

Eau Pleine Reservoir Aeration System

Dissolved Oxygen Monitoring, Aerator Operations, and Costs

Introduction – In 1981 Wisconsin Valley Improvement Company (WVIC) joined in a cooperative effort with the Wisconsin DNR and the Marathon County Parks Department to help mitigate the effects of dissolved oxygen (D.O.) depletion in the Eau Pleine Reservoir during the winter period. The project involved the installation and operation of a diffuser aeration system in the reservoir near the Big Eau Pleine County Park. The reservoir historically experienced late-winter fish kills that resulted from oxygen depletion.

The purpose for the aeration system was to help minimize the occurrence of winter fish kills by creating 30-60 acres of open water for natural surface aeration and to an extent, promote oxygen transfer to the water column. Aerator operation helps create a limited refuge for fish. The system helps mitigate low D.O. conditions that occur from the decomposition of organic material carried into the reservoir as well as organic material generated within the reservoir from blue-green algal blooms.

As a part of aerator operations WVIC has implemented several reservoir operational measures to help further minimize low D.O. problems. Those measures have included D.O. monitoring, coordinating operation of the aeration system with the agencies, controlling reservoir releases in conjunction with aeration, raising the minimum water level four feet to ensure an adequate depth of water over the aerator diffusers and consultation with the agencies. These represent standard operating procedures.

Reservoir D.O. Monitoring - WVIC monitors D.O. and biological oxygen demand (BOD) at every reservoir mile or 18 miles from the dam to Spindler's Bridge weekly or every two weeks as conditions warrant. D.O. and temperature profiles are measured in the original river channel (deepest depth) at each mile. Monitoring is initiated in early January and continues until ice conditions are unsafe which generally coincides with ice-out.

The D.O. monitoring results are plotted on a cross-section profile of the reservoir to characterize oxygen conditions and identify D.O. sags when and where they develop. Historically, two D.O. sags can develop in the reservoir. One D.O. sag can develop upstream from the aerator and the second can develop downstream in the lower four miles of the reservoir.

For the upstream D.O. sag, a mini-model is used to calculate the rate of movement of the D.O. sag. The BOD measurements are used to identify the potential severity of the D.O. sag. This information combined characterizes the magnitude and severity of the D.O. sag (horizontally and vertically) and its movement. This is employed to determine (trigger) when the aeration system should be turned on in advance of the approaching D.O. sag as it moves downstream. The operation of the gates at the dam can be used, to a certain extent, to regulate or control the rate of movement of the D.O. sag when necessary. The results of D.O. monitoring and BOD measurements are given to the DNR weekly followed by consultation for determining start-up of the aeration system.

The downstream D.O. sag develops on the reservoir bottom and rises vertically. The magnitude and severity of this D.O. sag varies from year to year depending on accumulation of organic material and to some extent on reservoir gate operations.

Aerator Operation – The aerator PVC lines must be deiced during the winter prior to start-up and the safety fence must be installed and "Open Water" warning signs erected on site and at the boat landing access points. The aeration system has been operated every winter since installation, except in 1999, 2002, 2003 and 2006. In those years, favorable reservoir oxygen conditions precluded the need for aeration. The length of time the aerator operates varies from year to year and has ranged from 6 days to 74 days with an average over the last 10 years (when it operated) of 35 days.

Operating Costs - The electrical operating costs for the aeration system currently average approximately \$136/day. This cost varies slightly over the operating period depending on the head or depth of water over the PVC aerator lines in the reservoir.

Proposed Aeration System Upgrades, Rationale and Costs

The equipment in the aerator building supplies the air flow during the winter through 14 PVC aeration lines located on the reservoir bottom. The aerator lines fan out over a one mile area from the aerator building. The 14 PVC lines range in length from 700 ft to 2,200 ft and total approximately 22,000 ft. Over the years, some of this equipment has degraded and it is also believed that the aeration requirements have increased due to increased non-point source runoff from the Eau Pleine Reservoir watershed. A discussion of the recommended upgrades in response to these factors is presented below.

The proposed upgrades can be separated into two categories: “Aerator Building” and “PVC Aeration Lines”. The proposed upgrades would increase the aeration system’s operating capacities beyond its original design. This would be achieved by increasing the blower speeds and therefore increasing the volume of air pumped into the reservoir by up to 40% over the original design. To accommodate the increased volume of air, the original 1½ inch PVC lines, which have deteriorated over the past 28 years, would be upgraded and replaced with 2 inch lines. The increased air volume pumped into the reservoir would help further mitigate low D.O. conditions and help maintain a limited refuge for the fishery.

Aerator Building – Upgrades to the mechanical equipment located in the aeration building would compliment the proposed upgrade of the aeration lines. The current lines are 1½ inch inside diameter (ID) and the proposed upgraded lines would be 2 inch (ID). This upgrade would allow up to 40% increase in airflow through the lines. To achieve this increase in airflow, the RPM of the two blowers in the aerator building could be increased from currently providing 377 Cubic Feet/Minute (CFM) each up to 530 CFM (40% increase) each.

Proposed aerator building and equipment upgrades below represent safety upgrades in equipment and also reflect advanced engineering standards:

- **Manifolds:** Fabricate & deliver (2) 6” CS sch. 80 pipes, 6’ long with pipe caps & (7) 2” half couplings, (1) 1” drain connection - \$1,500 ea. The manifolds to which the 14 PVC lines are attached do not meet today’s engineering design and safety standards and warrant replacement with new manifolds.
- **Blower Pressure Relief Valves:** Replace two 15 psig air relief valves w/ handles - \$500 ea. The blower pressure relief valves are old and unreliable and thus present a safety hazard and should be replaced.
- **Airflow Pressure Gauges:** Replace existing mercury manometer with two electronic pressure gauges – \$300 ea. The airflow pressure gauges are used for monitoring the psig of air into the PVC aeration lines. The existing two mercury manometer gauges represent an environmental and safety hazard and should be replaced with new electronic gauges.
- **Blower Speed Upgrades:** Replace existing V-belt compressor drives (2) - \$1000 ea. The blower speed upgrades will allow the blower speed to be increased from the current 2120 RPM (377 cfm) up to 2700 RPM (530 cfm).
- **Building Ventilation:** Purchase and install one 1000 cfm roof mounted, temperature controlled exhaust fan - \$1,500. The building ventilation will maintain a more uniform seasonal temperature and airflow through the building to eliminate stagnation of air and thus provide a better environment long-term for the electrical and mechanical equipment.

Total estimated cost: \$8,100 (Itemized on Table 1).

PVC Aeration Lines – Upgrading and replacing the entire field of PVC aeration lines is recommended so that larger lines (2” versus 1.5”) can be installed to take advantage of the increased air delivery proposed with the blower speed upgrades described under “Aerator Building” upgrades. The PVC aeration field size would remain largely the same with optimization of discharge port (orifice) placement in the deepest contours. This will create the desired open water area to enhance natural surface aeration and also allow the greatest contact time for the air to mix with the water column.

Total estimated cost: \$46,079.94 (Itemized on Table 1).

Total Combined Estimated Cost of Aerator Building and PVC Aeration Line Upgrades: \$54,179.94

Proposed Funding for Aeration System Upgrades

The Big Eau Pleine Citizens Organization (BEPCO) has offered to apply to Marathon County for a grant from the American Transmission Company (ATC) Mitigation Fund for the \$54,179.94 (Table 1.). The ATC Fund provides a 50/50 cost-share arrangement so \$27,089.97 would need to be matched. Of this amount, BEPCO has offered to contribute \$23,039.97 for the replacement and upgrade of the PVC lines. WVIC and DNR would contribute to BEPCO the funds for the aerator building upgrades or \$4,050 (50% of \$8,100).

Other Funding Contributions

WVIC In-Kind Service:

To date, WVIC has expended approximately \$4,250 in labor working with BEPCO and DNR in evaluating the aeration system and developing cost estimates for upgrades.

WVIC's In-kind contribution for removal of the existing 1½ inch PVC lines (22,000 ft) is valued at \$18,925 (Labor = \$16,400; equipment and travel = \$2,525). Eight days to remove the PVC lines - five WVIC employees.

WVIC's In-kind contribution for installation of the new 2 inch PVC lines (22,000 ft) is valued at \$9,325 (Labor = \$8,500; equipment and travel = \$825). Five days to install the PVC lines - five WVIC employees.

WVIC's total projected In-kind contribution including labor costs plus \$2,025 toward the Aerator Building Upgrade = \$34,525.

WVIC has also agreed to pay the cost of the electricity for operating the aeration system during the winter of 2010 (January – March). Value of \$2,000 - \$6,000 depending upon length of operation. WVIC will also be monitoring D.O. and Biological Oxygen Demand (BOD) conditions in the reservoir throughout the winter and coordinating aerator operation with the DNR.

Wisconsin DNR:

DNR staff will operate the aeration system during the winter 2010.

DNR staff time for operating the aeration system during the winter and erecting the safety fence should be calculated and credited to DNR.

DNR has purchased fiberglass poles and materials (\$3,100) for erecting the safety fence around the aerator system (open water), and will coordinate installation of the fence and warning signs with volunteer help and monitor the safety fence.

Proposed Schedule

Schedule of Tasks:

Remove old PVC aeration lines – WVIC would need to know if BEPCO is successful in obtaining the ATC grant no later than the end of August 2009. This would allow approximately five weeks (to the end of September) to schedule WVIC's crew and professional divers to begin removing the lines by early to mid-September.

Install New PVC lines – This would be conducted as soon as the ice is thick enough to support vehicles (12 inches). A root cutting machine would be used to cut slots in the ice on the survey coordinates for each PVC line so the PVC lines can be sunk in the reservoir. Need to allow 2 weeks to order and receive the PVC lines and associated hardware.

Proposed aerator building upgrades listed above could be completed anytime before December.

Table 1. Eau Pleine Reservoir Aeration System							
Cost Estimate for Upgrade of							
Aerator Building and Aeration Lines **							
<u>AERATOR BUILDING</u>							
<u>Custom Manufacturer</u>							
Manifolds				\$3,000.00			
<u>Ferguson Enterprises, Inc</u>							
Blower pressure relief valves				\$1,000.00			
<u>Simone Engineering</u>							
Air flow pressure gauges				\$600.00			
<u>Motion Industries</u>							
Blower speed upgrades				\$2,000.00			
<u>McMaster Carr</u>							
Building Ventilation				\$1,500.00			
				SubTotal =	\$8,100.00		
<u>PVC AERATION LINES</u>							
<u>Ferguson Enterprises, Inc - Aeration Line Materials</u>							
2" ID PESI 15NK100 (Aeration line)				\$19,261.00	(22,000 ft @ \$0.8755/ft)	Replace all 14 lines	
2" brass insert couplings				\$670.68	(36 @ \$18.63 ea)		
2" brass insert male adaptors				\$172.90	(14 @ \$12.35/ea)		
2" stainless steel threaded end caps				\$70.98	(14 @ \$5.07/ea)		
2" brass/nickel plated ball valves				\$536.34	(14 @ \$38.31/ea)		
2" brass male adapters for ball valves				\$172.90	(14 @ \$12.35/ea)		
Stainless steel hose clamps				\$85.14	(86 @ \$0.99/ea)		
Tooling for airline brass orifices				\$200.00			
				Aeration line materials =	\$21,169.94		
<u>Wausau Steel Corporation</u>							
5/8" rebar Grade 40				\$10,560.00	(22,000 ft @ \$0.48/ft)	Sink aeration lines	
Misc Materials				\$100.00			
				Rebar + misc =	\$10,660.00		
<u>J.F. Brennan Co., Inc. (Commercial Divers)</u>							
Mobilization/Demobilization				\$1,000.00			
3-person commercial dive team				\$13,250.00	(\$2,650/day @ 5 days)	contingency for assistance in removal of existing aeration lines.	
				\$14,250.00			
				SubTotal =	\$46,079.94		
				TOTAL =	\$54,179.94		

** Represents a complete upgrade from 1½ " PVC lines to 2 " PVC lines with all new associated hardware. This coupled with the increased blower speeds will increase the volume of air (cfm) by up to 40% delivered to the reservoir.								

Coon/My Documents: EP3 Aerator Updated Costs.doc