Aqua Link, Inc.
Water Resources & Watershed Management

Schultz Lake
Lake Water Quality Summary Report
Evaluation of AirLift Aeration System

Aqua Link, Inc. was retained to assess whether the water quality of Schultz Lake has improved since 2002. Schultz Lake, a 20.5-acre impoundment, is located in near the Town of Tunkhannock in Wyoming County, Pennsylvania. In 2002, Schultz Lake was intensively studied as part of the Smales and Schultz Lakes Phase I Diagnostic-Feasibility Study. Smales Lake is an upstream lake (impoundment) that directly flows into lake. **One of the key recommendations offered in the Phase I Study Report was to install a diffused-air aeration system in Schultz Lake to improve lake water quality.**

1. Summary of the Phase I Study

In 2002, Aqua Link, Inc. assessed the water quality of Schultz Lake. Overall, the lake is best described as a moderately deep, dimictic lake. Dimictic lakes are those lakes that turn over (completely mixing) twice annually and typically remain thermally stratified throughout the entire growing season. The mean and maximum water depths of the lake are 7.5 and 19.0 feet (2.3 and 5.8 meters), respectively. Water temperatures were stratified during the months of June through August in 2002. The greatest degree of thermal stratification occurred on June 27th where the surface and bottom water temperatures were 28.1° C (82.5° F) and 12.0° C (53.6° F), respectively. Dissolved oxygen concentrations were strongly stratified when the lake was thermally stratified during the months of June through August. During this period, dissolved oxygen levels in the lake's hypolimnion typically fell below 1.0 mg/L (millgrams per liter). The greatest degree of dissolved oxygen depletion was observed on June 27th. On this study date, dissolved oxygen concentrations were less than 1.0 mg/l at water depths ranging from approximately 2.2 to 5.8 meters (9.8 to 19.2 feet).

Based upon the 2002 report, Schultz Lake was classified as eutrophic (highly productive). The mean Carlson's Trophic State Index (TSI) values for total phosphorus, Secchi disk transparency and chlorophyll-a for Schultz Lake were 53, 53 and 59, respectively. The 2002 data indicates that phosphorus is the limiting nutrient and therefore, phosphorus will likely determine the overall level of aquatic productivity or degree of eutrophication in Schultz Lake. Low dissolved oxygen levels in the deeper bottom waters (hypolimnion) are exacerbating the internal release of nutrients (phosphorus and nitrogen) from lake sediments. In turn, these nutrients are allowing for additional algae growth resulting in poorer water clarity. Lastly, low dissolved oxygen concentrations are promoting the formation of toxic forms of ammonia nitrogen. Both low dissolved oxygen concentrations and ammonia nitrogen are adversely impacting the ecological health of the lake's warmwater fishery.

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In general, oligotrophic lakes are typically clear and deep with low quantities of phytoplankton (microscopic free-floating aquatic plants or algae) and rooted aquatic plants. In these lakes, the deeper, colder waters are generally well oxygenated and often capable of supporting coldwater fish such as trout. Conversely, lakes with high nutrient levels and high levels of aquatic productivity are referred to as eutrophic. Eutrophic lakes are generally more turbid and shallower due to the deposition of sediments and the accumulation of detritus (e.g., dead aquatic plants, leaf litter). If deep enough, the bottom waters of eutrophic lakes are generally less oxygenated or may be devoid of dissolved oxygen (anoxic). Eutrophic lakes are often capable of supporting warmwater fish such as bluegill and bass. Mesotrophic lakes are somewhere in between oligotrophic and eutrophic lakes. These lakes contain moderate levels of nutrients and moderate levels of aquatic productivity.

2. Installation and Operation of AirLift Aeration System

In the Fall 2005, a custom **AirLift diffused-air aeration system, manufactured by Hydro Logic Products** (www.HydroLogicProducts.com), was installed Schultz Lake. The custom aeration system consisted of a single custom cabinet containing three 1/3 H.P dual piston air compressors, four AirPod XL air diffusers and 2,500 feet of DownUnder self-weighted air supply tubing. This custom AirLift aeration system is equivalent to installing two standard AirLift aeration systems: one AirLift 1XL system and one AirLift 3XL system.

The AirLift aeration system was first turned on in April 2006 and was allowed to run through September 2006. In October 2006, the aeration system was turned off and remained turned off through March 2007. Once again, the AirLift aeration system was turned back on in April 2007 and remained fully operational through September 2007.

3. Lake Monitoring Program for 2007

Similar to the 2002 Phase I Study, Aqua Link, Inc. visited the study lake monthly from June through August in 2007. On each study date, Aqua Link visually inspected the overall appearance and ecological condition of the lake using a 17-foot boat equipped with an outboard motor, and a Lowrance depth and GPS chart recorder. Next, Aqua Link collected both in-situ lake water quality data and lake water samples at Station SH1. Station SH1, which is located in the deepest part of the lake near its dam, is the same lake station that Aqua Link monitored during the 2002 Phase I Study.

In-situ lake water quality data were collected incrementally from the surface to the bottom of the lake using a YSI (Yellow Springs Instruments) 610-D data logger interfaced to a YSI 600XL Sonde. The YSI data logger and Sonde were used to collect the following data: water temperature, dissolved oxygen, conductivity, specific conductance, pH, total dissolved solids, oxidation reduction potential

(ORP) and salinity. In addition, Secchi disk transparency (water clarity) was measured and recorded using a standard 8-inch (20 cm) freshwater Secchi disk.

Lake water samples were collected at two different depths. Surface samples were collected 0.5 meters (1.6 feet) below the lake's surface and bottom samples were collected 0.5 meters (1.6 feet) above the lake sediments. All water samples were collected using a Kemmerer water sampler unit. Once collected, all water samples were placed in bottles, preserved accordingly in the field, and then shipped to the certified contract laboratory for further analysis. The collected surface water samples were analyzed for total phosphorus, dissolved reactive phosphorus (namely orthophosphorus), nitrate, nitrite, ammonia, total Kjeldahl nitrogen, total suspended solids and chlorophyll-a. The bottom water samples were analyzed for all of the above parameters except chlorophyll-a.

4. Lake Water Quality Data – Results and Discussion

Schultz Lake was completely mixed (thermally destratified) during the Summer 2007. Dissolved oxygen concentrations were generally considered very good to excellent at all water depths. In contrast, the lake was layered (thermally stratified) during the Summer 2002 prior to aeration. During the Summer 2002 (June through August), dissolved oxygen concentrations were extremely low with values recorded less than 1 mg/L (milligram per liter) in the bottom waters.

In 2007, the total phosphorus concentrations for surface and bottom waters improved and significantly improved, respectively. The chlorophyll-a concentrations and Secchi disk transparency also improved in 2007. Chlorophyll-a is a photosynthetic pigment found in all aquatic plants (including algae) and indicates how much algae is present in lakes. Based upon the Phase I Study, it was determined that phosphorus was the limiting nutrient in Schultz Lake. Therefore, decreased amounts of phosphorus concentrations in the lake allowed for less algal growth resulting in better lake water clarity (transparency). The significantly lower total phosphorus concentrations in the surface and bottom waters in 2007 are directly related to aeration. It appears that by keeping the bottom waters well oxygenated, lake aeration has significantly reduced the internal release of dissolved reactive phosphorus from lake sediments. The decrease in phosphorus concentrations in the bottom waters is also well correlated to decrease specific conductance and increased ORP values measured in the field.

In 2007, the total nitrogen concentrations dramatically decreased in the bottom waters and only slightly increased in the surface waters. The huge decrease in the bottom waters is due to maintaining high dissolved oxygen levels in the bottom waters. Under such conditions, ammonia nitrogen including its toxic forms is converted to nitrate nitrogen and ammonia gas. Conversely, the very slight increase of total nitrogen in the surface waters is simply an artifact of mixing nutrient enriched bottom waters with the surface waters. Overall, the water quality data clearly suggests an overview decrease of total nitrogen within the entire lake system.

5. Summary

Based upon our assessment, lake aeration has significantly improved the water quality of Schultz Lake. Presently, the lake is thoroughly mixed and well oxygenated from surface to bottom. This phenomenon has allowed in-lake phosphorus concentrations to significantly decrease, thereby promoting less growth of algae (low concentrations of chlorophyll-a) and improved water clarity (transparency). In addition, high dissolved oxygen concentrations in the bottom water have allowed for a substantial decrease the internal release of nutrients by anoxic lake sediments. Potentially toxic ammonia nitrogen was virtually eliminated from the lake due to its conversion to nitrate nitrogen and nitrogen gas under oxygenated conditions. Lastly, our field observations during the study dates indicate the largemouth bass, bluegill and crappie fishery appears to be in excellent condition. We observed large bass and bluegill spawning in early June. Young-of-year of both species also were observed in the lake in August.