ISL Engineering and Land Services

Inspiring sustainable thinking

2018 CANADIAN CONSULTING ENGINEERING AWARDS

Drayton Valley Water Treatment Plant

Category:
Water Resources

Client/Owner:
Town of Drayton Valley

Subconsultants:
Manasc Isaac Architects Ltd.
Clark Engineering Inc.
Golder Associates Ltd.
Magna IV Engineering Ltd.
Hoggan Engineering & Testing (1980) Ltd.

Contractors:
Nason Contracting Group Ltd.
Parkway Enterprises Ltd.

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BACKGROUND

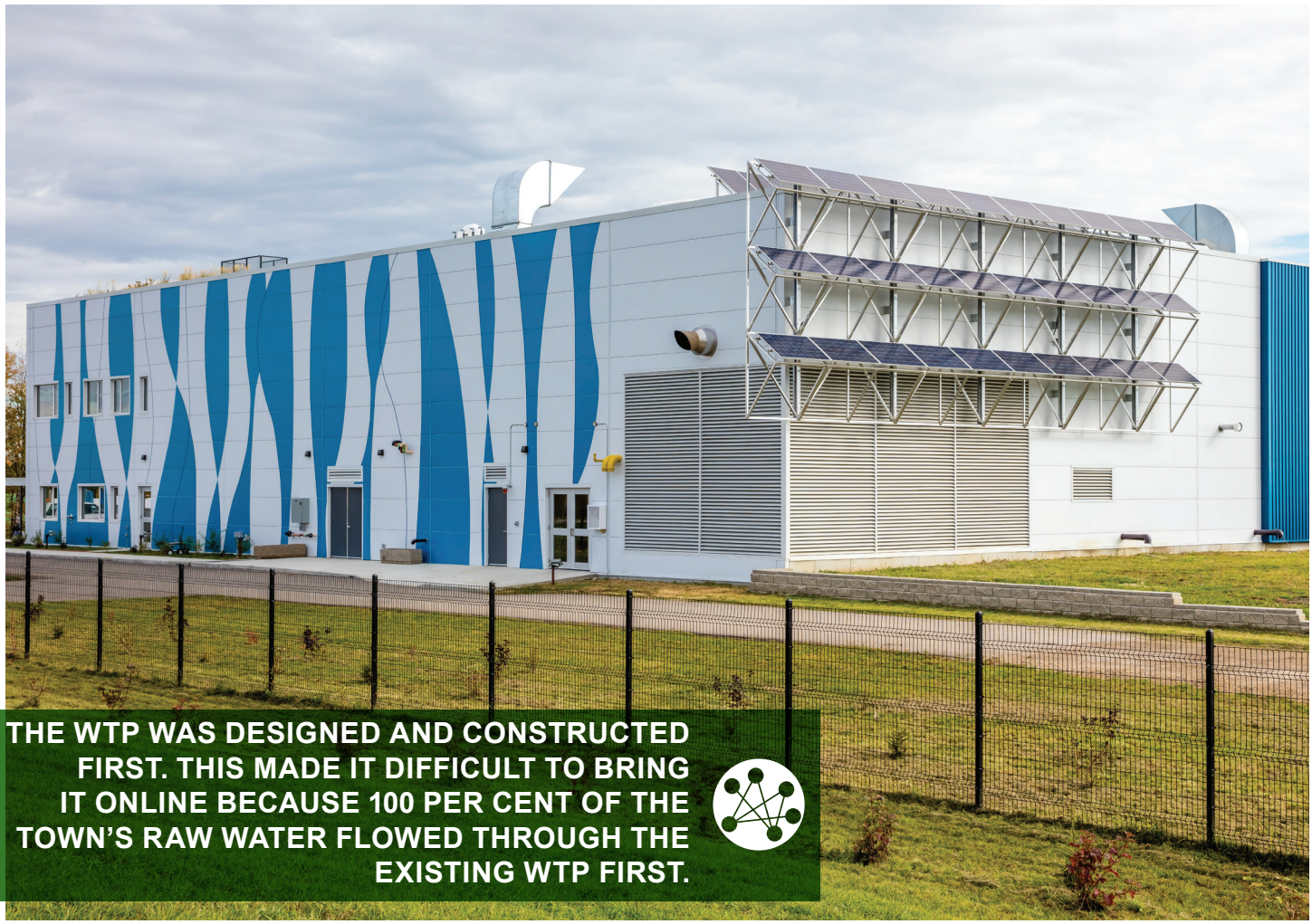
Much like many municipalities throughout Alberta, the Town of Drayton Valley has experienced a dynamic growth in population and civic development. While this growth comes with many positive benefits, it also places inevitable stress on existing infrastructure – especially infrastructure that was designed and built in the early stages of the Town's development.

THE DESIGN WAS LARGELY DRIVEN BY THE TOWN WITH ITS EXPECTATION THAT THE NEW FACILITY WOULD NOT ONLY GROW TO MEET LOCAL DEMAND BUT THE PROJECT WOULD INCLUDE AS MANY SUSTAINABLE AND ENVIRONMENTALLY CONSCIOUS ASPECTS AS POSSIBLE.

Commissioned in 1971, with upgrades completed in 1987 and 2007, the Drayton Valley Water Treatment Plant (WTP) had reached the end of its service life; it was no longer equipped to provide potable water to the Town's existing population and was deemed unfit to sustain further population growth.

Following a mechanical failure, the WTP was shutdown, leaving the Town to face a boil water order for over a week – a new WTP was desperately needed. Leading a team of subconsultants, including Manasc Isaac Architects, Clark Engineering, Golder Associates, Magna IV Engineering and Hoggan Engineering and Testing (1980), ISL Engineering and Land Services (ISL) got right to work developing a solution that would not only meet the current and future demands of the community but was also innovative in its use of ultra-filtration membranes to eliminate existing issues with turbidity, was designed with the Operator at the top of mind and integrated sustainability into nearly every facet of the design. A smooth transition was important to ensure the new treatment process was introduced without further impacting the Town's water supply.

The design was largely driven by the Town with its expectation that the new facility would not only grow to meet local demand but the project would include as many sustainable and environmentally conscious aspects as possible.



THE WTP WAS DESIGNED AND CONSTRUCTED FIRST. THIS MADE IT DIFFICULT TO BRING IT ONLINE BECAUSE 100 PER CENT OF THE TOWN'S RAW WATER FLOWED THROUGH THE EXISTING WTP FIRST.

INTRODUCING THE NEW FACILITY

The primary goal of the project – that is, the true need, was to complete a new WTP to replace the aging facility – one that would be equipped to meet the current and future needs of the Town.

Transitioning from Old to New

While the original plan was to design and construct a new dedicated raw water pump station before the new WTP, the way the funding worked out negated this plan and the new WTP was designed and constructed first. This meant that for the new WTP to receive raw water, the existing WTP and high lift pumping and piping infrastructure had to be modified to achieve dual purpose (i.e., remain the main source of potable water for the Town, while also serving as an interim raw water pump station supplying untreated raw water to the new WTP) with no risk of cross contamination. This required internal piping and control system modifications to effectively create an interim raw water supply system separate from the water treatment process, while coming from the same source of water. The interim raw water supply system will remain in place until a new, fully separate raw water pump system is introduced.

The team made the transition as smooth as possible to ensure that the new treatment process was commissioned without impacting the community's water supply. To reduce errors and minimize disruption to the existing WTP and distribution system while integrating the new plant and watermain connections, the design team, contractor and owner devised a step-by-step commissioning and communication plan with visual diagrams. This plan was an essential element in the successful transition.

Growth and Innovation Meet Demand

At 11,000 ft^2 with a treatment capacity of 18 MLD (millions of litres per day) and a 2,800 m^3 potable water storage reservoir, the new facility has greatly increased capacity to meet current and future demand. The WTP is also the first plant of its kind to use fiber reinforced membranes for a potable water treatment process.

The Drayton Valley WTP is a direct withdrawal plant, extracting water directly from the North Saskatchewan River. Given the high spikes in turbidity that are occasionally experienced from the river and the lack of provisions for solids settling between the river and the treatment process, the team opted to use fiber reinforced membranes. Though these membranes are more commonly used in wastewater treatment, they were beneficial in this application because their strength makes them better able to handle the higher solids. This new ultra-filtration membrane treatment process has eliminated the problems previously experienced by the Town, including the need to declare boil water advisories when the WTP was unable to treat enough water to meet local demands due to high turbidity in the river.

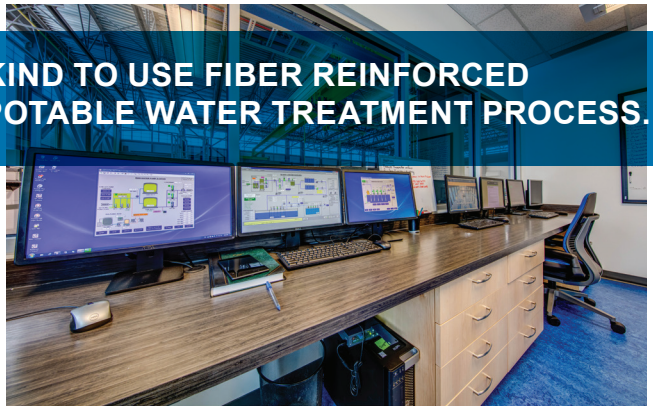
Teaching Operators a New System

ISL anticipated the challenges that the Operators would see going from operating a conventional gravity based water treatment process using clarifiers to a high rate membrane filtration plant and recognized the importance of properly educating them on the design intent of the facility rather than merely showing them how the equipment worked. ISL specified an in-depth training program for all of the Operators complete with both hands-on and classroom training. All training was recorded with high quality video cameras and edited into professional training videos that can be used for future reference.

3DOM-IS

ISL also developed its Operations and Maintenance Information System (3DOM-IS) software platform. 3DOM-IS is a working, interactive 3D model that shows the entire treatment facility and its internal components, allowing the Operator to navigate the plant visually and call up a specific function or process (e.g., record drawings). It is a customized 3D tool that provides quick access to spatially referenced information, makes it simple and intuitive to explore virtual environments and provides pertinent information on demand and in a wide range of formats – it is even available on the Operators' phones. The software is extremely helpful for troubleshooting equipment and performing regular maintenance.

FIRST PLANT OF ITS KIND TO USE FIBER REINFORCED MEMBRANES FOR A POTABLE WATER TREATMENT PROCESS.



REIMAGINING SUSTAINABLE DESIGN AND CONSTRUCTION

The Town was clear in its desire for a WTP with a sustainable focus that would encapsulate the true basics of sustainable design, including improving efficiencies and performance, lowering operating costs, streamlining environmental and material impacts, measuring short and long-term payoffs and redefining the status quo. All of these initiatives would ensure that the new treatment plant exceeded all expectations, while quietly doing the job it was designed for. Committed to inspiring sustainable thinking, ISL took this mission to heart, designing and constructing a state-of-the-art sustainable water treatment facility that included a number of high-performance and efficient sustainable features and considered the environment every step of the way. As ISL Project Manager, Jason Kopan, stated: “It’s not only what’s built, it’s how it’s built”.

Energy Reduction, Cost and Use

During the design phase, the team noted that reducing energy use in buildings was the most cost-effective way of reducing greenhouse gas (GHG) emissions in Canada. ISL incorporated a number of energy efficient building features with both sustainability and cost-savings at top of mind. Many of these features concentrated on harnessing the power of the sun:

- Daylight harvesting offsets the amount of electricity needed to properly light the space. Translucent panels and accompanying sensors were incorporated to detect ambient light levels ensuring that when there is enough daylight, the lights do not come on. Occupancy sensors were also installed, triggering the lights to shut off when nobody is in the vicinity and therefore light is not needed.
- Solar tubes were introduced to the main atrium of the building, bringing a large amount of natural light into the office area of the plant. The tubes look like large, very bright light fixtures but are simply a series of reflectors that bring sunlight down to a radiant dish that then casts the light into the space below.
- A solar wall made up of perforated metal panels built into the walls of the main plant conditions the incoming air in cold winter months, warming it and reducing the amount of natural gas needed to heat the plant. Additional electricity in the office area comes from an array of solar panels.
- Low-E (low emissivity) windows were installed throughout the building. Low-E is an energy efficient glass solution that uses natural light and keeps heat in at the time people will most benefit from it. In the winter, Low-E glass allows in natural light, while keeping rooms heated and in the summer, natural light is let in without damaging UV rays entering through the windows. This natural light reduced the need for electric lights, thereby reducing energy.

After a one-time capital cost for these systems, the energy contribution to building operations is free. While natural gas and electricity availability and price may not be certain, sunlight should be available at no cost for the next 30-50 years.

ISL INCORPORATED A NUMBER OF ENERGY EFFICIENT BUILDING FEATURES WITH BOTH SUSTAINABILITY AND COST-SAVINGS IN MIND.

Free Cooling System

Used by the air handling system during the warmer months of the year to provide cooler air to the office portion of the plant, the free cooling system generates energy savings. To create the system, the team wrapped a section of the large 300 mm diameter stainless steel raw water main that was coming into the plant in heat exchange piping complete with insulation. Since the raw water coming from the North Saskatchewan River is always very cool in temperature, the system capitalizes on the difference in temperature to draw the heat out of the air supplied to the office and consequently cools it.

Green Roof

The green roof atop the office building portion of the plant was installed to reduce the heat island effect that traditional roofing systems cause and reduce the environmental footprint of the plant. The heat island effect occurs when land surface and naturally occurring vegetation are lost, preventing heat from easily escaping. Dark roof surfaces are one of the major culprits of temperature increases. Consequently, one popular technique for combatting the heat island effect is installing green roofs. Lined with soil and vegetation, the green roof helps regain some of the cooling effects typical of natural landscapes and keeps the building interior cooler in the summer because it absorbs the sun's energy. The green roof also helps retain stormwater, sending it to the stormwater management wetland (described below) and provides habitat for insects and birds. The green roof was a pilot project by the Town to showcase what can be accomplished when sustainable technology is applied. For other areas of the roof, a light coloured membrane was applied.

The selection of materials, specifications and design details were all completed with a target of 50 year service life before significant reinvestment is required.

Natural Stormwater Management

On the south portion of the site, the constructed wetland will retain the stormwater not only from the site but also from the soon-to-be-built adjoining residential areas. By holding the water on site long enough for particles to settle out and by using plants to clean nitrogen and phosphorus, the site will naturally treat water for return to the North Saskatchewan River without a more costly process.

Habitat Replacement

Large areas of the site, most recently fallow farmland, will be returned to a natural state to reduce stormwater runoff and restore habitat for native birds, insects, flora and fauna. Habitat disturbance of both dry and wet lands is the primary cause of bird and animal population reduction and minimizing habitat removal is an effective strategy to reduce the impact of municipal infrastructure on wildlife.

Embodied Energy

Embodied energy is the energy consumed by all of the processes related to the frontend construction of a building. This makes material choice and construction methods extremely important because embodied energy content varies between products and materials. In this case, steel and concrete were selected as the key building materials for the plant. While these materials are high embodied energy materials pound for pound, they contribute to a lower operating energy.

The team used concrete with high fly-ash content, reducing the amount of cement (i.e., the biggest CO2 contribution to concrete) required and resulting in a lower embodied energy than if conventional concrete had been used.

Building Modelling

To ensure these sustainability features would perform exceptionally and not hinder the building's operations, the team used the latest energy, daylight and renewable energy computer models to simulate the effect of each design decision. For example, if making windows larger could increase daylight but also heat loss, how would one decide when the benefit of better daylight was outweighed by the increased heating and cooling cost? Running models with different sized windows let the team compare the energy use and daylight effect results to choose the right size for the plant.

Although the building will not qualify as a LEED (Leadership in Energy and Environmental Design) building due to the power requirements of pumps used to feed water to the facility, it includes many of the principles used in LEED buildings.

A MODEL FOR SUSTAINABLE CONSTRUCTION

While the Drayton Valley WTP may have looked like a standard construction site to the casual observer, there was a lot more going on behind the construction fences. To ensure sustainability was carried forward into construction, ISL specified the need for a sustainable approach to managing waste during construction in the contract with Nason Contracting Group Ltd. This meant Nason was expected to recycle all of the materials that could be recycled and only landfill the waste that had absolutely no other suitable option.

Though Nason was initially apprehensive, the company was quick to embrace sustainability, taking initiative and going above and beyond ISL's requirements and expectations for the site. Full adoption of the policies and procedures ensured that all employees made proper waste management and recycling part of their routines. Actions ranged from the smaller touches such as using compostable coffee cups and instituting a no idling policy for vehicles and equipment when not in use, to larger undertakings such as separating out all recyclable material to divert materials from the landfill and crushing excess or unused concrete to use as aggregate for roads and backfill. Wood waste was also stripped of all nails and sent to Valley Power for its use, while ash from the burnt wood was distributed for use balancing pH levels in local fields. In addition, as many materials as possible were sourced locally to support local business and cut down the environmental impact of trucking it in.

With seven pages worth of environmental initiatives being undertaken on the site during construction, Nason monitored the impact the measures had on the overall construction footprint and soon found its team favouring this new way of doing things. As it turned out, although there was a learning curve for subcontractors on site, adopting a sustainable approach not only lessened the environmental impact of construction, but it actually resulted in a cleaner and safer site. After directly experiencing the benefits of the sustainable approach ISL specified, Nason has gone on to adopt a similar approach on other projects.

ADOPTING A SUSTAINABLE APPROACH NOT ONLY LESSENED THE ENVIRONMENTAL IMPACT OF CONSTRUCTION, BUT IT ACTUALLY RESULTED IN A CLEANER AND SAFER SITE

DELIVERING A CENTRE FOR WATER INTELLIGENCE

The facility is not only an operating WTP and model for the sustainability, but it also brings water treatment to the forefront with educational components designed to make the WTP a true centre of excellence.

In what seemed a logical move, the new WTP was built in the uplands, closer to the community, the wastewater treatment facility and one of the major stormwater management outfalls that services the Town. This formed a hub or campus of water resource services and presented Drayton Valley with a unique opportunity to showcase how water is managed within the Town in terms of being used for drinking water, being treated effectively as wastewater and being managed properly as stormwater. This water campus evolved into the Centre for Water Intelligence – a place for the community to visit and learn about what the Town does to manage water and a place for further research into water and wastewater treatment technologies and advancements (i.e., a place to learn new ways of doing things within the industry).

Creating an Inviting and Educational Outdoor Space

A first step towards increasing public awareness regarding water treatment occurred when the new WTP was built in the uplands, closer to the community where residents will more regularly see the facility. To encourage residents to actually visit the new WTP, to welcome them to the site and to accomplish the longer term goals of public education, park space was developed adjacent to the plant and around the stormwater management pond. This park space is connected to the walkable pathway system that the Town has developed. The longer term goal for this park space is to continue to enhance the landscaping and create and install interpretive signage to highlight how the water is managed.

Offering a Glimpse Inside

With community and public education in mind, a large space was created on the main floor of the plant to host tours. The space is complete with seating and a large floor-to-ceiling glass window that invites visitors to take a look inside and see the equipment that is used to turn North Saskatchewan River water into the clean and safe drinking water that comes out of the Town's taps.

A FIRST STEP TOWARDS INCREASING PUBLIC AWARENESS REGARDING WATER TREATMENT OCCURRED WHEN THE NEW WTP WAS BUILT IN THE UPLANDS, CLOSER TO THE COMMUNITY WHERE RESIDENTS WILL MORE REGULARLY SEE THE FACILITY.

CONCLUSION

Drayton Valley WTP is not only a model water treatment facility but also a model for sustainable design and construction, as well as water resource education. Mindful of what the Client wanted, the team integrated sustainability into the design and went so far as to ensure the Contractor adopted sustainable construction practices. As a company that aims to inspire sustainable thinking, this project was an opportunity for ISL to put a sustainable approach into practice. For Nason Contracting Group Ltd., the project was an opportunity to learn an entirely new approach that proved so effective at keeping the site clean and safe, in addition to its environmental benefits, that the company has since adopted and integrated it into its other projects. Consequently, sustainability as it relates to the Drayton Valley WTP went far beyond the enhancements seen and heard about at the site – it was an important education piece and actually resulted in lasting behaviour changes.

DRAYTON VALLEY WATER TREATMENT PLANT PROJECT – AT A GLANCE!

Innovation	• First WTP of its kind to use fiber reinforced membranes for a potable water treatment process. • At 11,000 ft^2 with a treatment capacity of 18 MLD (millions of litres/day) and a 2,800 m^3 potable water storage reservoir, the WTP has greatly increased capacity to meet current and future demand. • Designed with the Operator in mind. • ISL developed an in-depth operators' training program and 3DOM-IS
Complexity	• Minimized disruption to the existing WTP and distribution system while integrating the new plant and watermain connections. • The original plan was to design and construct a new dedicated raw water pump station before the new WTP but the way the funding worked out negated this plan and the WTP was designed and constructed first. This made it challenging to bring the new WTP online because 100% of the raw water that the Town had access to, flowed through the existing WTP first.
Social / Economic Benefits	• Provided the Town with the Centre of Water Intelligence complete with sustainable elements. • Used a membrane filtration system to ensure that the WTP could treat enough water to meet local demands and prevent further boil water advisories. • Moved the WTP up from the river bank and more into the public's awareness. • The selection of materials, specifications and design details were completed with a target of 50-year life before significant reinvestment is required. • A large multipurpose room was created on the main floor of the WTP, complete with seating and a floor to ceiling glass window providing a view of the treatment plant floor and equipment. • Developed park space adjacent to the plant and around the stormwater management pond. The plan is to eventually make this a space for education.
Environmental Benefits	• Reduced energy use thereby decreasing GHG emissions. Energy efficient building features include daylight harvesting, solar tubes, a solar wall, Low-E windows, a green roof and a free cooling system. • Selection of materials, specifications and design details were all completed with a target of 50-year service life. • Constructed wetland retains stormwater from the site and adjoining residential areas, naturally treating the water for return to the North Saskatchewan River. • Large areas of the site will be returned to a natural state to reduce stormwater runoff and restore habitat. • High fly-ash content reduced the amount of cement required, resulting in a lower embodied energy. • Modelled sustainability features. • Called for sustainable approach to managing waste during construction in the specifications for the contract with Nason. Following these practices helped Nason maintain a cleaner and safer site and after experiencing the benefits, Nason adopted a similar approach on other projects. • Sourced local materials wherever possible.
Meeting the Client's Needs	• Replaced the aging facility with one that was equipped to meet the Client's current and future needs. • Made innovative use of ultra-filtration membranes to eliminate turbidity issues and ensure the Town would not require any more boil water advisories. • Ensured a smooth transition – commissioning the new treatment process without impacting the community's water supply. • Integrated sustainability into nearly every facet of the design and went a step further by stipulating that the Contractor take a sustainable approach to waste management. • Adapted the design to meet the Client's growing need for water resource education.