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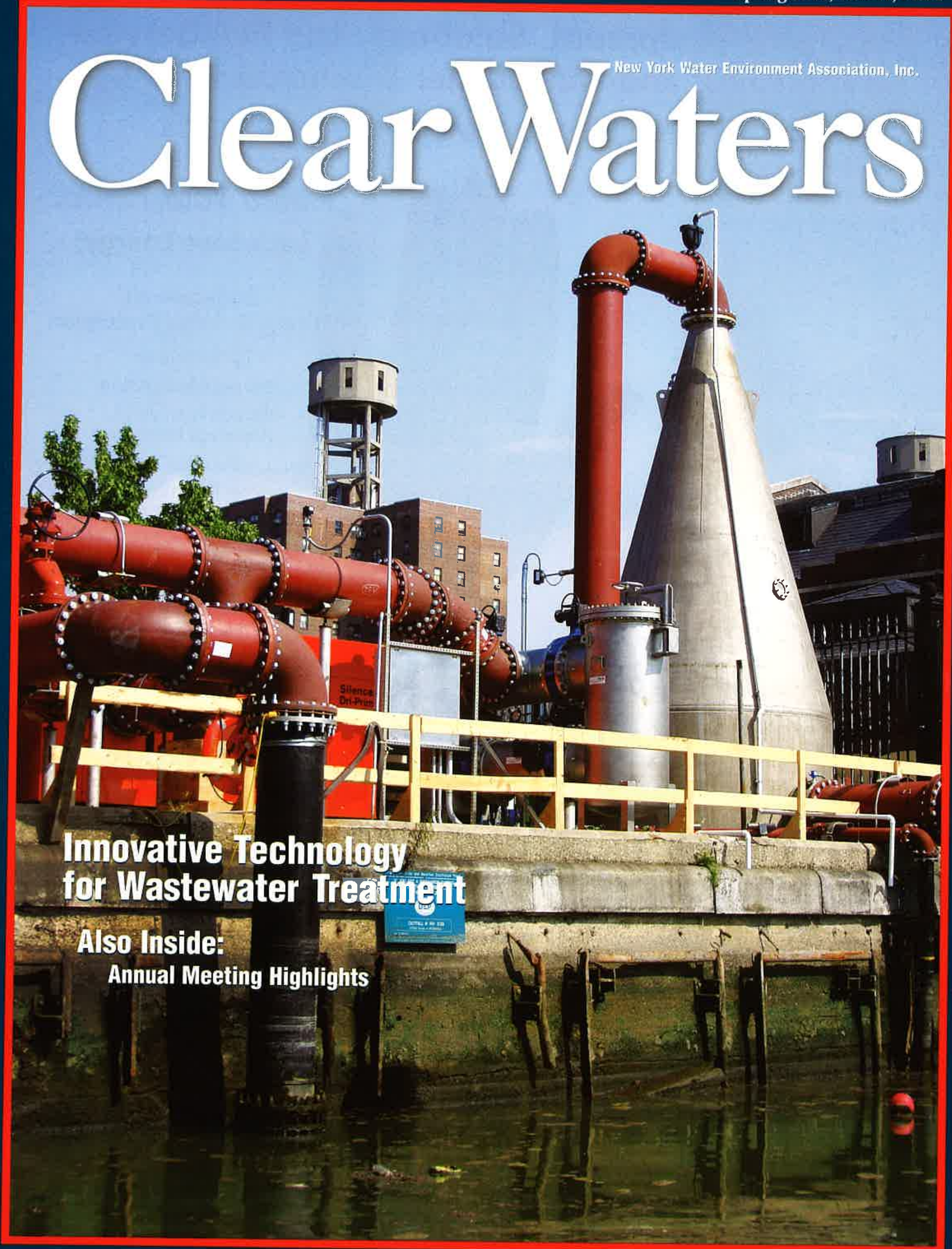
New York Water Environment Association, Inc.

Clear Waters



Innovative Technology for Wastewater Treatment

Also Inside:

Annual Meeting Highlights

Superoxygenation: Managing Dissolved Oxygen in Water Ways

by David Clidence

Our national water ways are essential to the public health and welfare of our nation. Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of our country and as the country's population continues to rise, so too does the water demand. The urgency of restoring and maintaining our water ways have caused the US Environmental Protection Agency (USEPA), state and local agencies to institute a number of environmental regulations including strict water quality permitting and compliance, and total maximum daily load (TMDL) limits.

One critical water quality parameter to measure the health of a water body is dissolved oxygen (DO). Natural levels of DO in our water ways are being depleted as a result of rising temperatures, increased water usage, excess nutrient loading and increased organic loading. Low levels of DO have a number of negative environmental effects. Fish impairment and kills, hydrogen sulfide (H_2S) production, mercury methylation, the release of phosphorus, iron and manganese from the sediments are all directly related to anaerobic conditions caused by low levels of DO. High levels of DO not only prevent these negative impacts, they help increase the speed of remediation and the restoration of water ways impaired by low DO.

Responsible management techniques can be used to limit excess nutrients and organic loading. In many situations, these techniques are either not enough or not feasible to prevent decreases in DO levels. In these applications, supplemental DO through "superoxygenation" has proven to be an effective, environmentally friendly and economical means to manage DO in water ways.

Supplementing Dissolved Oxygen

Superoxygenation is a process to dissolve pure oxygen into water to supplement DO into receiving water ways. Superoxygenation systems are designed by Eco Oxygen Technologies, LLC (or ECO_2). The superoxygenation system, also known as the Speece Cone technology, is based upon the scientific principle of Henry's Law. (William Henry's gas law states the saturation concentration of a gas dissolved in a liquid is a function of the partial pressure of the gas in contact with the liquid.)

The Speece Cone is designed to provide enough inlet water velocity to break up the oxygen gas entering the cone. This action forms an intense bubble swarm which has exceptionally large oxygen and water interface. As the bubble swarm grows, the cone's diameter increases thereby reducing the water velocity to a point lower than the buoyant velocity of the bubbles. This prevents the bubbles from escaping and holds them in suspension until they are dissolved.

The system's oxygen transfer efficiency is 90 to 95 percent. Depending on the pressure in the system, DO levels can be increased to 40 to150 mg/L, or above. There are no internal baffles or static mixers, nor are there any moving parts in the cone that would require maintenance.

Conventional aeration systems elevate DO, but require high energy costs and limit the DO boost that can be achieved. Furthermore, air in contact with water under pressure increases the dissolved nitrogen concentration above 100 percent saturation which can adversely affect fish. Typical aeration systems require 2,000 kWhr/ton of dissolved oxygen. The superoxygenation achieves DO concentrations of 40 to 150 mg/L with 90 to 95 percent oxygen absorption efficiency at 400 kWhr/ton – 1,000 kWhr/ton of dissolved oxygen. With this system, it is possible to pull a side stream from the body of water, superoxygenate it and dilute it back into the main body of water to satisfy DO deficiencies without treating the entire body of water.

The system can be installed in a small footprint, above or below water surface or even mounted on barges which can then be moved to wherever and whenever needed. The flexibility and efficiency of the superoxygenation system makes it successful in meeting DO discharge requirements and aiding in the recovery of impaired rivers and lakes. The superoxygenation system, a simple process with no chemicals and no moving parts other than standard industrial water pumps, also is viewed as an effective, environmentally-friendly green technology that can be used in a variety of settings.

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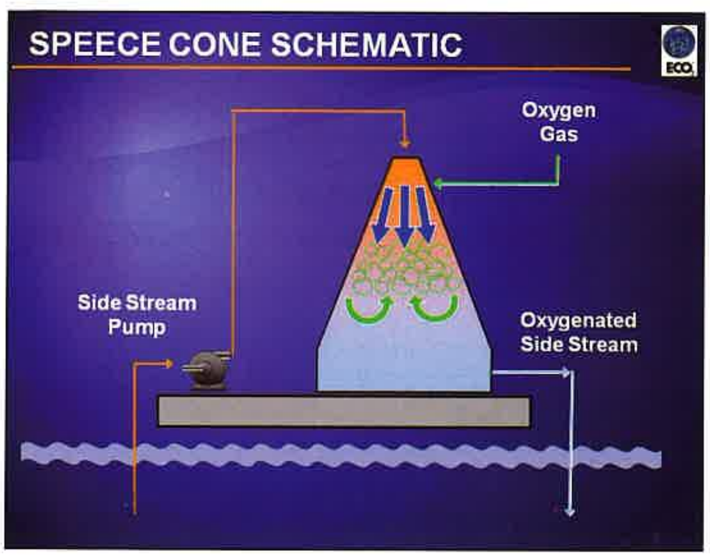

Courtesy of ECO_2

Schematic diagram outlines the operation of the Speece Cone.

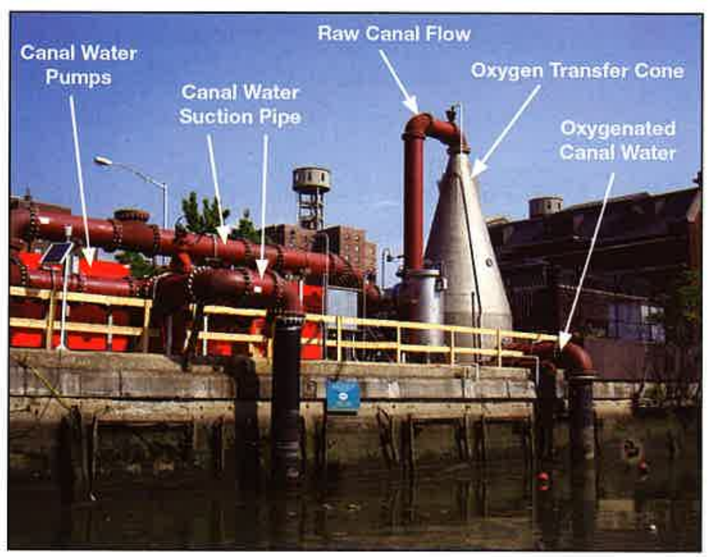

Photo by D&B Consulting Engineers

The superoxygenation system was installed in the Gowanus Canal, Brooklyn, New York. ***(Read more about the project on page 55).***

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Photo by David Clidence, ECO_2

Gowanus Canal cone unit

Photo by David Clidence, ECO_2

Superoxygenation system was installed here at Kennebunk, Maine for dissolved oxygen compliance of total maximum daily load.

Areas of Use

Polluted Water Ways: Superoxygenation can help aid in the biological recovery of polluted water ways. Gowanus Canal is a 30-meter wide, 2,400-meter long enclosed tidal basin located in western Brooklyn, New York, adjacent to Upper New York Bay. This canal has been historically polluted by industrial waste, CSO discharge and urban runoff. The New York City Department of Environmental Protection (NYCDEP) in conjunction with Dvirka and Bartilucci Consulting Engineers designed an interim oxygen transfer system to add DO to the canal as part of its Combined Sewer Overflow Long-Term Control Plan (LTCP) effort. The NYCDEP installed a superoxygenation system whereby canal water is withdrawn, oxygenated, and returned via a diffuser system. The system is currently in operation and is maintaining satisfactory oxygen levels throughout the length of the canal *(read article on page 55 for more description of this project).*

TMDL Compliance: Dissolved oxygen impairment is the most frequent source of TMDL violations and is usually associated with excess biochemical oxygen demand (BOD), low re-aeration characteristics of receiving waters, or nonpoint source pollutants. Superoxygenation has been used to dissolve pure oxygen directly into water ways to bring them into DO compliance with their TMDL.

Superoxygenation can be located and used directly at the water body or located at point source discharges. Installed directly on the water body, the superoxygenation system would withdraw a side stream of water, superoxygenate it and return the oxygenated water back to the receiving water body. The oxygenated water would be returned through a diffuser pipe to distribute the oxygenated water into the water body. A study of the Snake River in Wyoming, which has insufficient DO because of excessive nonpoint phosphorus loading, found that superoxygenation could be supplemented directly to the river to achieve TMDL DO standards for only 3 percent of the cost of reducing nonpoint source phosphorus.

Superoxygeation can also be incorporated into point source discharges by raising the DO level in the effluent to offset the negative impact the residual BOD has on the receiving body. By using the new method, the DO of secondary treated effluents can be superoxygenated to a concentration equivalent to its ultimate BOD so that no net DO resources are extracted from the receiving waters, thus negating tertiary treatment. SuperOxygenation costs much less than tertiary removal of BOD.

Wastewater Treatment Outfalls: Some states require that treated wastewaters have a DO which is commensurate with the DO standard for the receiving water or higher, for example, 5 mg/L or higher. Commonly, wastewater treatment effluents contain only 0 to 2 mg/L, unless some provision is made to post-aerate the secondary effluent. A strong and rational argument has been made by some cities and industries to their State Water Quality Boards that has allowed them to discharge additional BOD in their effluent if they also supplement additional DO into their effluent. For instance, if a treated wastewater effluent contained 30 mg/L of ultimate BOD and the effluent was supplemented with an equal 30 mg/L of DO, then no additional oxygen resources in the river would be required to completely stabilize the residual organics in the effluent. For example, superoxygenation could help the water quality of Long Island Sound. If the City of New York supplemented 30 mg/L of DO in all of their wastewater discharges into Long Island Sound (about 1 billion gallons per day), this would amount to 250,000 pounds of DO per day, which would help to solve the low DO conditions prevalent there due to phosphorus induced algae growth.

Harbor Deepening: Proposed deepening of parts of the nation's harbors is needed in order to accommodate larger deep-draft ships. Without deepening, ports are at risk of losing significant business and revenue to other coastal ports that can accommodate the growing

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number of larger ships. Unfortunately, harbor deepening also has the unintended consequence of reducing atmospheric re-aeration into the harbor's deepened water column. This reduced re-aeration can result in reduced DO concentrations, particularly during the critical summer season when river temperatures rise and lower river flows prevail. Superoxygenation can be used to supplement the DO lost due to reduced re-aeration from river deepening.

Portions of Savannah Harbor do not consistently meet acceptable DO criteria during the critical season. The harbor is on Georgia's Section 303(d) list for impaired waters that do not comply with water quality standards for DO. A superoxygenation system was successfully piloted in Savannah Harbor to dissolve 20,000 pounds per day of DO into the harbor.

Drinkwater Reservoirs: Superoxygenation also addresses water quality problems associated with deep reservoir thermal stratification. Influent runoff combined with algal growth within the lake basin itself, lead to the accumulation of large volumes of organic sediments on lake bottoms. During summer stratification, microbial breakdown of these organic sediments exerts oxygen demand that leads to the depletion of oxygen in the lake hypolimnion – the cold lower layer of water that is noncirculating.

Anaerobic conditions form and are the cause of a number of negative environmental consequences including the release of iron and manganese from the bottom sediments to the overlying water as well as the formation of malodorous and corrosive hydrogen sulfide. The resulting anaerobic sediment and water interface also allows phosphorus to be recycled into overlying waters at rates several orders of magnitude greater than under aerobic conditions. High nitrogen and phosphorus concentrations in lakes have been determined to be the primary cause of excessive summer algae biomass, which can lead to major water quality issues.

The New York City Water Department withdraws cold hypolimnion water from stratified New York State reservoirs. During the summer months, these reservoirs may have to be taken off line due to the lack of DO caused by algae proliferation in warm surface waters. The decay of this excess algae causes anaerobic conditions, which allow iron and manganese release and hydrogen sulfide production in the hypolimnion. These reservoirs must be taken off line until colder weather mixes and destratifies them. Successful direct supplementation of superoxygenation to the hypolimnion, however, would avoid seasonal closing of the drinking water sources while at the same time prevent destratification of the reservoir. Stratification must

Photo by David Clidence, ECO2

Superoxygenation was employed in the drinking water Marston Reservoir in Denver, Colorado

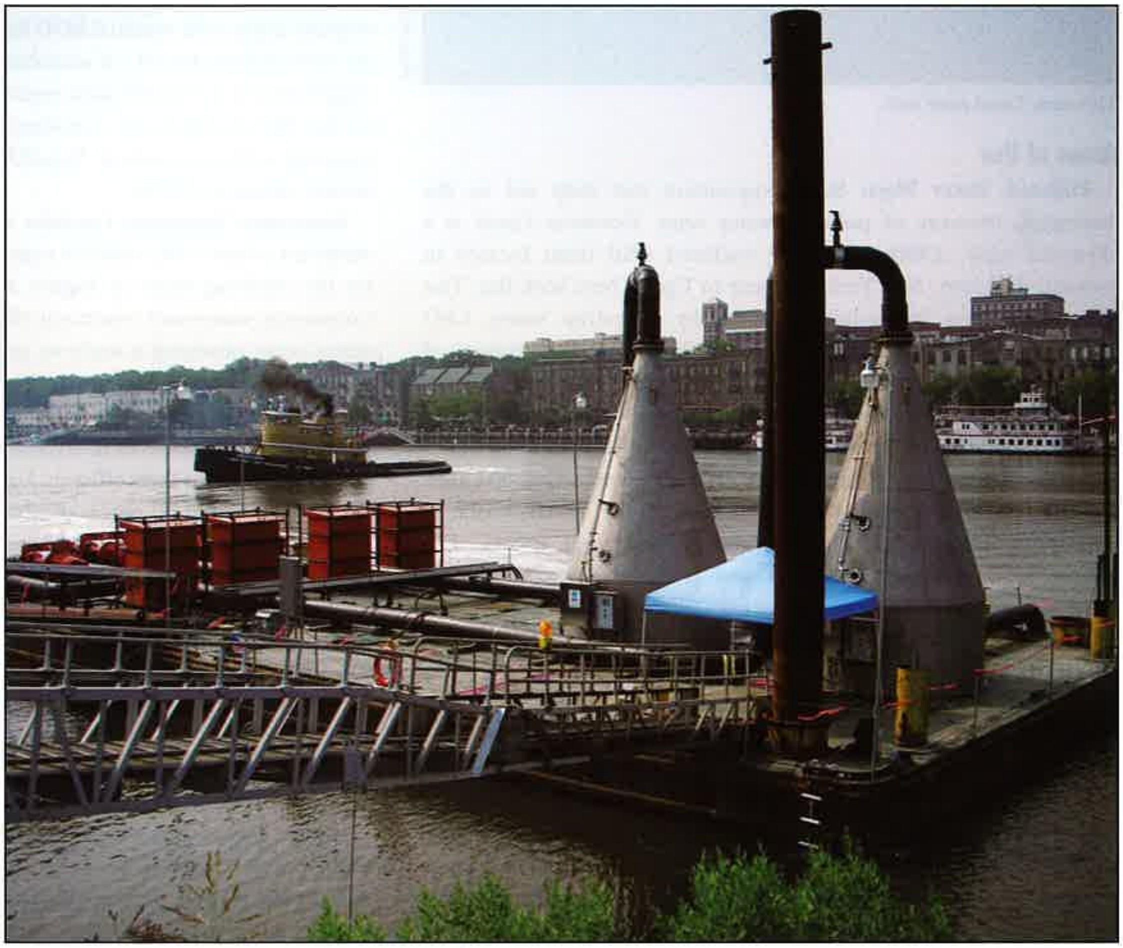

Photo by David Clidence, ECO2

Superoxygenation was installed to correct dissolved oxygen after deepening of Savannah Harbor.

be maintained in order to provide cold temperature drinking water and to protect the cold water fishery. In addition, the potential problem of dissolved nitrogen supersaturation and artificial destratification, which arises when air is injected below the water surface, can be avoided in rivers, canals and reservoirs when superoxygenation is employed as the treatment method.

Role Critical to Water Ways

As the nation monitors its most indispensable resource, greater emphasis is placed on protecting and restoring its water ways. Dissolved oxygen plays an important role in the health of all these water ways. Adequate DO levels are needed to: prevent iron, manganese and hydrogen sulfide production in drinking water reservoirs; improve impaired water ways; mitigate effects of harbor deepening; offset residual BOD in wastewater treatment plant effluent; and, help meet TMDL limits. Superoxygenation is an effective and economical tool of the water treatment industry in supplementing DO to enhance water quality and maintain this nation's most important resource.

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