

Inspiring sustainable thinking



2015 CCE AWARDS SUBMISSION St. Albert Pump Station

Category:	Water Resources
Client/Owner:	Alberta Captial Region Wastewater Commission
Consultants :	Manasc Isacc Architects
	Magna IV Engineering
	Ptarmigan Engineering Ltd.
	Thurber Engineering Ltd.
	Golder Associates
Contractor:	Alberco Construction Ltd.

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St. Albert Pump Station

Past, Present and Future

The St. Albert Pump Station is one of the largest municipal wastewater pump stations in Western Canada. The facility was designed to serve the City of St. Albert and neighbouring communities until least 2040, when the required capacity is projected at 2,300 L/s. Located in the Red Willow Park river valley, in the heart of the St. Albert's Kingswood neighbourhood, it unassumingly presents an artistic building concept of a wastewater pump station that subtly conceals its functionality and the huge pumping capacity within.

The original design brief was to upgrade the existing St. Albert pump station facility, which was comprised of two interconnected pump stations: the 1975 Sturgeon Pump Station and the 1990 St. Albert Pump Station.

The combined pumping capacity of the existing facility was less than the service level that the Alberta Capital Region Wastewater Commission was required to provide. Additional capacity was therefore urgently needed, not only to address the then-current requirements, but also future capacity needs as cost effectively as possible. After considerable design investigation, it was determined the maximum capacity that could be achieved from the existing facilities was 1,700 L/s. Achieving this would not only require extensive upgrades with significant bypassing of flows required during construction, it would also require an alternative solution to address the capacity deficit.

Storage and the addition of a new supplementary pump station were assessed as options to provide the additional capacity when required. However, neither was found to be cost effective, and upgrading presented significant construction risk in terms of managing existing flows during construction. Because of this, an option to design and construct a new pump station that could provide for the short and long terms needs was assessed and ultimately found to present the most cost-effective solution.

FORMING A CREATIVE AND INNOVATIVE DESIGN

A 3D model was developed to investigate the feasibility of upgrading the portions of the existing facility, this included the key structural and mechanical components such as inlet structures, wet wells, pumps, and discharge headers. The model was developed based on record drawings and confirmed by field measurements within the existing stations where accessible.

The model proved to be especially valuable when assessing the limitations of the existing facility, and they were also used to investigate options to bypass flow if the stations were to be upgraded, enabling comprehensive layouts of skid pumps and pipework to be developed. This helped identify the bypass pumping capacity potential as well as the limitations and risk associated with bypass pumping.

The design of a new pump station with the capacity to handle current and future flows was ultimately found to be the most cost-effective

solution. However, developing a cost-effective design solution faced some extremely complex and unique issues.

The pump station had to be constructed very close to two existing live stations, which had to remain in operation until the new station was commissioned.

Additionally, the design also had to contend with existing utilities and sewers, including a 10m deep 1050 inlet sewer and a 6m deep 900 forcemain, poor soil conditions, a high water table and actively used parkland complete with trails. It also had to be acceptable to the local community.

Overcoming these challenges required a creative and innovative design approach.

Before the design of the pump station could be initiated, the pumping requirements had to be determined and the optimal pump size and number needed to be selected to maximize efficiencies and performance. Minimizing the



number of pumps would require larger pumps that would not be efficient in the interim. Conversely providing multiple smaller pumps would lose efficiencies when more pumps were required. An additional option was to minimize the number of pumps by initially installing small capacity pumps and replace them with larger pumps at a future date was also considered. However, this latter option would have created considerable high risk issues as the station would have to be bypassed when upgrading and commissioning the larger pumps.

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Extensive geotechnical and hydrogeological investigations were conducted to help determine feasible construction methods that would enable the station to be constructed in a constrained space that included two operational pump stations, which had to remain in full operation until the new station was constructed and commissioned. The design also had to contend with existing utilities and sewers, including a 10 m deep 1050 mm inlet sewer, a live 900 diameter forcemain, as well as three smaller forcemains, a high water table and a community that required a visually acceptable structure in their neighbourhood.

A comprehensive hydraulic assessment was undertaken to consider effective pump types and efficiencies in pump and forcemain operation. Ultimately the most efficient solution was to use dry mount submersible pumps complete with 730 hp motors. With each pump capable of a rate in excess of 700 L/s, a total of four pumps were required with a fifth pump installed as stand by.

The key parameter to ensuring that all these components would work and function efficiently was the construction of the 17 m deep circular concrete caisson.



PUMPING FOR CAPACITY

As each pump could produce in excess of 700 L/s, an effective means of controlling start-up and shut down was imperative to address possible transient pressure waves from impacting the forcemains. A combination of soft starters and flow control valves were used for this purpose, with the flow control valves used to cushion the transfer between stop and running states.

This process was carefully designed in collaboration with the pump supplier to ensure that the pumps were not overly stressed when pumping against closed or near closed valves.

The pump station discharges to a 900 forcemain which can pass flow in two directions, including direct to the discharge point and also via twin 600 forcemains. This 900 forcemain has a relatively low pressure rating and thus the design had to incorporate a robust pressure relief system that would protect this forcemain against surge pressures. To achieve this, the design included a pressure relief system with twin surge relief valves that will relieve high pressures by directing flow back to the wet wells.

A transient analysis was carried out during the design and a post construction analysis was undertaken to verify the performance and impacts. This was used to assess the most efficient forcemain combinations to be utilized during each stage of the facility's growth.



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THE ENVIRONMENTAL SOLUTION

Generally pump stations are built in industrial locations or in undeveloped areas of a municipality. In this situation, the St. Albert Pump Station was designed and built in a mature and affluent neighbourhood near the heart of city centre and adjacent to the Sturgeon River. With the creation of a circular design, ISL engaged a local architect to design a building that broke from the traditional 'form follow function' industrial approach that are the primary designs of pump stations and create an architectural design that would complement its location within a mature neighbourhood .

The pump station wet well incorporates a massive channel grinder which pulverizes solid material and helps prevent large objects from becoming blocked within the pumps.

There was strong desire for this as the previous facility screened solids and deposited them in a large trash bin for intermediate collection, and this process created an odour nuisance for nearby residents.

There is a risk associated with grinding wastewater streams because they often contain inorganic materials which, when grinded into small pieces, can cause problems in the treatment processes at downstream wastewater treatment plants (WWTP). However, in this instance the ACRWC WWTP has a large grit chamber which settles out such inorganic material and minimizes any negative impact these may have to the treatment process.

AS A RESULT OF THE GRINDERS THE WET WELL IS VIRTUALLY SELF-CLEANING WHEN IT IS PERIODICALLY DRAWN DOWN BY THE PUMPS.

The wet well also includes pump suction inlet bays which include flow splitters at the mouth of the suction inlets. These combine to restrict the area in which the solids can settle and to maintain a higher velocity at the location of the inlet. As a result of the grinders the wet well and the suction inlet bays are virtually self-cleaning when it is HOWEVER, THE ACTUAL LEVELS OF H2S HAVE REMAINED BELOW OH&S OPERATIONAL EXPOSURE LIMITS AND THE ACRWC HAS NOT RECEIVED ANY COMPLAINTS SINCE THE STATION WAS COMMISSIONED.

periodically drawn down by the pumps.

With odour being a particular nuisance with the previous facility, there was a strong commitment from the ACRWC to ensure that it would not become an issue with the new station. While eliminating the screening and the trash bins would have a considerable impact on reducing odours, an odour survey was carried out to determine the residual odours and identify what level of treatment was required. The survey measured H_2S and found the level was generally low with intermittent peaks coinciding with the operation of the pump from the adjacent country residential areas in Sturgeon County.

Several odour control technologies, including activated carbon, bio filters, chemical scrubbing and ultraviolet radiation (UV) were explored. An assessment of the technologies suggested activated carbon and UV radiation offered the most suitable technologies for this particular project, with UV offering considerable cost benefits in terms of capital and operational costs. The UV technology acts as a catalyst, breaking down the ambient oxygen and water molecules into ozone ions (O+) and hydroxide ions (OH-) that oxidize the odorous contaminants in the air. This reaction results in a sequential and instantaneous gas break down of the contaminants with byproducts of elemental sulphur, CO₂, water vapour, molecular oxygen and trace ozone.

Post commissioning, there has not been a formal monitoring of the effectiveness of the UV system to control odours. However, the actual levels of H_2S have remained below OH&S operational exposure limits and the ACRWC has not received any complaints since the station was commissioned.

CONSTRUCTION AND COLLABORATION

The pump station was formally opened in the spring of 2014.

When working on a project of this size and complexity, creating a collaborative environment between the stakeholders, contractors and ARCWC was of paramount importance. As the Project Managers, ISL dealt with a myriad of issues that could have created an impact on the community.

Stakeholder liaison and coordination was of particular importance as the station received flow directly from deep large diameter gravity trunks and three separate stakeholder pump stations. All of these flows had to be diverted to the new station, requiring a coordinated and collaborative effort to ensure that the work was diligently planned. This collaborative approach ensured that risks to the public, the contractor and stakeholders were identified and preventative measures implemented. The most complex construction element was the sinking of caisson segments that were each approximately 3m tall and allowing gravity to sink the caisson by removing soil from the centre segments. This process took over five months, with contractor. working continuously through what was a particularly aggressive winter season, meticulously controlling the decent and ensuring the structure remained vertical until it reached its final elevation.

The materials used during the construction of the pump station were significant and required careful logistics to ensure that they arrive on site at the desired time. The complexities of the construction schedule meant that materials arriving would



need to be installed at a later date. This required ISL to build a trusting and collaborative relationship between the contractors, vendors and ARCWC that would ensure that material costs wouldn't adversely affect the construction schedule and would mitigate the financial risks to all parties. The existing pump stations were due to be decommissioned once the new pump station was placed online. The age and condition of these existing stations was a concern. Towards the end of construction, this concern was realized when an externally routed pipe break occurred. At the time the new station was in the process of being commissioned and, fortunately, enough systems had been tested to allow flow to be bypassed to the new station, mitigating what could have been a much more serious environmental incident.

The combined efforts and innovation that were part of the design and construction allowed all these elements to create a highly efficient facility that will have a lasting impact on the future development of the St. Albert community.

THE MOST COMPLEX CONSTRUCTION ELEMENT WAS THE SINKING OF CAISSON SEGMENTS THAT WERE EACH APPROXIMATELY 3M TALL AND ALLOWING GRAVITY TO SINK THE CAISSON...

