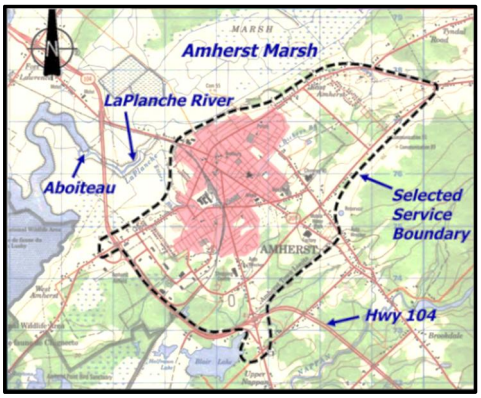
Engineers Nova Scotia
2014 Call for Nominations - Lieutenant Governor's Award for Excellence in Engineering
Amherst Wastewater Treatment Facility

Project Overview

Beginning with its original founding in 1764, Amherst, like many Canadian communities, discharged its wastewater without treatment to nearby watercourses. Currently, Amherst's 9,717 residents (2011 census), commercial, industrial and institutional sources generate, on average, approximately 75 L/s (1.4 million igpd) of untreated municipal wastewater. For many years, the town's sanitary effluent discharged untreated to a series of outflow pipes primarily along the Amherst Marsh, with the flow proceeding to the LaPlanche River and ultimately the Bay of Fundy.


Typical Marsh Sewer Outfall c.1985

Efforts to address the Town of Amherst's (Town) wastewater treatment requirements began in earnest with the completion of the Cumberland Regional Sewerage and Water Plan (H.J. Porter and Associates) in 1979 and a follow up Treatment Options Report (Porter Dillon Limited) in 1989. Founded on the recommendations of a subsequent 1993 Pollution Abatement Strategy Report completed by Dillon Consulting Limited (Dillon), the Town completed several capital projects to consolidate wastewater flows and acquire property in advance of the construction of a centralized treatment facility. In early 2004, the Town commissioned the LaPlanche River Pumping Station (LRPS), with collected wastewater being directed via forcemain approximately 1800 m to a discharge location on the saltwater side of the LaPlanche River aboiteau. Following the completion of subsequent waste flow consolidation projects, the LRPS became the central consolidation point for all of the Town's municipal wastewater. With its forcemain passing directly adjacent to the previously-identified site west of Highway 104 near the community of Fort Lawrence, there was finally an opportunity to effectively treat all of Amherst's wastewater.



Amherst and Selected Service Area

In 2004, with support through FCM's Green Municipal Environmental Fund, Dillon completed an updated review of the preferred treatment technology recommendations made in the 1993 Pre-Design Study (e.g., secondary treatment using aerated lagoons along with engineered wetlands). Subsequently, the Town retained Dillon through a competitive process to provide design, approval and construction administration services to establish their wastewater treatment facility. In May 2010, Brycon Construction Limited was awarded the contract to build the Amherst Wastewater Treatment Facility (WWTF). Commissioning of the $11M facility was conducted in August and September 2012 with the official opening, involving representatives of all three levels of government, taking place in October 2012.

Over 30 years in the making, but through the determination of Town staff and successive municipal councils, Amherst realized its goal of providing an effective and efficient wastewater treatment solution to its businesses and residents. This submission serves to summarize how the creative application of engineering techniques and technologies allowed the Town to achieve its overall facility objectives.

Design Objectives

The specific design objectives for the Amherst WWTF were founded primarily on direction provided in two documents:

1. Evaluation of Wastewater Treatment Technologies, Dillon Consulting Limited, November 2004.
2. Amherst Wastewater Treatment Facility Design Brief, Dillon Consulting Limited, May 2010.

The 2004 Evaluation of Wastewater Treatment Technologies report, completed with the support of FCM's Green Municipal Environmental Fund, took the recommendations of previous investigations one step further, incorporating elements of sustainability, best practices and new technologies. Within the 2004 report, the Town identified its design objectives for the WWTF as follows:

- Specific consideration of new, "leading-edge" methods, acknowledging the unique marshlands context of the selected treatment facility site.
- Specific evaluation of engineered wetlands with consideration of the habitat development objectives of Ducks Unlimited Canada.
- Development of an overall management strategy, emphasizing the importance of generator education, industrial/commercial user audits, source control (including pollution prevention) responsibility, by-law development and enforcement and long term sustainability.
- Establishment of a successful "best-practices" integrated wastewater management approach to be used as a template by other similar-sized municipal units in Nova Scotia and throughout Canada, regardless of selected treatment technology.

Site Prior to Development

Completion of the November 2004 report incorporated direct engagement of citizens and business owners in the Amherst area, serving to confirm resident preferences for the Town's overall wastewater treatment system. Outcomes of the 2004 evaluation included preparation of a draft (later enacted) Sewer Use By-Law, confirmation of a previously-identified site west of Highway 104 on the Amherst Marsh as the preferred treatment plant location, definition of aerated lagoons followed by engineered wetlands as the selected treatment technology and identification of collection system modification/consolidation requirements.

Consistent with standard practice and provincial regulatory requirements, Dillon prepared a Design Brief to provide a basis for the preparation of tender documents for the construction of the WWTF. An initial version of the WWTF Design Brief was issued to NS Environment in January 2010 and was subsequently revised following the selection of a preferred contractor in May 2010. The Design Brief confirmed the following WWTF performance attributes:

- Design requirements were developed using a 25 year horizon, based on information provided by the Municipality and requirements of the Atlantic Canada Wastewater Guidance Manual for Collection, Treatment and Disposal, 2006 (ACWGM).
- Using historic data and forecasts incorporating municipal growth, the projected 25-year average daily flow recommended for design of the treatment system was 121 L/s. Similarly a peak flow value of 350 L/s was selected.
- Discharge to the saltwater (marine) side of the LaPlanche River aboiteau.

- Design Influent Criteria
  - Biochemical Oxygen Demand (BOD): 150 mg/L
  - Suspended Solids (SS): 130 mg/L
- Design Effluent Criteria
  - BOD: 25 mg/L
  - SS: 25 mg/L
  - Total Residual Chlorine: 0.02 mg/L
  - Treatment criteria for any additional parameters to be established following an environmental risk assessment to be completed for the facility within five years of commissioning.

Based on the defined treatment objectives, it is estimated that establishment of the Amherst WWTF will reduce annual BOD loading to the LaPlanche River by approximately 350,000 kg and discharged SS by 325,000 kg.

Design Features

Detailed design of the WWTF required a noted degree of flexibility and creativity on the part of the Town and the Dillon team. Noted challenges encountered and addressed during the design phase, as well as progressive facility features, included the following.

Relocation of the LaPlanche River Aboiteau

The existing forcemain outflow from the LaPlanche River Pumping Station (established in 2004) had been identified by the Town as the selected discharge location for the proposed Amherst WWTF. Situated on the saltwater (marine) side of the LaPlanche River aboiteau, it provided a preferential discharge location as compared to freshwater option. With preliminary design efforts underway, the Town was informed by the NS Department of Agriculture that it intended to relocate the existing aboiteau approximately three kilometres downstream from its current location. This necessitated the expedited design of a pumping station to direct effluent from the existing outfall (thus also serving the proposed future WWTF) to the newly identified location. The Province completed the relocation of the aboiteau, but it was destroyed during a storm event in June 2008. Noting that the Province still intends to relocate the aboiteau, Dillon's design for the WWTF effluent pumping station remains ready for use when needed.

Project Team

Client – Town of Amherst
Lead Engineer – Dillon Consulting Limited
Structural – J.M. Giffin Engineering Inc.
Mechanical/Electrical – F.C. O'Neill, Scriven and Associates Limited
Architectural – Arthur Arseneau Architects Limited
Geotechnical – GEMTEC Limited
General Contractor – Brycon Construction Limited

Available Site Size Reduction

The Town of Amherst purchased the 19.8 ha property for the WWTF shortly after the completion of the 1993 Pollution Abatement Strategy Report. Initial layout, hydraulic calculations and lagoon sizings for the WWTF were developed based on standard setback allowances from property lines, watercourses and other site features. However, after design efforts were underway, the Town was contacted by the NS Department of Agriculture to request that a 100 m setback from the LaPlanche River dyke be established, essentially making development of the site impractical. Through negotiations involving Dillon, the Town and the Province, the setback requirement was reduced to 35 m, but a significant reconfiguration of the WWTF's hydraulic design and layout was still required.

"Active" Engineered Treatment Wetlands

In some instances, engineered wetlands are incorporated into the design of wastewater treatment facilities to address a final (and often redundant) "polishing" requirement as opposed serving as a significant contributor to the overall treatment process. In the case of the Amherst facility, the design objective was to ensure that the engineered wetlands, incorporating both surface and subsurface flow configurations, were substantial contributors to the complete treatment system, with a focus the removal of BOD and SS. Facility design calculations for the WWTF assumed a balanced treatment contribution between the aerated lagoons and the engineered wetlands. By making the wetlands an equal partner in the treatment effort, the requirement for electricity to operate the aeration blowers was reduced significantly as compared to a traditional "lagoon only" configuration. Further, the design of the subsurface flow wetlands incorporated a novel subgrade aeration piping network, allowing for improved treatment during winter operations and enhanced ammonia nitrogen removal performance as needed. As a final element, both the surface flow and subsurface flow wetlands were developed using local plant species, harvested during the initial stages of site construction.

VFDs and Heat Recovery

Beyond the long term energy savings associated with the incorporation of engineered wetlands in the overall WWTF treatment train, design of the site's Control Building included additional features to reduce energy consumption and address the Town's objective of establishing an effective and sustainable operation.


Blowers 2 and 3 with VFD units

Acknowledging that incoming effluent strength and the treatment capabilities of the engineered wetlands will vary with the seasons, the three blowers serving the lagoons incorporate Variable Frequency Drives (VFDs), allowing for both automated (e.g., based on dissolved oxygen rates in the lagoons) or manual adjustment of blower effort and energy consumption. To extract and utilize heat resident in the effluent, the air management system serving both the Headworks and UV Rooms in the Control Building incorporate Heat Recovery Ventilators (HRVs), further contributing to a reduced overall energy requirement for the WWTF.


HRV1 Serving the Headworks Room

Marsh Barn Aesthetic

Working with the Town and Arthur Arseneau Architects, the WWTF's Control Building exterior design was developed in an effort to capture a "marsh barn" aesthetic, consistent with historic hay barns that were at one time a common sight near the Nova Scotia border. In acknowledgment of the harsh weather conditions common to the area, building material selection focused on robust and resilient materials, including split face block exterior walls and steel roofing shingles.


WWTF Control Building

Construction and Commissioning

Disinfection Infrastructure Savings

Following the selection of Brycon Construction Limited in 2010 as the preferred contractor to construct the WWTF, opportunities to reduce to overall capital cost of the facility were investigated. Through collaborative discussions involving the Town, NS Environment, Dillon and Brycon, a significant candidate adjustment to the

treatment train, focusing on disinfection and the use of engineered wetlands, was identified. The parties agreed that the use of engineered wetlands was likely to introduce fecal coliforms associated with birds, including ducks and a variety of other marsh species into the treated effluent stream. Further, the ultimate tidal marine discharge location served to mitigate immediate concerns related to coliforms in general. Thus it was agreed that while a dedicated room/channel and necessary connecting infrastructure for a UV system would be included in the construction of the Control Building, the actual UV unit would not be installed as part of the initial establishment of the facility. Instead, NS Environment agreed to define a monitoring program for the initial years of operation to determine if installation of the UV unit was necessary. This practical refinement, which acknowledged the unique design and context of the WWTF, served to reduce the initial capital cost of the facility by approximately $400,000 with an immediate power cost reduction of approximately $30,000 per year. It is noted that performance data after the first year of operation has not supported a requirement to install the UV unit.

Use of TDA as a Treatment Media

During the early stages of site development, an opportunity to utilize a new "made in Nova Scotia" construction product (from a material that has historically been considered waste) as part of the development of the engineered wetlands was identified. A Dillon client, Halifax C&D Recycling Limited (Halifax C&D) approached the Town of Amherst to see if there would be a potential to replace the clear stone media component of one of the subsurface flow (SSF) wetlands with a select grade of Tire Derived Aggregate (TDA). In 2010, through an agreement with Resource Recovery Fund NS, Halifax C&D began processing the approximately 900,000 vehicle tires generated in the province each year. The end result of the processing activity is a shredded rubber product (defined in ASTM D6270 – 08) that is suitable for use in select civil engineering applications. Through research completed by Dillon, it was confirmed that TDA has been used previously as an engineered wetland media. Ultimately, agreement was reached amongst the parties that 3500 m^3 of Type "A" TDA would be used to replace the clear stone component of one of the four subsurface flow wetlands. Further, NSE prescribed specific monitoring requirements to allow for the ongoing evaluation of the treatment effectiveness of the TDA cell. As of late 2013, no issues of concern had been identified in relation to the use of the TDA media.

TDA Placement in SSF Wetland No.2

Incorporation of a Wind Turbine

Following the initial definition of design requirements for the WWTF, it was confirmed that the establishment of a 50 kW wind turbine, through a separate initiative of the Town of Amherst, would need to be incorporated into the tender documents. Specifically, the yard layout and electrical room required modification to accommodate conduit and control infrastructure for the turbine unit. Final erection and commissioning of the turbine is scheduled for 2014, pending finalization of requirements with NS Power. Once operating, the turbine will serve to offset a portion of the WWTF's overall electrical demand.

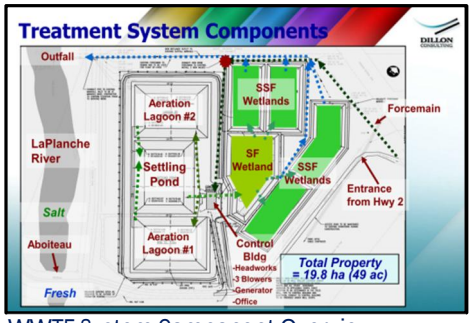
Managing Marsh Soils

Beginning with initial geotechnical investigations of the WWTF property in the 90s, it was recognized that the site would offer the typical development challenges associated with temperamental marsh soils. The very fine grained, silty composition of marsh soils (marine clays) leads them to be very slow draining and prone to structural failure if loaded without significant care. Opportunities to expedite soil dewatering using wick drains were investigated but found to be cost prohibitive. With support from GEMTEC Limited's Moncton office, specific staged construction requirements for the WWTF site were incorporated into the tender documents, requiring pre-loading of the Control Building compound and close monitoring of site settlement.

Even with significant attention to soil management requirements at the site, construction challenges were encountered. Anticipated settlement of the Control Building compound area proceeded very slowly, impacting the construction schedule. But more significant was the amount of rain at the site once construction began in earnest, with above average rainfalls being received for 10 of the first 14 months of construction. Two minor slope failures of lagoon berms occurred during the construction phase, leading to the definition of necessary repairs and updating of lagoon geometry and associated treatment hydraulics.

Excavation of Marsh Soils

Upcoming Initiatives



WWTF System Component Overview

With more than one full year of operation now complete, the WWTF is achieving and exceeding anticipated performance results. Consistent with the stipulations of the Provincial Operational Approval, and in addition to traditional treated discharge monitoring requirements, specific analysis of the need for enhanced coliform removal (by installing the UV unit) and the effectiveness of the TDA media in SSF Wetland No.2 will be ongoing. By 2017, as prescribed in the Operational Approval and as defined by CCME's Canada-wide Strategy for the Management of Municipal Wastewater Effluent, the Town will be obliged to conduct an Environmental Risk Assessment of the WWTF's discharge to the LaPlanche River.

The winter of 2013-14 represents the second season of cold weather WWTF operation, necessitating the establishment of an insulating ice layer within the SSF wetlands and other adjustments to typical facility procedures. On a periodic basis during the summer months, vegetation from within the surface flow and subsurface flow wetlands will require harvesting to ensure effective nutrient removal within the overall system. In the years to come, Town staff will continue to optimize procedures associated with these and other unique seasonal operational requirements.

In Conclusion

Both the environment and the residents of the Town of Amherst will benefit from the establishment of the WWTF. The discharge of untreated sewage to the LaPlanche River has long been an issue of concern for residents of Amherst; it is inconsistent with the desire of the Town to be an environmentally-responsible municipal leader for jurisdictions of its size in Atlantic Canada. Further, many prospective industries are now critically reviewing the environmental management record of a municipality when evaluating potential locations for new facilities. The provision of plentiful and clean drinking water as well as natural gas has been a powerful catalyst for economic development in Amherst; establishment of a full wastewater management capability will further enhance the Town's ability to bring new industries and investors into the community.

Aerial View of the WWTF – July 2012

The WWTF's Surface Flow Wetland

The design of the facility, led by Dillon Consulting Limited, has been founded on a well-established and robust municipal wastewater treatment approach; the use of aerated lagoons. However, consistent with the marsh setting of the WWTF, it also included the development of an extensive engineered treatment wetland, incorporating both surface and subsurface flow components. Energy conservation was a noted design theme of the facility, including heat recovery, variable frequency drive blowers and the incorporation of a wind turbine in the development of the site. The high-visibility location of the WWTF, along with the use of engineered wetlands as a key system component, presents an opportunity for it to serve as a centre of excellence for progressive and sustainable wastewater treatment.

Additional information provided with this submission on enclosed CD-ROM:

1) Amherst Wastewater Treatment Facility, July 2013 – Record Drawings
2) Amherst Wastewater Treatment Facility, September 2013 – Operations and Maintenance Manual (Rev 13-1)
3) Amherst Wastewater Treatment Facility, October 2012 – Presentation at ACWWA Annual Conference, Charlottetown, PE