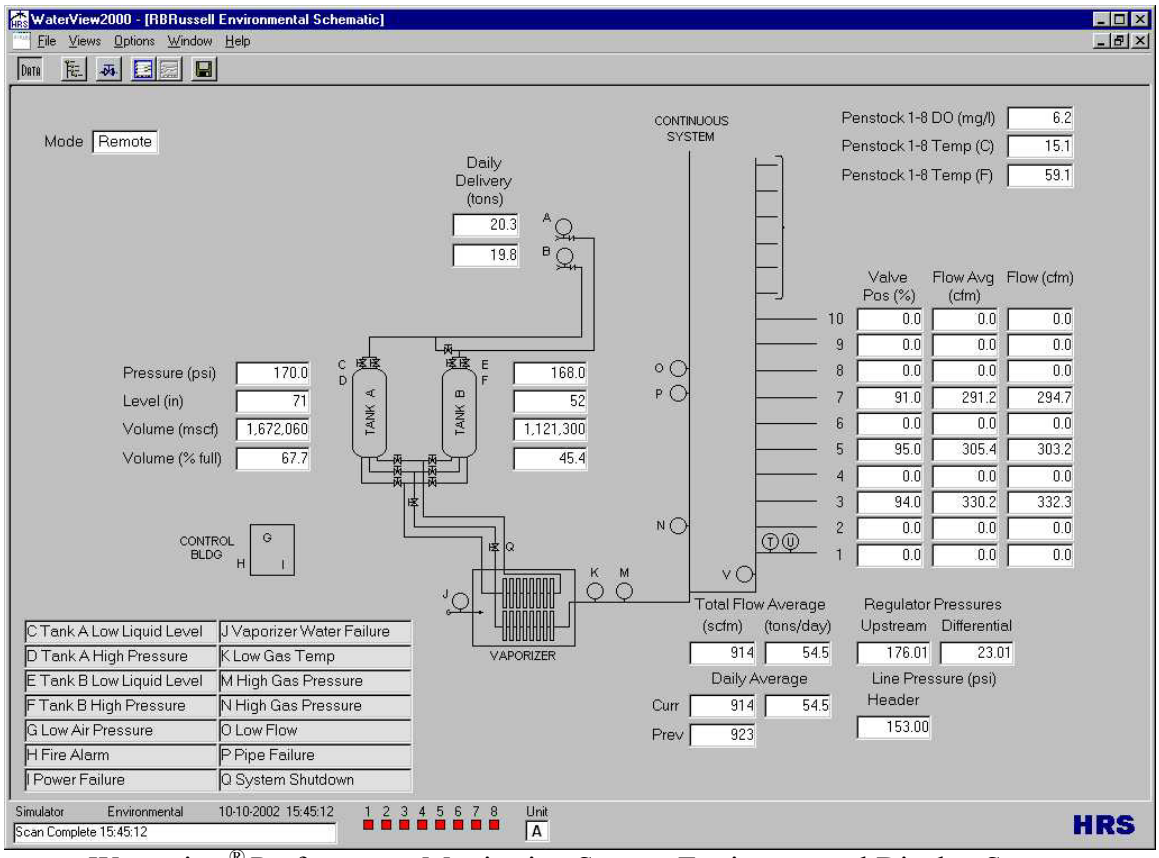
The oxygen system was operated successfully for the remainder of the 2002 season and all of the 2003 season to maintain release dissolved oxygen levels. Late in 2003, an additional diffuser line was run laterally on top of an old cofferdam near the powerhouse to distribute some of the oxygen input higher and closer to the dam.





Richard B Russell Profiles





Waterview® Performance Monitoring System Environmental Display Screen

Conclusion:

The new diffuser system at Richard B. Russell offers tremendous flexibility with individual control of each diffuser line, but this system places oxygen differently in the reservoir from what the operators are accustomed to and continued monitoring will be required to optimize the operation. Compared to the old continuous system, the line diffuser places oxygen much lower in the reservoir due to the low energy bubble plume and high oxygen transfer efficiency of its design. The oxygen input is also spread over almost a mile in the forebay instead of a single cross-section point. Thus, the operation characteristics of the new diffuser system will require new approaches to optimize the timing and rate of the oxygen placement to meet release DO requirements. The WaterView® performance monitoring system will provide valuable control and monitoring functions as the diffuser operations are adjusted to match turbine operation, total water flow and seasonal oxygen demands in the reservoir. Flexibility in oxygen placement, monitoring and control will be even more important in meeting the more complicated demands of maintaining downstream DO requirements with the re-initiation of pumped storage operations at Richard B. Russell.