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Stephenville's engineered wetland facility completes NRC testing

By Laura Parsons

Stephenville, located on the west coast of Newfoundland, commissioned a new, state-of-the-art wastewater treatment facility in the fall of 2009. The facility was designed by Newfoundland and Labrador Consulting Engineers Ltd. (NLCEL), a Trow Global Company, to treat the combined sewer from the town.

It featured an Abydoz Engineered Wetland system to naturally treat the sewage and sludge through a series of sub-surface engineered wetlands (Figure 1). The $10-million facility received a considerable grant from the Federation of Canadian Municipalities Green Municipal Fund, and was featured at the National Wastewater Conference in Niagara Falls, Ontario, in 2009. The system is the largest sub-surface engineered wetland system in Canada, providing secondary sewage treatment.

During 2010, the National Research Council of Canada (NRC) partnered with Abydoz Environmental Inc. to test and evaluate the treatment results of the system. Throughout the year-long testing program, the system continuously reduced biological oxygen demand (BOD), and total suspended solids (TSS) levels, to well below discharge limits.

Figure 1. Aerial view of Stephenville wastewater treatment facility.

The technology

Abydoz Engineered Wetland systems are based on a patented technology, invented in Germany by Dr. Reinhold Kickuth, which uses sub-surface flow engineered wetland technology. The original European systems are now over 40 years old, and are not showing any sign of reduced performance. Abydoz Environmental Inc. is the licensed representative of the Kickuth technology in Canada.

Reed plants are used to transfer oxygen to the soil matrix, fostering aerobic microbial activity, which is used to biologically and chemically break down contaminants. It is capable of purifying a wide variety of domestic, municipal and industrial wastewaters, as well as municipal sludge. The treatment area is a stable, engineered ecosystem and is based on complex interrelationships between plants, soils and micro-organisms. A highly simplified illustration is shown in Figure 2.

Figure 2. Cross-section of Abydoz Engineered Wetland.

The effluent first enters a settling chamber/clarifier for primary treatment, where the majority of suspended solids are removed. It then enters the wetland beds for secondary treatment.

As the effluent flows sub-surface through the specialized matrix, it encounters oxygen-rich and oxygen-depleted zones. These "zones" create habitats for thousands of different types of bacteria. The primary zones are anaerobic (no dissolved oxygen), anoxic (no dissolved oxygen but contains nitrite/nitrate), and aerobic (contains dissolved oxygen). These bacteria consume the waste and break down the contaminants to produce a clean effluent.

The plants are specially adapted, nursery-produced reed plants, with superior oxygen transfer capabilities.

Description of process

The Stephenville Wastewater Treatment Facility is located on the Stephenville airport property. The subsurface flow ensures that the wetland does not attract water fowl, or other wildlife, thus enabling it to meet all airport requirements.

Combined sewer effluent from the town enters a small headworks building, where it passes through a spiral lift screen to remove gravel, solids and non-biodegradable matter greater than 9 mm in diameter. The flow then enters a primary clarifier to settle out approximately 70% of the suspended solids. From the clarifier, the flow is split eight ways and proceeds through the horizontal-flow wetland beds, where biological reduction takes place. It is then recombined and passes through two vertical beds, with final discharge to the ocean.

Municipal sludge is collected in the

clarifier by a chain-in-flight system and pumped to a solids holding tank, located below the control building. It is then taken by a pumper truck to the engineered wetland sludge treatment cells on the other side of the airport (Figure 3).

Reed plants dewater and mineralize sludge from the clarifier, producing a compost-like material. Liquid in the sludge is partly consumed by the plants and the remainder moves through the cells, leaving the solids behind. It is then treated by a small wetland bed, near the sludge treatment cells.

On-site sludge treatment provides significant cost savings by eliminating expensive sludge transportation and disposal costs. It also provides mineralized compost, that can be reused by the community after seven to 10 years in the cell.

The system uses no chemicals, few mechanical parts and minimal electricity to treat the wastewater and solids. Not only does this reduce operating and maintenance costs, but it makes for a more sustainable and natural way to treat the town's sewage.

Design requirements

The treatment system was designed to treat a population equivalent of 7,800 people, with an average flow of 4,555 m^3/day. The design objective was to reduce the inlet concentrations from 95 mg/L BOD and 110 mg/L TSS to outlet concentrations below 40 mg/L BOD and 60 mg/L TSS. The system discharges into the ocean (salt water body), allowing for higher discharge criteria under Newfoundland's environmental guidelines.

The Stephenville system has an overall treatment area of 20,000 m^2, composed of eight horizontal-flow subsurface wetland beds and two vertical-flow subsurface wetland beds. It is the largest subsurface engineered wetland system in Canada to date.

There are four sludge cells with a treatment area of 560 m^2 each, for a total area of 2,240 m^2.

All the effluent is held below the surface, eliminating surface contact areas and odour issues.

The engineered wetland is an aesthetically pleasing system that looks more like a green field than a typical sewage

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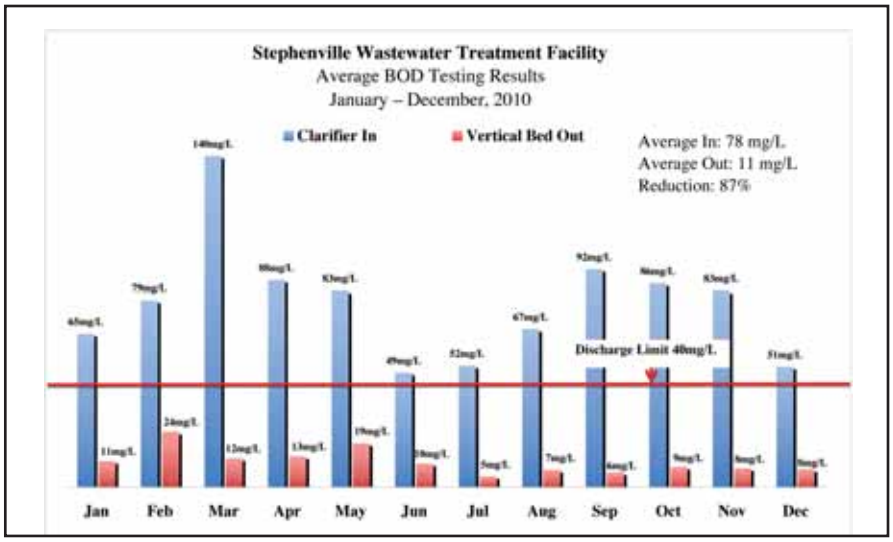

Figure 4. BOD reduction.

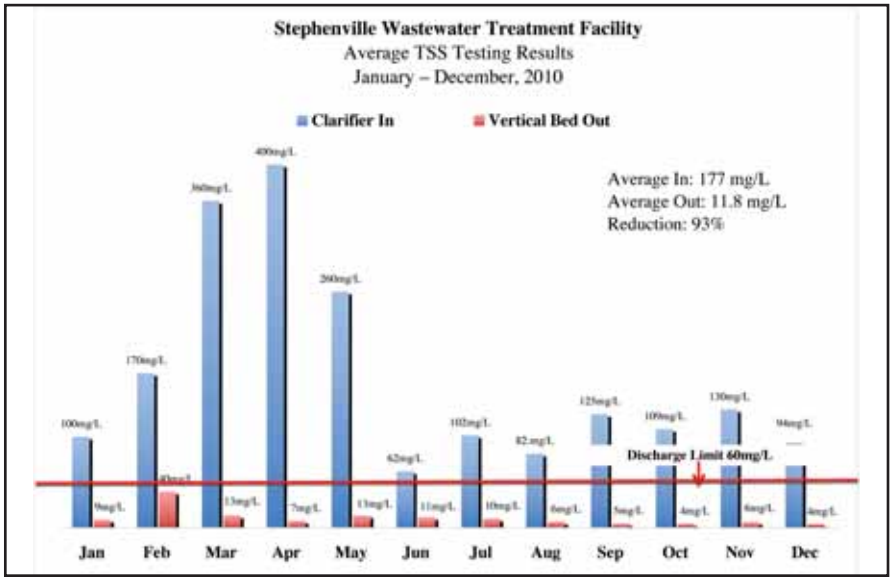

Figure 5. TSS reduction.

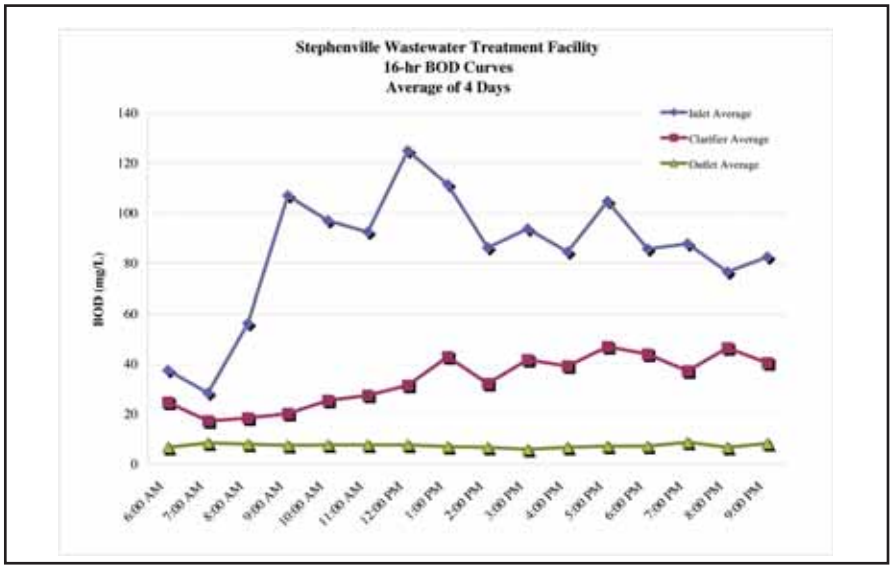

Figure 6. Average 16-Hour BOD testing results.

plant or lagoon. It has incorporated look-out areas and information display boards along town walking trails to encourage residents to visit and learn about the facility.

NRC project

The National Research Council of Canada, through the Industrial Research Assistance Program, had previously completed two projects to test pilot systems using the Abydoz Engineered Wetland technology, after it was transferred from Germany. The first was to test results from single-family home installations, and the second for a small-scale municipal pilot project in Marystown, Newfoundland. Results of these studies were very favourable and the designs were expanded for the full-scale municipal project in Stephenville.

The main objective of the project was to evaluate the treatment performance of a full-scale system, with design changes from the original German patented technology to allow for North American hydraulic loadings, climate and soil matrix composition. To reduce costs, local materials were also incorporated into the matrix design of the system.

During the main testing, inlet and outlet wastewater was sampled monthly for the main parameters of secondary treatment, primarily BOD and TSS. Composite sampling was undertaken, combining the effluent over a four-hour period to improve the quality of results and remove the problems associated with grab sampling.

Testing began in 2009. It was initially conducted quarterly while the beds were becoming established. This progressed to monthly testing when the beds were receiving the full design flow of 4,555 m^3/day and were fully commissioned. Testing was performed twice a month throughout 2010.

Overall treatment results for BOD and TSS are shown in Figures 4 and 5, respectively. The system is continuously providing more treatment than required, giving yearly average outlet concentrations of 11.6 mg/L BOD (87% reduction) and 11.8 mg/L TSS (93% reduction).

Effluent passes through the headworks and the wetland in a continuous operation. It takes four to six hours for it to move through the primary clarifier, and 11 to 20 hours to move through the wetlands.

The effect of freezing and winter con-

ditions was also monitored and no issues were found throughout the system.

During testing, the cyclic pattern of a municipal waste stream was of concern. To ensure results were not being taken from a low period in the cycle, and to determine if the outlet results fluctuated in accordance with the inlet results, BOD testing was performed every hour over a 16-hour period.

Daily loading patterns of the wastewater were tested on four separate occasions over a 16-hour period. BOD concentration of the wastewater was tested at the inlet to the system, the outlet from the primary clarifier, and the outlet from the secondary wetland treatment system.

BOD at the system's inlet rose in peaks at approximately 9:00 a.m., 12:00 noon and 5:00 p.m., which is consistent with daily fluctuations for domestic sewage. Inlet BOD was over 80 mg/L for the majority of the day and peaked at approximately 120 mg/L. Outlet BOD from the primary clarifier increased gradually over the test period, but had significantly reduced peaking compared with the inlet variations. Outlet BOD from the wetland treatment beds fluctuated very little, and was consistently below 10 mg/L for the 16 hour test period. (See Figure 6)

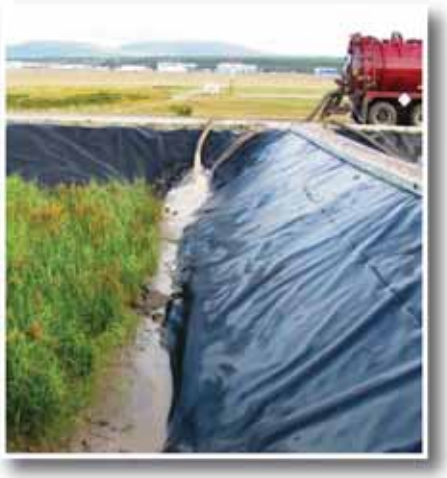

Figure 3. Stephenville sludge treatment cells being filled.

Conclusions

As shown by the treatment results, the modifications from the original German design have been very successful.

Laura Parsons, BASc, is with Abydoz Environmental Inc.
E-mail: lparsons@abydoz.com