Town of Ladysmith Wastewater Treatment Plant Upgrade:

Protecting the Harbour's Ecosystem through Innovative Design

Canadian Consulting Engineering Awards
Water Resources

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Ladysmith WWTP and Ladysmith Harbour

EXECUTIVE SUMMARY

Municipal wastewater discharge was polluting Ladysmith Harbour, a sensitive receiving environment valuable to the local community, First Nations and the shellfish industry. The Town of Ladysmith required a treatment strategy that would satisfy environmental regulations and serve a growing population.

The Town completed a staged Liquid Waste Management Plan (LWMP), which was approved by the BC Ministry of Environment in 2013. WSP facilitated the LWMP process which involved extensive consultation and outlined the roadmap for the Town's upgrade program, establishing key requirements, capacities and commitments.

The Ladysmith Wastewater Treatment Plant Upgrades project received the Award of Merit at the 2018 ACEC-BC Awards for Engineering Excellence

As Prime Consultant, WSP designed all phases of the upgrade. Phase 3 was completed in 2017 and included the construction of a new multi-level building, enclosing the secondary treatment processes with optimal odour control. The new building also includes integrated administration, laboratory and workshop facilities. The available construction footprint was very restricted, which led to the selection of the Moving Bed Biofilm Reactor (MBBR) process with Dissolved Air Flotation (DAF) for solids separation, providing high quality treatment in a compact area. This is the first time a MBBR-DAF combination has been used for municipal wastewater treatment in Western Canada.

Numerous sustainability initiatives were incorporated into the design including solar energy, effluent heat recovery for building heating and cooling, and reclaimed water for irrigation and non-potable plant use.

The quality of the treated effluent has vastly improved as a result of the upgrade, with Biological Oxygen Demand (BOD) removal improving from 54% to 98%, and Total Suspended Solids (TSS) removal improving from 70% to 98%.

The project recently received an 'Award of Merit' in the Municipal & Civil Infrastructure category at the 2018 ACEC-BC Awards for Engineering Excellence.

Backup Power Generator and Substation

PROJECT OBJECTIVES, SOLUTIONS AND ACHIEVEMENTS

BACKGROUND

Ladysmith Harbour is an environmentally sensitive ecosystem, relied upon as a traditional food source by First Nation communities for thousands of years. Pacific Oysters, originally from Japan, were successfully introduced to Ladysmith Harbour in the early 1900s to support the commercial shellfish industry. The Harbour continues to provide a thriving habitat for shellfish, and also hosts a variety of community recreational and commercial activities.

The Town of Ladysmith has a clear vision for a prosperous, sustainable and resilient future. Ensuring the Harbour is not adversely impacted by the discharge of human waste is an important priority for the community. The Harbour has been closed to recreational shellfish harvesting for several years, and only limited commercial operations using comprehensive depuration processes are permitted.

The Town initiated a staged Liquid Waste Management Plan (LWMP) process in 2007, for which final approval was received from the BC Ministry of Environment in 2013. WSP facilitated the LWMP process for the Town, involving extensive consultation with regulatory agencies, the local community, and the Stz'uminus First Nation. Strong support was expressed for upgrading the Town's wastewater treatment to protect the water quality in Ladysmith Harbour. The LWMP outlined the Town's road-map for the upgrade program, and established key requirements, capacities and commitments.

Phases 1 and 2 of the proposed upgrades were constructed between 2009 and 2012, including new headworks infrastructure (influent control, screening and grit removal), compact Salsnes belt filters for primary treatment and a dewatering centrifuge.

The culmination of the upgrade program, Phase 3, was completed in 2017 and included a new secondary treatment facility with integrated laboratory, workshop and administration facilities, as well as various upgrades and improvements to existing plant infrastructure. Phase 3 also included a backup power supply and remote monitoring and control systems to enable continuous and efficient operation of the facility 24/7.

Dissolved Air Flotation (DAF) Tanks

MBBR Tank (without media)

OBJECTIVES

Consistent, high-quality effluent is an important requirement of the new treatment facility. The LWMP process established that the plant should be designed to meet not only the existing provincial wastewater effluent standards, but also the anticipated federal standards that came into effect in 2012.

From the initial planning stages, the small site on a waterfront peninsula with steep slopes was a major design constraint, requiring an efficient and innovative site layout and compact treatment processes. Aesthetic appearance and odour control measures were also important due to the prominent location near residential and recreational areas.

Currently, the Town's population is just over 8,000 people, and the LWMP established that the upgraded plant must be sized for a service population of 17,200. The design also considered further expansion possibilities for increased service capacity and the potential for future advanced treatment using the existing site.

SOLUTIONS

The upgraded plant has been designed for a service population of 17,200, with spare process tanks integrated in the new facility that can be used to either accommodate future increases in service population or add advanced treatment (nutrient removal) capabilities to the existing process with minimal modifications.

The secondary treatment process selected to fit within the available space was a Moving Bed Biofilm Reactor (MBBR) with Dissolved Air Flotation (DAF) for biological solids separation. This combination is extremely compact, and produces a high quality of effluent. This is the first time a MBBR-DAF combination has been used for wastewater treatment in Western Canada, although it has a proven history in other parts of the world.

The MBBR process was developed in Norway in the 1980s and has some significant advantages over conventional secondary (biological) treatment processes. The biological component is very compact due to the large surface area of the plastic 'media' in the process tanks for bacterial growth, and the

DAF process eliminates the need for large gravity settling tanks with the associated return sludge piping. The MBBR is also resilient to peak loading and temperature variations, which are ongoing concerns due to seasonal loading fluctuations and inflow and infiltration issues with the older parts of the Town's sanitary collection system.

Extensive consultation and coordination with local First Nation communities allowed for the relocation of a midden deposit found on the site, under the supervision of representatives from the Stz'uminus First Nation. The midden was placed in a protected area and is clearly identified to prevent future disturbance.

ACHIEVEMENTS

The following two parameters are typically used in the wastewater industry to measure the levels of contaminants in a given sample.

Solids Content – measured as Total Suspended Solids (TSS) in mg/L

Organics Content – measured as 5-day Carbonaceous Biochemical Oxygen Demand (CBOD5) in mg/L

The following table summarizes the quality of the treated effluent before and after the secondary treatment upgrade was commissioned.

*Data averaged from weekly samples	12 months Prior To Commissioning	Post Commissioning	
TSS (mg/L)			
Discharge to Harbour	71* →	8*	**89% reduction**
Removal %	70%	98%	
CBOD5 (mg/L)			
Discharge to Harbour	124* →	7*	**94% reduction**
Removal %	54%	98%	

The reduction in human waste contaminant being discharged to Ladysmith Harbour will have a significant beneficial impact on the ecosystem.

Laboratory Facility

TECHNICAL EXCELLENCE AND INNOVATION

The limited site footprint available for this treatment plant required an innovative approach to achieve the requirements of compact, high quality treatment for an expanding service population. Building the first MBBR-DAF wastewater plant in Western Canada on such a constrained site required extensive planning and multi-disciplinary design coordination, and resulted in a unique yet effective solution.

An integrated multi-level building concept was developed for the new secondary treatment facility, which included partially underground MBBR process reactors on the south end, a large enclosed space to house the DAF tanks and miscellaneous process equipment in the centre. There is a two-storey building with administration and laboratory facilities on the upper level and a workshop, storage and electrical room on the lower level. The entire structure was built into the existing slope adjacent to Highway 1 and was designed to retain the slope in a seismic event.

The upgraded facility was carefully designed hydraulically to operate with a single set of pumps at the influent wet well, with the remainder of the treatment processes fed by gravity. This minimizes the amount of energy required throughout the plant.

Heat Exchangers and HVAC Glycol System

Rooftop Solar Panels

ENVIRONMENTAL, ECONOMIC AND SOCIAL SUSTAINABILITY AND AESTHETIC ASPECTS

ENVIRONMENTAL SUSTAINABILITY

Protecting the Ladysmith Harbour environment was the central driving force behind this project. The improvements outlined in the achievement section above clearly show the reduction in contaminant levels and demonstrate the beneficial impact that this project will have on the receiving environment over the coming years.

In order to further align the project with the Town's vision for environmental sustainability, the following initiatives were incorporated in the design to minimize the overall environmental impact of the new facility:

- Heat Recovery from the effluent stream heats and cools the new buildings. A portion of the treated effluent is diverted to heat exchangers which interface to a glycol loop connected to six (6) heat pumps in different areas of the building. These heat pumps are monitored and controlled by a central system to optimize heating and cooling based on occupancy and demand.
- Solar Panels on the roof of the new building supplement the power demand of the entire facility. A net metering arrangement has been set up with BC Hydro to make the most of the additional supply.
- Reclaimed Water system which further filters a portion of the secondary effluent and makes it available for plant processes, general cleaning and irrigation use.

Secondary Treatment Facility

ECONOMIC SUSTAINABILITY

A sustainable Ladysmith Harbour is an important factor in the Town's vision for a prosperous, sustainable and resilient future. The Harbour is an important asset to many of the Town's major employers, and also provides many recreational opportunities for residents of Ladysmith.

As described previously, energy efficiency has been integrated in the design wherever possible (e.g., utilizing effluent heat recovery for building heating and cooling, high efficiency process equipment and carefully designed plant hydraulics to minimize the pumping energy required.)

By building in spare process tanks that can be used for a future service capacity expansion or implementing advanced treatment capabilities, the upgraded plant has been designed to serve the Town's needs for decades without requiring significant capital expenditure for future upgrades. This minimizes the long-term tax burden on the Town's residents.

SOCIAL SUSTAINABILITY

By ensuring that the Town's wastewater is treated to a high standard, this project has ensured that the community, the local Stz'uminus First Nation, the shellfish industry and ultimately shellfish consumers are being protected.

The Liquid Waste Management Plan included extensive consultation with the community and First Nations, and strong support was expressed for upgrading the Town's wastewater treatment to protect the water quality in Ladysmith Harbour. The community acceptance of the project has been positive.

AESTHETIC ASPECTS

The new secondary treatment facility was designed as an integrated structure, appearing to be a single building from the outside. The colour scheme was selected to match the existing facilities as closely as possible, with the roof colour blending in to the surrounding evergreen vegetation. As the plant is visible from parts of the Town uphill and from the Harbour, visual impact was an important consideration. The inclusion of architectural enhancements ensured that the building maintained a sense of appearance as well as utility.

Process Schematic

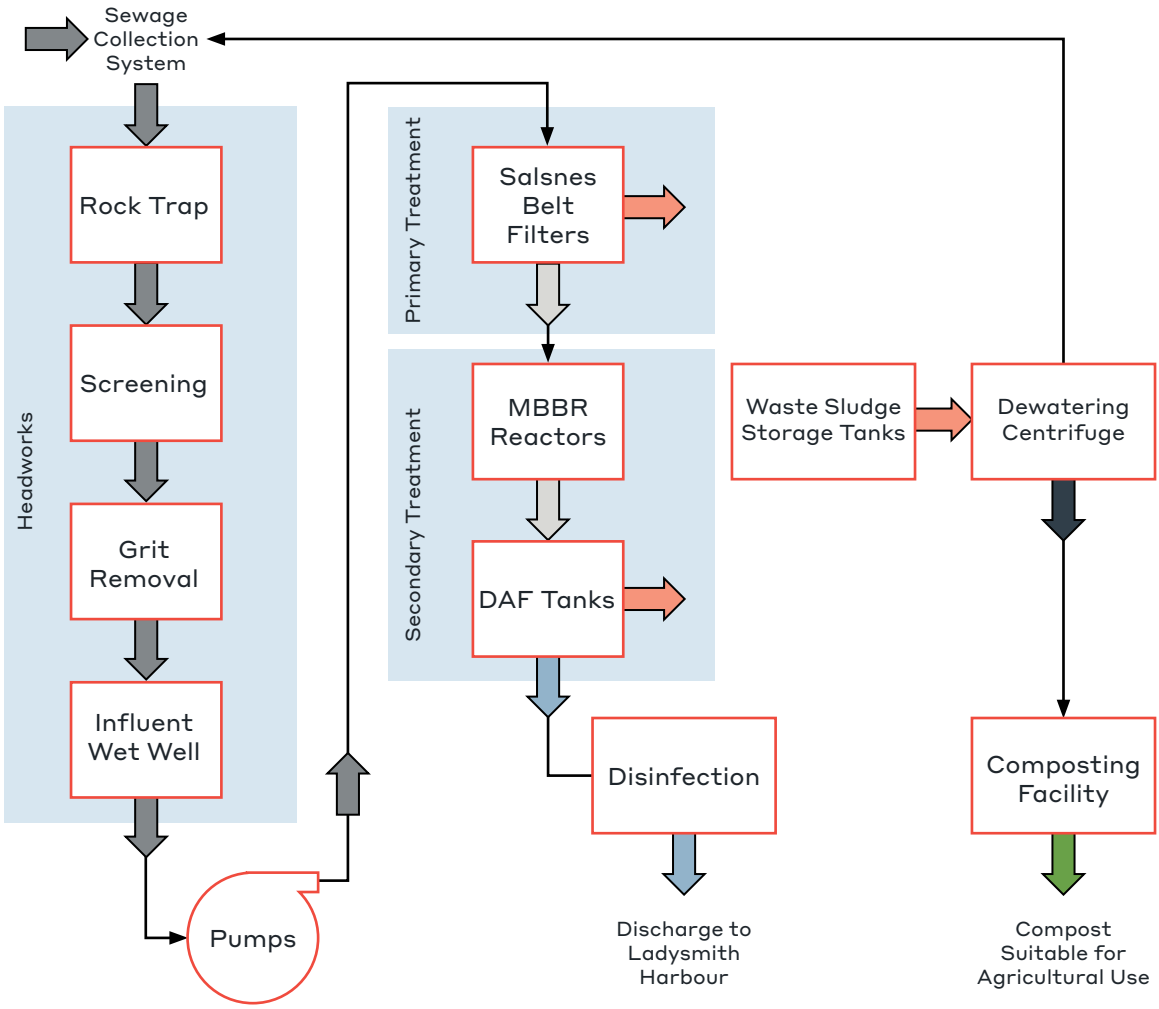

Figure 9: Ladysmith WWTP Process Schematic

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