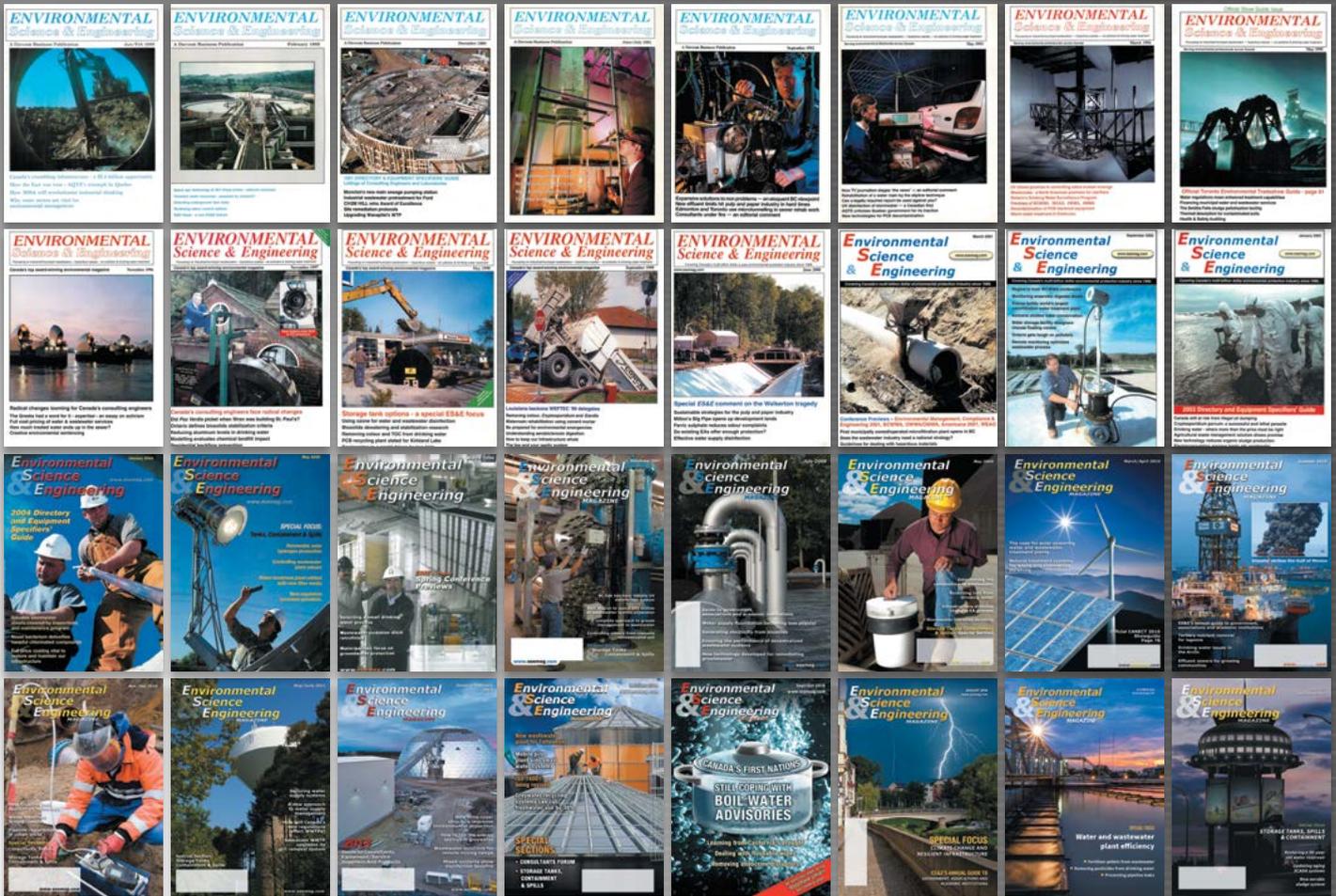


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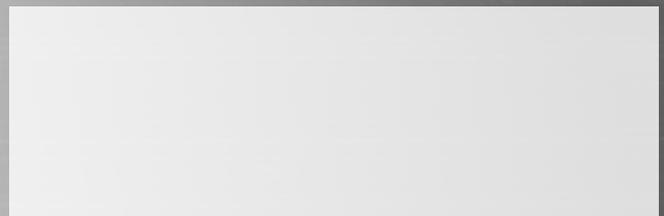


## 2018 Guide to Consultants, Equipment/ Service Suppliers and Products

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safer aeration system maintenance

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evaluating OGS devices

Optimizing drinking water plant  
coagulation and flocculation processes

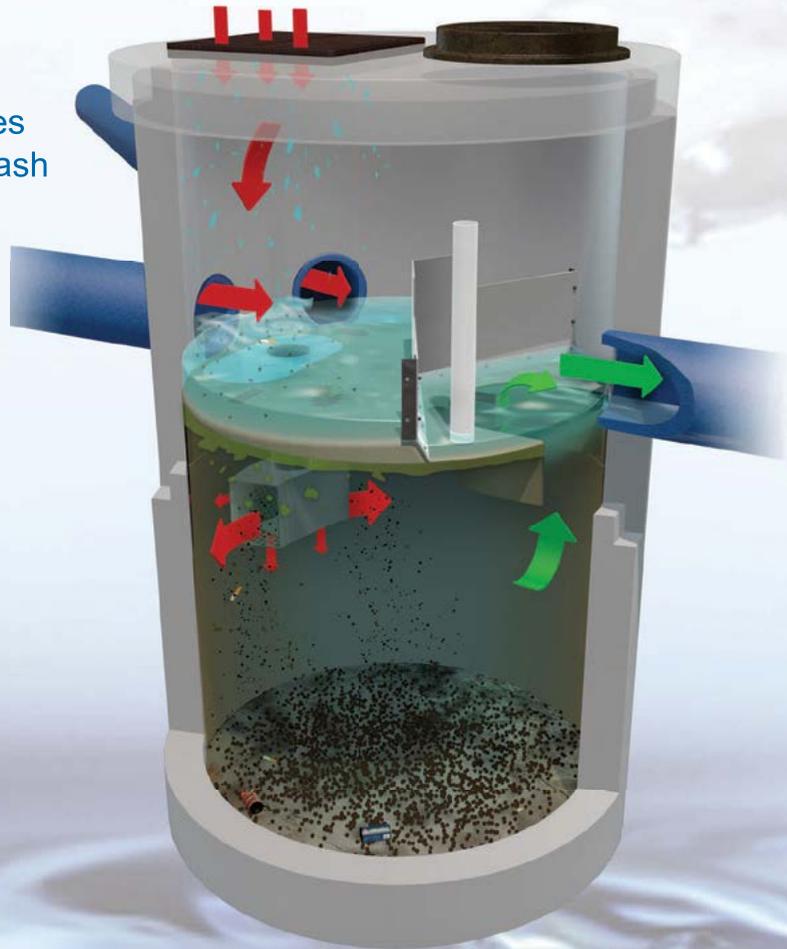


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# WATER: IS IT STILL CANADA'S MOST NEGLECTED RESOURCE?

This issue marks 30 years since the publication of *Environmental Science & Engineering Magazine's* first issue. As part of our anniversary year, *ES&E* will be revisiting and exploring important topics, technologies and events that have impacted Canada's water, wastewater and environmental protection industries.

To kick-off, we go back to our February 1988 inaugural issue, where we published an exclusive review of then Federal Environmental Minister Tom McMillan's perceptions about the state of Canada's water sector.

In 1987, *ES&E* staff met with Mr. McMillan in both Ottawa and again in Philadelphia at WEFTEC '87, where his vigorous presentations were well received by some of North America's top environmental professionals. We thought it would be interesting to see how much has changed during the three decades that have passed since then.

## WATER CONSUMPTION AND PRICE

**Minister McMillan:** "Among industrialized countries, our consumer price for water is the lowest. We must start viewing water not only as a key to environmental health – but also as a scarce commodity

## WATER: Canada's most neglected resource

*ES&E* Staff met with Federal Environmental Minister Tom McMillan in both Ottawa and Philadelphia last year where his vigorous presentations were well received by some of North America's top environmental professionals. In Philadelphia, we conducted an exclusive review of his subsequent views which we are proud to publish in our inaugural issue. Mr. McMillan's portrait is by world renowned photographer Karan of Ottawa.



© 1987 Karan, Ottawa

our country is the world's most water of water. Among industrialized countries, our consumer price for water is the lowest. We must start viewing water not only as a key to environmental health, but also as a scarce commodity that has real value. And we should begin managing it – and pricing it – accordingly. In part of Canada's fresh water abundance that we Canadians can continue to overuse and abuse it in the way we have done in recent decades.

If water is so cheap, why are water treatment and delivery systems across Canada currently valued at \$30 billion? If water is both cheap and abundant, why are some Torontonians proposing a \$200 million pipeline to transport

water from Georgian Bay to the city? If water is truly cheap, why do Canadians spend \$100 million a year on bottled drinking water?

If Canadians view water as cheap, and they do, it is because, as a nation, they have never had to pay anything close to what it costs to deliver it past the tap. It is arguably the single most heavily subsidized commodity in the marketplace today.

Canadians are willing to pay \$18,000 for a cubic metre of whiskey and \$200 for the same amount of oak. And yet they have never been asked to pay more than 50 cents for a cubic metre of pure water delivered not merely to the door, but to every drop of the house, not to every room. Canadian water is at once the world's best bargained and the most devalued; for we pay dearly in the long run for such sloppiness. By underpricing our water, we encourage its waste. And by underpricing water, we encourage its abuse. Municipalities are foregoing a source of revenue badly needed to ensure that water is, in fact, the world's most abundant and precious resource.

Water pollution has become so bad in this country that vast numbers of Canadians cannot take water quality for granted in their own homes. What is more, of Ontario, only 10 per cent of the country's population (25 million people) live in a jurisdiction that do not treat their sewage. Elsewhere, sewage treatment systems are in such deplorable shape that it will cost \$3 billion over the next five years

to repair aging underground pipes alone.

Faced with these bills, municipalities in every part of Canada are seeking a quick fix. Having ignored the problem for so long, without planning for the day of reckoning or budgeting for it, they are turning to the federal government to help bail them out. The federal government can neither the cash nor the jurisdiction to do so. At a time when the federal government is too likely to pay its own bills without creative borrowings, it is certainly not in a position to pay the bills of other governments.

Indeed, 33 per cent of all federal revenues are now required to service the Government of Canada's accumulated debt. By contrast, only 10 per cent of revenues are required to service provincial debts. For municipalities, the figures are only 9 per cent. The federal government is, in fact, the most severely strapped jurisdiction in the country. It is therefore, the least able to inject more debt for any purpose, let alone for municipal infrastructure programs.

There is, by any standard, little more the federal government can do to help address the problem. The federal government does not intend to re-launch multi-billion dollar programs to support municipal waterworks projects. Least of all, we intend to do so in a way that will perpetuate provincial indebtedness. It is the federal government's policy that wastewater, underground, sewerage and water waste at the federal government's expense.

The Federation of Canadian Municipalities expects that infrastructure rehabilitation is beyond the fiscal capacity of local governments. But given

that has real value. And we should begin managing it – and pricing it accordingly."

According to a 2011 report by the Canada West Foundation ([www.cwf.ca](http://www.cwf.ca)) prices charged for water and wastewater services vary greatly among Organisation for Economic Co-operation and Development (OECD) nations. On a national level, OECD nations with the lowest charges for water and wastewater services per m<sup>3</sup> are Mexico (\$0.49), Ireland (\$0.65), and Korea (\$0.77). OECD nations with

the most expensive water and wastewater services are Denmark (\$6.70), the United Kingdom (\$4.77), and Belgium (\$4.03). At \$1.50 per m<sup>3</sup>, Canada certainly trends toward the lower end, as does the U.S. at \$1.25.

**Minister McMillan:** "In Europe, water charges are four times higher than in Canada, and per capita use is less than half that of Canada." As reported in *The National Post*, a 2008 study showed Canadians used an average of 329 litres of water per person, per day. This is second only to the U.S. in the developed world, and is still more than twice as much as Europeans use.

**Minister McMillan:** "If water is both cheap and abundant, why are some Torontonians proposing a \$200 million pipeline to transport water from Georgian Bay to the City?"

This pipeline has thus far not been needed. In fact, capacity upgrades to its four treatment plants and extensive water conservation programs have enabled the City to sell surplus water to other jurisdictions, including York Region, where it goes as far north as Newmarket.

**Minister McMillan:** "If water is truly cheap, why do Canadians spend \$100 continued overleaf..."

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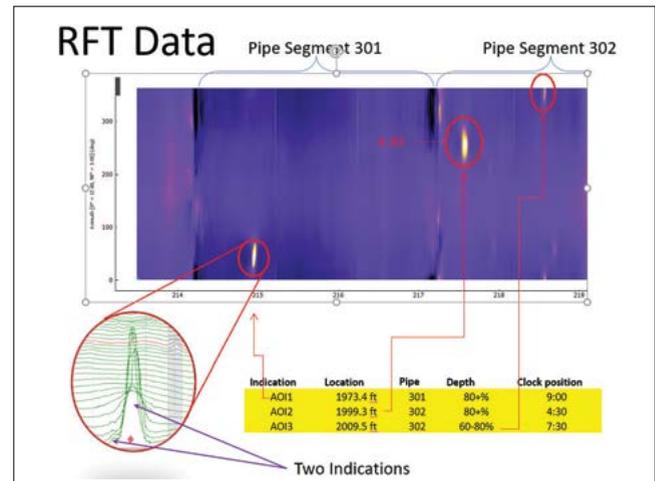
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million a year on bottled drinking water?"

The bottled water issue seems to have grown increasingly contentious. In recent years, when parts of Ontario and British Columbia were under drought conditions, news that Nestlé was pumping millions of litres of water per day for next to nothing prompted outrage and boycotts from activist groups, such as the Council of Canadians.

In 2016, the Government of Ontario announced a moratorium on new and expanded water takings by bottlers and raised prices on August 1, 2017, from \$3.71 for every million litres of ground-water taken to \$503.71.

Yet since 1988, bottled water consumption has ballooned in Canada, with sales reaching \$2.5 billion (2.5 billion litres) in 2016, according to Euromonitor International.

**Minister McMillan:** "Canadians are willing to pay \$18,000 for a cubic metre of whiskey and \$800 for the same amount of cola. And yet they have never been asked to pay more than 50 cents for a cubic metre of pure water... Unless we put in place a more realistic pricing policy, the country will have neither the funds to deliver pure water to Canadians nor the incentive to ensure it remains available for future generations."

Currently, a cubic metre of Seagram V.O. whiskey from Ontario's liquor stores (LCBO) would cost about \$32,500, not far from double the price 30 years ago. Interestingly, cola has appreciated relatively moderately, with a cubic metre of cola costing about \$860 at Walmart. A cubic metre of water in Aurora, Ontario, where ES&E is based, costs \$2.29. This is roughly 50% higher than the 2011 average of \$1.50 and 450% the price in 1988. (Note: If you happen to purchase cola and liquor by the cubic metre, please let ES&E know the bulk price you pay and we'll update our numbers accordingly.)

As more municipalities recognize the need for full cost recovery to pay the true cost to operate and maintain their water systems, we can expect water rates to continue to rise.

## WASTEWATER TREATMENT

**Minister McMillan:** "East of Ontario, only 10% of wastewater is treated; in all,

a third of the Canadian population (8 million people) live in municipalities that do not treat their sewage."

According to Statistics Canada, in 2006, Canadian municipalities generated a daily average of 668 litres of wastewater per person. Of Canadians served by sanitary wastewater collection systems, wastewater was treated at the secondary level, or better, for 79% of the population. Almost 2% were not served by wastewater treatment facilities at all. In 2009, 82% of Canadians lived in dwellings connected to municipal sewer systems, while 13% used private septic systems and 1% used communal septic systems.

## INFRASTRUCTURE COSTS

**Minister McMillan:** "It will cost \$3 billion over the next five years to repair aging underground pipes alone."

Progress on the infrastructure deficit has not been positive. According to the 2016 Canadian Infrastructure Report Card, target average annual reinvestment in linear assets (pipes) for potable water is 1% - 1.5%, yet the actual rate of 0.9% falls short. Survey results from jurisdictions accounting for 19 million residents showed the replacement value of wastewater assets in poor or very poor condition is \$26 billion. The replacement value of potable water assets in poor or very poor condition is \$25 billion.

Mr. McMillan held political office for several years after serving as Environment Minister. In 2017, he wrote a book entitled *Not My Party: The Rise and Fall of Canadian Tories from Robert Stanfield to Stephen Harper*, based on his experiences and studies.

It was an honour to have published his opinions in our inaugural issue and to this day we are grateful he gave us much needed support when we first started.

If you have suggestions on what we should revisit in our coming issues, please let us know.

Steve Davey is editor and publisher of ES&E Magazine. Email: [steve@esemag.com](mailto:steve@esemag.com)





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**BC MOVES TO IMPROVE ENVIRONMENTAL PROTECTIONS FOR COASTAL AREAS**

The BC government is moving to protect the environment and health of wild salmon by strengthening the requirements for fish processing and finfish aquaculture operations.

The Ministry of Environment and Climate Change Strategy will begin a review of fish processing plants to ensure waste materials produced from these operations do not affect wild salmon stocks. The purpose of the review is to ensure provincial regulations and permits governing waste discharge from fish processing are informed by the best available science and best practices in other jurisdictions, and that fish processing discharge is free of contaminants and pathogens.

In addition, the ministry will immediately review whether treatments for sea lice are scientifically supported and are consistent with best practices in other jurisdictions. Results from this review will inform potential changes to the Integrated Pest Management Regulation, which regulates sea lice treatment.

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**MORE MEASURES PROPOSED TO PROTECT BC FROM SPILLS**

The BC government is proposing a second phase of regulations to improve preparedness, response and recovery from potential spills.

The first phase of the regulations, approved in October 2017, established a standard of preparedness, response and recovery necessary to protect the environment. With some exceptions for oil and gas regulated entities, the Phase-1 regulations apply to pipelines transporting any quantity of liquid petroleum products, and rail or trucking operations transporting over 10,000 litres of liquid petroleum products. For the second phase, the Province will be looking for feedback in five areas:

- Response times, to ensure timely responses following a spill;
- Geographic response plans, to ensure resources are available to support an immediate response, that take into account unique characteristics of a given

sensitive area;

- Compensation for loss of public and cultural use of land, resources or public amenities in the case of spills;
- Maximizing application of regulations to marine spills; and
- Restrictions on the increase of diluted bitumen (“dilbit”) transportation until the behaviour of spilled bitumen can be better understood and there is certainty regarding the ability to adequately mitigate spills.

An independent scientific advisory panel will be established to make recommendations to the Minister of Environment and Climate Change Strategy on if and how heavy oils can be safely transported and cleaned up, if spilled.

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**UN RECOGNIZES QUEBEC’S LEADERSHIP IN PROTECTING THE OZONE LAYER**

The United Nations Environment Programme (UNEP) awarded Quebec the Political Leadership Award, at the November 2017 Ozone Awards ceremony, held in conjunction with the 11th meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer and the 29th meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer.

Quebec received the honour in recognition of its efforts to ban ozone-depleting substances (ODS). It is worth noting that Quebec decided to link its approach to protect the ozone layer to its overall strategy to combat climate change. The reduction in the use of halocarbons is a specific measure in the 2013-2020 Action Plan on Climate Change. Moreover, under Quebec’s International Policy launched in April 2017, the government appointed an emissary responsible for climate change and northern and Arctic affairs to broaden their influence on the international scene and promote Quebec’s positions in this field.

By overseeing the installation of equipment that requires halocarbons, the Quebec measures go beyond the tools that target the manufacture and importing of such equipment elsewhere in the world. The province is also seeking to subject

air conditioning and refrigeration equipment to extended producer responsibility (EPR), an initiative that should engender additional benefits by capturing greater amounts of ODS and halocarbons before they reach the atmosphere.

**QUEBEC TO CREATE A VAST PROTECTED AREA**

Quebec has announced the creation of an extensive Caribou-Forestiers-de-Manouane-Manicouagan protected area on the Côte-Nord and Saguenay-Lac-Saint-Jean territories.

From a sustainable development perspective, the creation of this protected area, where the highest densities of woodland caribou are observed in Quebec, will ensure the protection of a high-quality habitat for this species, which has been designated as vulnerable since 2005.

The vast protected area will stand out by its size and will meet the specific needs of caribou in order to ensure their survival. The creation of this biodiversity reserve will cover an area specific to the woodland caribou of approximately 10,200 km<sup>2</sup>, which is 21 times the size of the Island of Montreal, and will add nearly 7,000 km<sup>2</sup> to Quebec’s network of protected areas.

As a result, the proportion of Quebec’s protected land and freshwater territory will reach 11.1% (the target is 17%) and the proportion of protected territory covered by the Plan Nord will climb to 12.4% (with a target of 20% by 2020). This takes into account the planned biodiversity reserve projects that have been previously announced.

**IMPROVING ALBERTA’S WATER AND WASTEWATER SERVICES**

Recently, Amarjeet Sohi, Minister of Infrastructure and Communities, and Brian Mason, Alberta Minister of Transportation, were joined by Vermilion Mayor Caroline McAuley to announce federal-provincial funding of more than \$16.3 million for four water and wastewater projects in Alberta.

In the towns of Vermilion, Barrhead  
*continued overleaf...*

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and St. Paul, wastewater treatment plant upgrades will increase capacity and ensure cleaner water is released back into the environment. In the Municipal District of Pincher Creek, a new water reservoir for the Hamlet of Beaver Mines will ensure an emergency supply of clean drinking water is available at all times.

These investments are part of an agreement between Canada and Alberta for the Clean Water and Wastewater Fund. With these new projects, a total of 66 water projects will benefit communities across the province.

This new system will manage the distribution of treated effluent through pumps and valves controlled by an integrated SCADA system. This project will ensure residents benefit year round from more reliable wastewater treatment and distribution.

As part of this \$2.9 million project, the federal government is providing \$1.45 million, the provincial government is providing \$725,000, with the Village of Westport funding the remaining \$725,000.

[www.ontario.ca/buildon](http://www.ontario.ca/buildon)

### UPGRADING WATER AND WASTEWATER SERVICES

Bob Chiarelli, Ontario Minister of Infrastructure and Robin Jones, Mayor of the Village of Westport, Ontario, recently announced funding for a large sub-surface disposal system in the Village of Westport through the Clean Water and Wastewater Fund.

### UNINTENDED CONSEQUENCES OF MUNICIPAL WATER CONSERVATION

Indoor residential water conservation can have unintended consequences in places where wastewater reuse has been implemented, diminishing both the quantity and quality of influent available for treatment, according to researchers

from the University of California, Riverside (UCR).

The researchers outlined their findings in a recent paper, which appears online in the journal *Water Research*, published by the International Water Association.

In the past, recycled water was only applied to areas such as low-value crops and median strips. Recently, however, it has been considered safe to drink, provided it either undergoes multiple rounds of treatment to remove concentrations of salts, nutrients, and other contaminants, or is injected into the ground and pumped back out later.

However, as wastewater flows decrease, their levels of salinity and other pollutants increase. Higher levels of pollutants present significant challenges for treatment facilities that are not typically designed to handle elevated concentrations of total dissolved solids, nitrogen species, and carbon.

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be implemented to mitigate the water quality effects, increasing the value of the remaining effluent for reuse, whether it is for surface water augmentation, groundwater replenishment, or irrigation of crops, golf courses, or landscapes.

To develop an economic model by which wastewater can be treated in a more cost-effective way, thereby increasing its value, the researchers identified feasible wastewater treatment technologies and wastewater treatment trains either in use or available for potential use.

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### GREASE CUP COLLECTION PROGRAM LAUNCHES CANADA-WIDE

To address the fallout of paying \$600,000 a year to flush out “fatbergs” from its wastewater system, the City of London, Ontario has found success and clog prevention in its “Your Turn” collection cup campaign that allows citi-

zens to store and return kitchen fats, oils and grease, known as FOG.

Since the FOG collection program began in 2013, some 100,000 32-ounce paper cups have been distributed across London’s 381,000 service residents, saving the city more than \$100,000 each year on its drain diversion program. It’s also been fatberg free for three years.

“People want to do the right thing but it also has to be convenient,” Barry Orr, sewer outreach and control inspector for the City of London, said in a statement to media.

In collaboration with London, Montreal-based FluksAqua, an online forum for water utility professionals, has elevated the program’s profile and generated actual collection opportunities across Canada and the U.S., stoking interest as far away as Australia and Japan.

December marked the rollout of the national campaign for Your Turn FOG cup collection across Canada. Ontario municipalities like Sarnia, Windsor,

Sudbury, Oxford County, Middlesex Centre and Central Elgin are already on board. Your Turn has spoken to municipalities in Alberta and New Brunswick about joining the program as well.

“Water professionals regularly discuss their frustration at the expense, environmental damage and safety issues of maintenance personnel caused by fatbergs,” said Dr. Hubert Colas, President Americas, FluksAqua. “With easy access to Your Turn cups through our campaign, we’re hoping municipal water professionals will sign up to bring cups to their communities and residents will use the Your Turn cups to keep FOG out of the water system.”

BC is also in talks to join the Your Turn program, but has also taken independent efforts to fight fatbergs through a public awareness video ad campaign. Metro Vancouver says it spends some \$2 million every year to unblock FOG from its sewer pipes.

[www.getyourfogcup.com](http://www.getyourfogcup.com)

*continued overleaf...*

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**UPGRADES LEAD TO END OF 11-YEAR WATER ADVISORY**

Kelowna’s wastewater treatment plant has existed in British Columbia since the early 1900s, undergoing a series of periodic upgrades. Now, for the first time in 11 years, about 18,000 Kelowna residents are no longer subject to a tap water quality advisory.

The Glenmore-Ellison Improvement District, with approval from Interior Health, has removed the advisory for people in Kelowna’s Glenmore area. Since the advisory was issued in 2006, the district has undertaken various projects to improve the quality of the water drawn from Okanagan Lake.

The district’s system, originally supplied from Mill Creek, faced issues of chronic turbidity and frequent colour issues, according to Interior Health. To improve water quality and service delivery, the district added nearly \$20 million in infrastructure, including a deep-water intake and a high-capacity pump station from Okanagan Lake, along with a \$3.6-million ultraviolet treatment facility and a treated water storage reservoir.

About 600 Ellison area residents serviced by the improvement district remain under a water quality advisory, pending further system improvements expected to be completed within two years.

**WATER TESTING LABORATORY AND OWNERS FINED**

Following two investigations, Central Ontario Analytical Laboratory Inc. (COAL) and its three owners were charged and convicted under the *Safe Drinking Water Act (SDWA)*.

According to the Ministry of the Environment and Climate Change, the convictions relate to offering or providing a drinking water testing service without authority or not in accordance with a drinking water testing licence, and conducting a drinking water test contrary to a drinking water testing licence.

The fines issued to the company and its owners total \$246,500 and the victim fine surcharges amount to \$61,625. Additionally, the court issued an Order that prohibits COAL, 2293560 Ontario Inc., Lesley Johnston, Teresa Johnston,

and Russell Johnston from ever holding or applying for a drinking water testing licence under the SDWA.

[www.news.ontario.ca](http://www.news.ontario.ca)

**AEROSPACE COMPANY FINED FOR FAILING TO REPORT OIL SPILL**

Aerospace company Vac Aero International Inc. (Vac Aero) has been fined for failing to notify the Ontario Ministry of Environment and Climate Change of a spill of a pollutant to the environment.

The company operates a facility on Speers Rd. in Oakville (the site) and specializes in heat treating aerospace landing components. The company uses oil quench vacuum furnaces, with a brand of oil known as Iloquench 33 Oil.

According to the MOECC, on August 23, 2015, approximately 27,750 litres of oil discharged from an on-site furnace when a joint coupling on the piping system separated. Some of the oil discharged to the storm sewer, which eventually led to 14 Mile Creek, causing a sheen and discoloration on the surface of the creek.

Vac Aero employees eventually identified that the total volume of oil lost from the furnace was greater than the amount captured in the oil-water separator, and placed absorbent pads around the storm sewers on and around the site. The MOECC said that at no point was it notified by Vac Aero of the spill.

[www.news.ontario.ca](http://www.news.ontario.ca)

**MB TO STRENGTHEN WATERSHED MANAGEMENT**

The Manitoba government has proposed new legislation aimed at strengthening watershed management in the province through measures that would include protecting wetlands, improving approval processes and enforcement for drainage projects, and modernizing the conservation districts program.

*The Sustainable Watersheds Act* makes amendments to the *Conservation Districts Act*, the *Manitoba Habitat Heritage Act*, the *Water Protection Act* and the *Water Rights Act*. The new proposed Act would include a number of key changes, including the establishment of nutri-

ent targets to help measure water quality across jurisdictions and supporting transboundary water management for improved water quality and reduced impacts of flooding and drought.

The legislation would also set out a foundation to implement Growing Outcomes in Watersheds (GROW), which is programming for ecological goods and services that is based on the Alternative Land Use Services (ALUS) model. GROW would incentivize agricultural producers and other landowners to participate through best management practices in the areas of grassland and wetland restoration, water retention projects, and management of riparian areas.

[www.news.gov.mb.ca](http://www.news.gov.mb.ca)

**PURE TECHNOLOGIES ACQUIRED BY XYLEM**

Xylem is expanding its intelligent water services portfolio with its planned acquisition of infrastructure inspection and monitoring company Pure Technologies Ltd.

Pure Technologies is an international asset management, technology and services company which has developed patented technologies for inspection, monitoring and management of critical infrastructure. It offers: technical services including pipeline inspection, leak detection and condition assessment; asset management, primarily in the area of pipeline condition assessment for water and wastewater infrastructure; sales of proprietary monitoring technologies for pipelines, bridges and structures; and data analysis, site maintenance, and from technology licensing.

“The addition of Pure Technologies will strengthen Xylem’s position as a leading provider of intelligent solutions that address the water industry’s most persistent problems,” said Patrick Decker, Xylem president and chief executive officer. “Aging infrastructure is a top concern of water utilities around the world, and infrastructure assessment is an attractive, growing market that directly addresses this challenge in a cost-effective way.”

[www.puretechltd.com](http://www.puretechltd.com)

# Martin Jobke appointed as President of Associated Engineering



Martin Jobke, P.Eng. has accepted the role of President of the Associated Engineering group of companies, effective January 1, 2018. As part of the company's leadership succession, Associated Engineering's Board of Directors selected Martin, a civil engineer with 33 years of experience, to succeed President & CEO, Kerry Rudd, P.Eng., who retains the role of CEO. Kerry states, "Martin has demonstrated leadership and a vision for integrated, collaborative project delivery that will support our clients and guide Associated Engineering's continued growth and path forward."

Martin says, "I look forward to meeting our clients across Canada. Our clients can count on our continuing service, quality, and innovation to deliver resilient and sustainable solutions for their projects."

Associated Engineering is an employee-owned, Canadian consulting firm with a 70-year history of providing uncompromising, client-focussed service. Our commitment to client satisfaction, technical excellence, and innovation has resulted in national and international recognition, including twice winning the Schreyer Award, the highest award for Canadian consulting engineers.

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## ACEC MAKES INFRASTRUCTURE SPENDING RECOMMENDATIONS TO FEDERAL GOVERNMENT

The Association of Consulting Engineering Companies (ACEC) is the national voice of consulting engineering in Canada. Consulting engineers are experts in infrastructure and will be directly involved in delivering the federal government's \$126 billion commitment to infrastructure.

ACEC believes that infrastructure can be an effective investment in our social, economic and environmental quality of life. However, priority should be given to core infrastructure that grows the economy, creates jobs and expands the tax base. Growing the economy will be essential to making further investments in community and social infrastructure viable and sustainable in the long term.

Sufficient, up-to-date and well-maintained infrastructure creates wealth. In its 2010 report *Lessons from the Recession and Financial Crisis*, the Conference Board of Canada concluded that every dollar spent on infrastructure has the potential

to increase GDP by as much as \$1.20. By contrast, infrastructure under-investment is costing the Canadian economy 1.1% of real GDP annually and reducing the long-term profitability of Canadian businesses by an average of 20%, according to *Public Infrastructure Underinvestment: The Risk to Canada's Economic Growth* by the Residential and Civil Construction Alliance of Ontario (2010).

The Senate Standing Committee on National Finance recently released its interim report on federal infrastructure programs, entitled *Smarter Planning, Smarter Spending: Ensuring Transparency, Accountability and Predictability in Federal Infrastructure Programs*. ACEC is supportive of the current federal infrastructure programs and believes that the recommendations are sound public policy that will improve and further strengthen federal infrastructure programs.

The following recommendations are practical, pragmatic and very much consis-

tent with what ACEC has been advocating the federal government should do:

- Release all data on infrastructure projects, except where national defence and security are at stake, and that it also reports all provincial, territorial and municipal data on infrastructure projects.
- Develop a long-term national infrastructure strategy with clear priorities, concrete objectives and specific performance measures. This strategy should take into consideration municipal, provincial and territorial priorities as well.
- Report to Canadians on the achievements of the two stated goals of the infrastructure funding program, which are job creation and the delivery of sustained economic growth.
- Take appropriate measures to make up for delays that can occur in infrastructure spending.
- Continue its efforts by focusing on investments in basic and strategic infrastructure, such as broadband Internet

connectivity, to improve the quality of life of Canadian communities and enable Canada's rural, northern and Indigenous communities to fully share in the country's economic growth.

- Clearly define the governance of the Canada Infrastructure Bank, its business model, its practices and its strategic objectives.
- Ensure the independence of the chairperson and the board of directors of the Canada Infrastructure Bank by drawing on Canadian and international best practices in governance.

### NATIONAL INFRASTRUCTURE CORRIDORS

Currently, Canada has a fragmented and uncoordinated approach for planning and approvals, which is delaying and discouraging projects that could otherwise provide market access for Canadian products, allow movement of goods and services, provide energy, and otherwise grow the economy of regions

across Canada.

ACEC recommends that the federal government work with all levels of government and relevant stakeholders to identify and acquire lands and to facilitate the securing of required approvals for a network of national infrastructure corridors. A nationwide network of these corridors would connect all regions of Canada, help address social and environmental concerns and facilitate the planning, development and implementation of both public and private infrastructure projects in a less costly and more time-effective manner.

As recently as June 2017, a Senate report entitled *National Corridor: Enhancing and Facilitating Commerce and Internal Trade* proposed the building of a national infrastructure "right-of-way" across Canada's North and near north. The concept of such corridors is pre-established passages dedicated to accommodating multiple infrastructure assets, including road, rail, power, pipeline and communication projects. The

Senate report drew upon a recent study by the University of Calgary School of Public Policy, which in turn was inspired by a proposal by General Richard Rohmer during Canada's centennial in 1967.

An integrated planning approach to infrastructure would eliminate the need for multiple reviews of major nation building projects and allow governments to better consult with the First Nations and local stakeholders on the correct path for a right-of-way where projects could then be built.

One of the key benefits is that a national corridor would require a significantly smaller geographical and environmental footprint than the current fragmented approach. It would also allow for a more efficient and environmentally sustainable way of extracting natural resources and delivering them to market, helping to grow Canada's economy.

*continued overleaf...*

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# ONSET

**USE PROCUREMENT BEST PRACTICES**

Supporting Canada's infrastructure represents a significant investment of tax dollars. Upfront procurement decisions have a significant impact on not only the cost and quality of the design and construction phases, but on operations and maintenance of infrastructure assets. Engineering and other professional services typically account for only 6% – 18% of capital costs of infrastructure projects and 1% – 2% of total costs over the life cycle of infrastructure assets. Yet, these services dramatically impact all aspects of the financial and operational success of infrastructure for decades.

In order to ensure the best possible outcome and the best possible value to taxpayers, qualifications-based selection (QBS) should be used for the procurement of engineering and other professional services. It focuses on the qualifications of the project team and their understanding of the project objectives. QBS

**“In order to ensure the best possible outcome and the best possible value to taxpayers, qualifications-based selection (QBS) should be used for the procurement of engineering and other professional services.”**

results in a project scope, schedule and budget that are realistic and commercially fair and responsible. This results in high quality projects with increased service life and significant life cycle savings over the entire design life.

QBS also encourages and rewards innovative projects. However, current public procurement practices often discourage and even penalize innovation by: assuming the lowest price is the best price; by unilaterally transferring all risk to the proponent; and, by not respecting intellectual property of service providers.

It should also be noted that, in the context of NAFTA renegotiations, adoption of QBS would bring Canada into alignment with U.S. procurement practices for engineering and other professional services as mandated by its federal law.

**HARMONIZE FEDERAL AND PROVINCIAL APPROVALS**

It is important that proponents of major projects in both the public and private sector have confidence in the regulatory approval regimes in order to make informed business decisions. Proponents of projects support rigorous environmental assessment based on science, provided the process is clear and efficient with minimal inter-jurisdictional duplication and overlap.

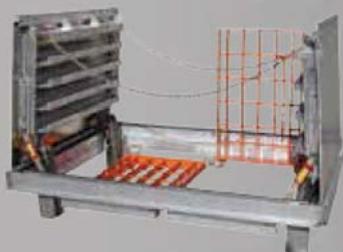
Unreasonable and unforeseen delays make it extremely difficult for both public and private sector proponents, as well as their consultants and contractors, to plan and commit resources to projects. Delays can also create uncertainty in both material and labour markets, resulting in significant cost escalation for projects. These can sometimes be ruinous to the proponent. Unnecessary delays to projects can also result in lost economic opportunity.

There is an adage that a timely “no” is better than an indefinite “maybe”. And while there may be cases where it will be in the greater public interest to not approve a project, the objective of environmental approvals should not be obstructionist. The objective should be to ensure the implementation of environmentally and socially responsible projects. ■

*For more information, visit [www.acec.ca](http://www.acec.ca), or email John D. Gamble, CET, P.Eng., President and CEO, ACEC: [jgamble@acec.ca](mailto:jgamble@acec.ca)*

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# HOW WILL CLIMATE CHANGE AFFECT EXTREME RAINFALL IN NEWFOUNDLAND AND LABRADOR?

By **Juraj Cunderlik**

The Government of Newfoundland and Labrador recognized in its 2011 Climate Change Action Plan that climate change is a long-term challenge for the province, with significant environmental, economic and social impacts.

Projections of future climate for Newfoundland and Labrador as estimated by global circulation models (GCMs) indicate that the increase in air temperature is predicted to be most pronounced in winter and smaller in summer and autumn. By the mid 21<sup>st</sup> century, air temperatures are expected to rise by 1°C – 3°C in Newfoundland and by 2°C – 4°C in Labrador. Seasonal differences in projected changes are expected to be generally smaller in Newfoundland due to the moderating influence of the ocean (Finnis, 2013).

Increased concentrations of greenhouse gases (GHGs) will not only increase air temperatures, but also evaporation, which in turn will enhance the atmospheric moisture content, and consequently, extreme rainfall rates (Trenberth, 1999). According to the Intergovernmental Panel on Climate Change (IPCC 2013), heavy rainfall events are expected to increase both in frequency and intensity under changing climate conditions. The return period of extreme rainfall events could be reduced by a factor of two or more by the end of this century (Kharin et al., 2007).

Increased rainfall will have a significant impact on infrastructure. Engineers, planners, and policy makers utilize rainfall intensity-duration-frequency (IDF) curves in municipal planning and infrastructure design. IDF curves characterize the relationship between the intensity of rainfall occurring over a specified period of time and its frequency of occurrence. They are based on historical observations of precipitation.



Figure 1. Rainfall intensity-duration-frequency stations used in the study.

In Newfoundland and Labrador, a number of the climate stations used to produce IDF curves are no longer active. In the most recent release of IDF curves (V2.3, 2015) published by Environment and Climate Change Canada (ECCC), 13 of the 19 IDF curves in Newfoundland and Labrador were generated from inactive stations. The resulting IDF curves may not reflect recent trends in extreme rainfall. It is noted that less than 10% of the

population live within a 50 km – 75 km radius of the six IDF stations still being operated by ECCC.

Future predictions of rainfall also depend on a clear understanding of current precipitation trends. In response to this concern, the Climate Change Branch of the Department of Municipal Affairs and Environment commissioned a study to update the 13 IDF curves generated from inactive stations (GHD, 2015).

## METHODOLOGY

Updated IDF curves were used to generate projections of future climate IDF curves for the province. The future climate IDF curves were produced using the Intensity Duration Frequency under a Changing Climate (IDF\_CC) tool developed at the University of Western Ontario (Srivastav et al., 2015), utilizing the latest representative concentration pathway (RCP) scenarios described in the IPCC Fifth Assessment Report (IPCC, 2013).

RCPs are the latest generation of scenarios that provide input to climate models. They are based on projections of GHG concentrations, as well as land use and land cover factors (Moss et al., 2010). Each RCP defines a specific emissions trajectory and subsequent radiative forcing. The RCP 4.5 scenario was selected for the development of future climate IDF curves as it represents the most likely future scenario.

The IDF\_CC tool fits the Gumbel

distribution to annual maximum rainfall intensities using the method of moments. The equidistant quantile matching (EQM) algorithm is applied to the IDF updating procedure (Srivastav et al., 2014). This algorithm captures the distribution of changes between the projected time period and the baseline period (temporal downscaling), in addition to spatial downscaling of the annual maximum rainfall (AMP) derived from the GCM data. The IDF\_CC tool produces annual maximum intensities for all standard ECCC IDF durations (5 min, 10 min, 15 min, 30 min, 1 hr, 2 hr, 6 hr, 12 hr, and 24 hr) and return periods (2, 5, 10, 25, 50, and 100 year).

An ensemble of 22 GCM projections was used to generate the future climate IDF curves. Using an ensemble of climate models is recommended when projecting future rainfall information (CSA, 2012). According to the Canadian Climate Change Scenarios Network (CCCSN) the use of an ensemble approach (multi

model means/medians) provides the best projected climate change signal (CCCSN, 2013).

The future climate IDF curves were calculated as the median value of the 22 GCMs. In addition, knowledge of the possible range of future rainfall projections around the median projection provides important information about the uncertainty involved in projecting future climate. Determining the minimum and maximum rainfall projections from individual GCM runs addresses the uncertainty related to climate modeling (such as representation of atmospheric processes, model resolution, etc.) and captures the large variation in projected changes. The minimum and maximum future climate IDF curves were determined from individual GCMs.

## RESULTS

Minimum, median, and maximum future climate IDF curves were gener-

*continued overleaf...*

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ated for three time horizons: 2011–2040 (2020s), 2041–2070 (2050s), and 2071–2100 (2080s). The percent increases in rainfall amounts from the current climate IDF curves averaged for all stations are shown in Table 1.

The median increase of rainfall amounts averaged for all return periods and rainfall durations ranged from 5%–20% for the 2020s time horizon; 14%–31% for the 2050s time horizon; and 13%–33% for the 2080s time horizon (see Figure 2).

It is noted that the predicted increases of rainfall amounts/intensities correspond well with results reported in other studies conducted in Atlantic Canada, particularly Lines et al. (2009) who reported an increase of 9%–31% for 24 hour rainfall amounts in the 2050s, and Finnis (2013) who reported an increase of 1%–37% for 6 hour rainfall, 4%–24% for 12 hour rainfall, and 4%–19% for 24 hour rainfall in the 2050s.

Rainfall amounts/intensities for the 25-, 50-, and 100-year return periods were compared for the existing and future IDF curves. It was found that the current 100-year return period will become the 50-year return period for all rainfall durations at 10 of the analyzed stations in the 2020s. The situation is predicted to be more dramatic in the 2080s when current 100-year return period will become the 25-year return period for all rainfall durations at 13 of the analyzed stations.

The results also suggest that the shortest duration rainfall amounts will increase more than the longer duration rainfall amounts and the small return period events will increase more than the large return period events.

## CONCLUSIONS

There are many uncertainties involved in projecting future climate. These uncertainties result in large variations in projections of future rainfall. In some regions, model projections disagree on both the sign and magnitude of the changes (ACASA, 2011). The spatial and temporal resolution of GCMs is particularly inadequate for capturing localized short-term extreme rainfall events, and may result in underestimation of rain-

**TABLE 1.** Average percent increase in future climate IDF curves.

Time Horizon	Percent Increase for All Stations, Durations, and Return Periods		
	Minimum	Median	Maximum
2011–2040	-5	12	35
2041–2070	-1	20	58
2071–2100	4	24	60

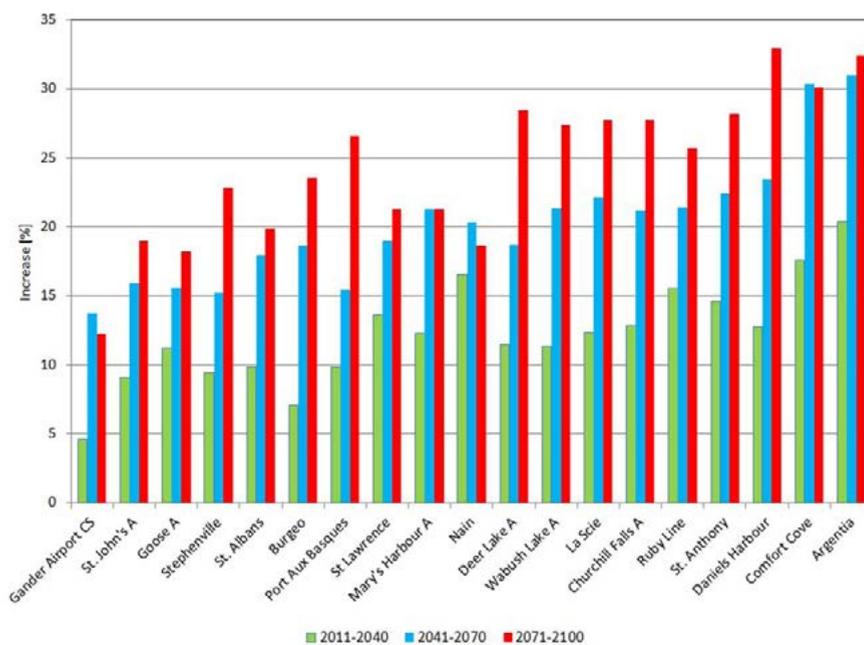


Figure 2. Median Increase of intensity-duration-frequency curves.

fall extremes by GCMs (e.g., Allan and Soden, 2008; Min et al., 2011).

Results presented in this study showed that there is considerable variation in the GCM estimates of the future climate IDF curves for each station. The range for a station tended to be larger when there was a high degree of variation in the station data (large natural variability) and/or the record length was short (large statistical uncertainty).

This indicates that the global circulation model estimates reflect the current climate data at the station and that the rainfall data strongly affect the results. Therefore, it is critical to keep existing IDF curves updated at regular intervals to assure that recent trends in rainfall

are reflected in the data and that the IDF curves provide up-to-date tools for climate change preparedness and adaptation. ■

## ACKNOWLEDGEMENT

The research presented in this study was funded by the Climate Change Branch of the Department of Municipal Affairs and Environment, Government of Newfoundland and Labrador. This support is gratefully acknowledged.

*Juraj M. Cunderlik, PhD, P.Eng. is with GHD. Email: juraj.cunderlik@ghd.com. To view a list of references cited in this article, visit: [www.esomag.com/article-557](http://www.esomag.com/article-557)*



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*The Universal Mount allows for aerator maintenance to be performed without the need for operators to enter the basin or reach over railing.*

## NEW MOUNTING SYSTEM ALLOWS FOR EASIER AND SAFER AERATION SYSTEM MAINTENANCE

By **Erin (Kober) Biesanz, Jing Huang** and **Josh Sablan**

Through conversations with plant operators and service experience, Aeration Industries recognized the importance of maintenance and safety for those servicing wastewater aeration equipment. The idea to develop a mount on a sliding pedestal so operators could maintain equipment safely on the walkway was conceived.

The secondary goal was to reduce the cost of maintenance and give plant operators the ability to service equipment on their own versus having to hire service teams. Plant operators are also facing strict permit limits, allowing less downtime for maintenance and repairs,

so this needs to be done efficiently without having to shut down the whole plant.

Conventionally installed aeration equipment often requires difficult and time-consuming maintenance. Surface mounted equipment relieves a portion of these issues, as all working components are readily available for full service without shutting down operations. Float mounted surface aerators pose unique maintenance challenges, including: servicing from within the basin, the requirement of cranes, and the need to move equipment to the shoreline or basin perimeter.

To address these unique concerns, Aeration Industries International developed the Aire-O<sub>2</sub><sup>™</sup> Universal Mount. With the use of a patented slide design and a low cost “mini-crane”, aerators

are hoisted and pivoted into a position that allows for simple service. The sliding mechanism allows the unit to move through varying water depths, creating a design that combines operational flexibility with ease of maintenance.

The Universal Mount is an all stainless steel mounting structure that is partially submerged and installed on the walls or walkways of wastewater treatment basins. The structure has a sliding pedestal on rollers with a solid bearing. The solid bearing has no moving parts, so it is durable in harsh wastewater environments, especially in a submerged condition. The sliding pedestal travels on a 45-degree track that allows the aerator to be positioned at the desired height depending on the freeboard. On the

sliding pedestal, there is a pivoting tube that allows the aerator to point in any direction to form a flow that will keep solids suspended efficiently.

Pedestals are pulled up and down by a cable which runs on a pulley that sits on top of the track. The pulley is engaged by a hand winch that is integrated into the mounting system. The hand winch and its pedestal are designed to be portable. Multiple universal mounts can share one hand winch for bringing the unit up and down. Universal Mount only requires four anchor bolts on top and two anchor bolts on the front to complete the installation of the mounting system.

When maintenance is due, operators can access the unit without a boat or renting a crane, allowing for safe and efficient maintenance. The whole process of bringing the aerator into the maintenance position takes no more than 10 minutes.

## THE UNIVERSAL MOUNT IN PRACTICE

One wastewater treatment plant selected Aeration Industries' Aire-O2 Triton® aerator/mixers coupled with Universal Mounts to replace aging rotors. Prior to the replacement, the plant had an oxidation ditch with six rotors. The rotors were not fully aerating the tank due to welds and bolted sections of the baffles failing and falling into the bottom of the ditch. With a 4.5 m deep ditch, it was very important that treatment was occurring throughout the entire volume of the ditch.

Access to the rotors was also very challenging for cleaning rags and other debris off the shaft and blades. To pull the rotors out, the operator had to pull the motor, gearbox and the seal plates at each end. There were also several problems with motor and gearbox failures. It was often a full day of work to maintain or fix one rotor.

Operators were looking for a new type of aerator with easy access for maintenance and repairs. Two Aire-O2 Triton aerators with the Universal Mount were installed to determine if the mounting systems were appropriate. Installation went smoothly. The mounting holes for the mount were pre-drilled before



*The sliding pedestal travels on a 45-degree track that allows the aerator to be positioned at the desired height. A pivoting tube allows the aerator to point in any direction.*

installation day and it only took half a day for the two mounts to be installed on the existing concrete walkway where the rotors were originally installed. Also, the mounting installation did not require the removal of existing rotors.

The mounting system allowed all wiring to be done right on the walkway. When it came time for maintenance, an operator only needed to crank the unit up with the hand winch. It took them one to two hours to do the maintenance on the walkway for each unit. This was much less time than with the previous rotors.

After running the Tritons on the mounts for approximately eight months and seeing the performance of the aerators, along with testing the ease of maintenance of the mounting system, eight more aerators were installed.

A month after startup with all 10 aerators running, the plant saw such successful mixing that they had to waste significantly more sludge than with their previous systems. They are also seeing better treatment, specifically lower total nitrogen numbers, which is due to the entire volume of the basin being aerated.

## SAFETY

One of the primary concerns with the improved mounting system was increas-

ing safety when maintenance is required on aeration equipment. The Universal Mount addresses this need, as operators never need to be in the water to service the equipment. Everything can be done safely on the walkway and reaching over the water has been eliminated.

The mount also diminishes the need for operators to drain the basin or climb down onto the equipment to make repairs. This reduces risk of injury while also simplifying the maintenance process.

Health was an essential concern, as well. There is a risk of Legionnaires' disease if wastewater splashes and creates a mist that is inhaled by operators. The Aire-O2 Triton does not create any splashing or mists and the mounting system does not require operators to be over the water, nearly eliminating this health risk. ■

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*Erin (Kober) Biesanz, Jing Huang, and Josh Sablan are with Aeration Industries International. Emails: [erin.kober@aireo2.com](mailto:erin.kober@aireo2.com), [jing.huang@aireo2.com](mailto:jing.huang@aireo2.com), [josh.sablan@aireo2.com](mailto:josh.sablan@aireo2.com)*

# HOW TO CONTROL ODOUR AND MICROBIAL INDUCED CORROSION IN WASTE STREAMS

By **Tafadzwa Mariga**

**H**ydrogen sulfide is typically the first suspect upon the mention of odour control. However, there are numerous other sources of odour in wastewater systems, including: mercaptans, methylamine, acetone and ammonia. Knowing the dominant source of the nuisance odour is essential for the correct mitigation approach. Odours may be exacerbated due to side-stream intercepts such as poultry facilities, paint manufacture effluent, and food process waste.

Concrete is the most abundant material in wastewater systems and the material that is subject to the greatest risk for corrosion. To understand corrosion in a

wastewater collection system, a simple understanding of microbial influenced corrosion (MIC) is required. Bacteria cause corrosion by respiring, producing metabolic byproducts and biofilm. While there are a plethora of bacteria-forming complex microbial populations in wastewater systems, several groups are responsible for MIC.

Metal oxidizing bacteria are of concern as they are very capable of driving metal corrosion in a process system of the wastewater treatment process. However, as most wastewater systems are primarily constructed with concrete, acid producing bacteria and bacteria that recycle sulfur

are of great concern.

One of the most common bacterial groups involved in the metabolism of sulfur is *thiobacteriales*, which synthesize energy from the oxidation of inorganic sulfur substances producing sulfide. Within this group of bacteria, there are some bacterial species that break down sulfur containing amino acids such as cystine in urine and keratin, or methionine from caesin.

Gelatine and wool are another source of sulfurous proteins. Interestingly, the hydrogen sulfide byproduct now becomes an energy substrate for another group of related bacteria such as *thionema* and *thiobacillus*. *Thionema* bacteria oxidize

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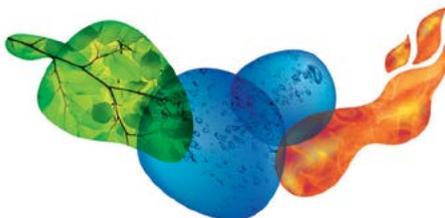
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hydrogen sulfide to produce elemental sulfur. *Thiobacillus thiooxidans* oxidize sulfur to sulfate and sulfuric acid. Whether it is the formation of sulfuric acid by rapid oxidation of sulfide in a warm oxic water environment, or by bacteria, sulfuric acid to concrete is equivalent to a hot knife through butter.

Dissolved sulfide is a dominant factor in understanding odour control and concrete corrosion within wastewater systems. While other approaches to dissolved sulfide control are available, many are just a band-aid cure.

Kemira's approach is an elimination of the dissolved sulfides with the use of ferrous or ferric salts. The byproduct is an insoluble FeS which precipitates out of solution. This prevents any off-gassing of sulfides in the system. pH adjusters don't eliminate the dissolved sulfides but rather keep them in solution. If the pH drops in the collection system, or at the treatment plant, sulfides are released atmospherically.

Providing an alternative food source

“Whether it is the formation of sulfuric acid by rapid oxidation of sulfide in a warm oxic water environment, or by bacteria, sulfuric acid to concrete is equivalent to a hot knife through butter.”

for bacteria can prevent sulfide byproduct release, but only as long as it is available. Typically, this works for short distances or short term, but down the line the bacteria may revert to sulfates as a food source and hence sulfides are regenerated.

Chemical application is half the battle. Knowing and understanding the source of the odour is critical for true mitigation, just as knowing and understanding the risk for concrete corrosion is critical for true mitigation.

The Kemira S-Guard™ Odour Control program monitors dissolved sulfide levels in real time and allows immediate dosing adjustments to control them. No manual

readings are required and the time delayed response is eliminated. This technology prevents over-dosing and under-dosing of the chemical. This not only reduces costs, but also allows for consistency in meeting desired sulfide levels.

It also offers a data management platform for the technology where the system can be monitored real-time via KemConnect, a web-based application. Trends, alerts, alarms, answers and automated product delivery can be accessed on mobile devices. ■

*Tafadzwa Mariga is with Kemira. Email: tafadzwa.mariga@kemira.com*



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# ADVANCED PUMP STATION MONITORING PROVIDES REAL-TIME DATA FOR PERFORMANCE ANALYSIS

By **Benoît Beaudoin** and **Pierre Michaud**

Most municipalities, whatever their size, would benefit from having pumping station monitoring systems that provide valuable information in real time and collect data for performance analysis, including: information on infiltration; overflow volume calculation required by provincial authorities; information to help plan and prioritize maintenance; instantaneous alarms; information for more efficient operation and reduced maintenance costs; and to help pin point intermittent operation problems, and record all the data required for more detailed event diagnostics.

Every day, approximately one-third of pumping stations can have intermittent

and abnormal incidents. These include: bouncing starters, faulty check valves, low pumping capacity at a critical time, unreliable level sensors or PLC programming issues.

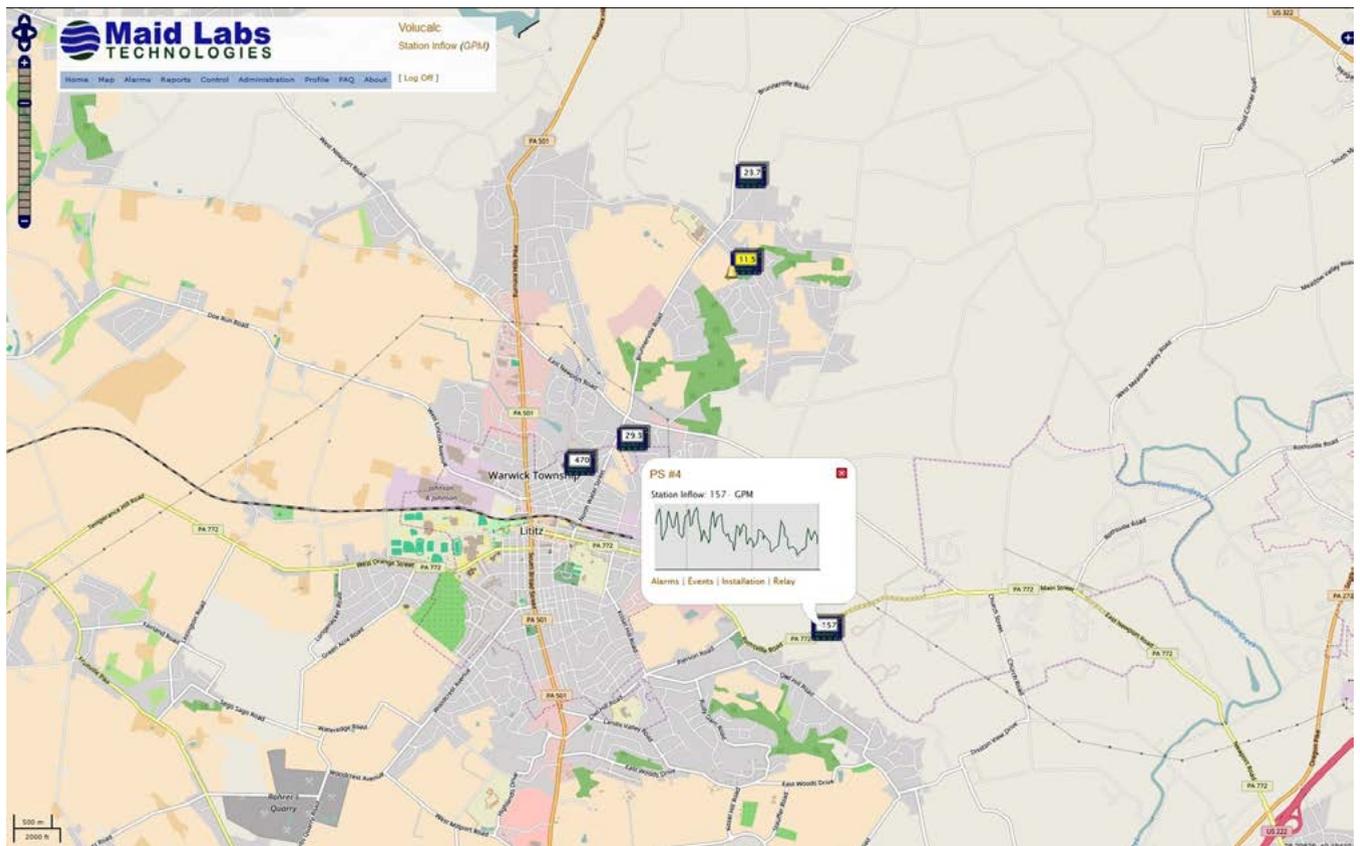
The cost of a typical real-time pumping station monitoring system can be prohibitive for small- to medium-size communities and often complex to operate. Volucalc, a device from Canadian manufacturer Maid Labs, makes use of very simple information available in the pumping station to collect data and alarm the operator if anything goes wrong. The technology and calculation algorithms used in Volucalc are the result of experimentation in conjunction with the development and manufacturing of

thousands of flow meters since 1986.

The system can also be used with more sophisticated control systems to provide additional information that would not be available otherwise. The Volucalc system has already been successfully deployed in a number of municipalities in the province of Quebec and in the United States.

## BASICS OF PUMPING STATIONS

The US EPA's *Collection Systems Technology Fact Sheet – Sewer Lift Stations* states that “power costs account for 85% to 95% of total operational and maintenance cost”. Very few municipalities use this valuable information to evaluate the pumps at their lift stations. With the



With remote wireless monitoring, operators can view an entire pumping station monitoring network at their desk.

right tool, getting the appropriate data is simple, inexpensive and can be done in-house. Software can now help analyze data and isolate potential problems and wasted energy.

The most expensive element of pumping stations is the electricity running them. It makes sense to measure the current used by the pumps as the primary way to monitor the operation of the pumps. Most of what is wrong within a pumping station can be tied to the pumps.

If the current from each leg is not properly balanced, chances are that the pump will wear faster and use more electricity to deliver less capacity. If the current is substantially lower or higher on any given leg for all the pumps, then the voltage may be the cause. Measuring the current tells when the pumps start and stop, and, therefore, their run times and number of starts.

The volume differential between the start and stop level measurements allows calculation of flow in and out of the pumping station. If the remote terminal unit (RTU) isn't properly programmed, if the pumps do not alternate properly, or if starters are chattering, the pumps will be affected, and this will be recorded through the current sensors, among other things.

Project		Name:	Jacobs Creek No.2	Type:	Station
File:	Jacobs Creek.misdf	Data:	Jacobs Creek.misdf		
From:	4/1/2016 1:00:00 AM	To:	4/30/2016 1:00:00 PM	Duration:	29.12:00:00
Contact:	Benoit Beaudoin	Phone:		Email:	benoit@maidlabs.com

Dimensions		Cylinder	A:	8,000 ft
Well input:	Influent at the top	Well depth:		ft
Operation mode:	Softmaid compatible mode	Measurement method:		Distance from top
Description	Depth	Volume		
	ft	US gal.		
Start of third pump	12.667	4,763		
Start of second pump	13.833	5,201		
Start of first pump	15.583	5,860		
Stop of all pumps	20.167	7,583		

Electricity		Phase 1	Unbal. 1	Phase 2	Unbal. 2	Phase 3	Unbal. 3	Average	Hours	Starts	Susp. events		
Input	Measure	Unit	Δ / Y	Δ: 1-2	%	Δ: 2-3	%	Δ: 3-1	%		≤ 10 s		
Fixed	Voltage	V	Δ	480.0		480.0		480.0		480.0			
Computed	Voltage	V	Y	277.1		277.1		277.1		277.1			
Motor 1	Current	A		39.9	0.9	38.0	-4.0	40.7	3.0	39.5	83.8	1,902	23
Motor 2	Current	A		34.3	1.9	31.9	-5.4	34.9	3.5	33.7	242.2	1,905	9
Motor 3	Current	A		39.0	2.1	36.3	-5.0	39.3	2.9	38.2	74.5	1,968	13

Efficiency		Power consumption			Power factor:			1.00	Volumetric flow			
Pumps	Total	Phase 1	Phase 2	Phase 3	Run time	Events	Capacity	Pumped volume	Efficiency	Avg cycle		
	kWh	kWh	kWh	kWh	hours		GPM (US)	US gal. × 1,000	%	US gal. / wh	hh:mm:ss	
1	2,594	21.8	872	831	891	78.7	1,894	1,355.6	6,403	25.9	2.47	0:02:29
2	6,417	53.9	2,178	2,024	2,215	228.9	1,900	830.8	11,411	46.2	1.78	0:07:13
3	2,068	17.4	703	654	710	64.9	1,893	1,461.1	5,685	23.0	2.75	0:02:03
1 and 2	262	2.2	89	83	90	4.4	11	1,485.1	393	1.6	1.50	0:24:01
1 and 3	42	0.4	14	13	14	0.7	7	1,798.5	75	0.3	1.78	0:05:56
2 and 3	525	4.4	179	166	179	8.9	75	1,372.8	734	3.0	1.40	0:07:08
Total	11,908	100.0	4,037	3,771	4,100	386.5	5,780		24,702	100.0		

Annual Energy Cost		Actual cost	%	Cost if single <sup>1</sup>	% variation	Cost per kWh	0.100 \$
Pumps							
Pump 1		3,212 \$	21.8 %	12,390 \$	-8.7 %	1,268 \$	423 \$
Pump 2		7,945 \$	53.9 %	17,198 \$	26.7 %	6,075 \$	2,025 \$
Pump 3		2,560 \$	17.4 %	11,123 \$	-18.0 %		
Other		1,027 \$	7.0 %				
Total		14,744 \$	100.0 %				2,448 \$

Extra annual electrical cost if modifications are not made: **3,621 \$** **25 %**

(1) Cost if only one pump would pump everything (2) Extra cost of electricity if each pump pumps the same volume of water

Monthly reports can help point maintenance personnel in the right direction to avoid emergency situations and costly incidents.

continued overleaf...





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## Zoran Filinov, P.Eng. is RVA's newest Vice President

Shawn Scott, President and CEO, is pleased to announce the appointment of Zoran Filinov as RVA's newest Vice President.

Over the past 30 years at RVA, Zoran has proven that he has the expertise and leadership needed to support the company's continued growth and development.

He has an extensive water and wastewater portfolio that includes many of RVA's marquee projects. Recent projects include City of Brantford's \$51-million Holmedale Water Treatment Plant expansion, Town of Smith's Falls new \$26-million WTP, and Durham Region's \$20-million Newcastle Water Supply Plant expansion.



## Ken Campbell will continue to serve as Chairman of the Board

Ken Campbell will be transitioning from his role as Vice President. He will continue to serve as Chairman of RVA's Board of Directors.

Ken has been instrumental in developing RVA's water business and industry profile, and will remain as a Technical Specialist on various water and wastewater projects. Ken will also maintain his duties as the company's Quality Assurance Director, where his recent focus has been on expanding RVA's Project Quality Management System.



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## EVERYTHING IS IMPORTANT

Four main elements are needed to properly analyze a station: electrical data; integrated smart software; a means to calculate the flow in and out of the wet well; and some basic knowledge and experience with pumping stations.

About one-third of electrical equipment will show intermittent abnormal behaviours at any given time. Being able to measure and analyze these erratic behaviours is the key to predict/report potential problems before they occur. Electrical equipment often gets sick before dying.

SCADA systems monitor the current used by pumps after the inrush peak, but what about the relay and the float switch? If the relay fails to keep the pump on, then the starting float switch might start and stop the pump every few seconds until burning the pump without generating a current based alarm or reaching the high-level alarm. Then, it will burn the other pump. Then, it will reach the high level and the telemetry system will report a high-level alarm.

Every component of a pumping station system is critical. Special analytical functions should be integrated to SCADA systems to detect all abnormal behaviours. Pumping station monitoring tools, like the Volucalc, integrate a number of real-time deductions based diagnostic functions which identify abnormal behaviours before they become critical. It is an inexpensive and easy to install addition to any existing pumping station.

Accurate flow in/out calculations and power consumption by the pumps are mandatory in pumping stations. Each of these elements should be monitored and generate alarms when too high or low. Furthermore, this information is required to calculate the efficiency of the pumps, which is the volume pumped per watt of electricity consumed. This effectively represents the operational cost to get the job done. As an example, a pump that consumes slightly more electricity than before while pumping slightly less than before might not trigger any time or current based alarms but would generate an efficiency alarm from Volucalc.

## CONTROL SYSTEMS ARE NOT MONITORING DEVICES

The main reason to monitor pumping stations is to minimize the number of catastrophic events and by doing so, reduce the cost of operating and maintaining the system. These two goals are intimately related. Often, maintenance departments react to emergencies when they get an alarm because their existing system does not have the capabilities to offer predictive information. They do not perform the required analysis to be an advanced warning system. This is a missing ingredient common to a lot of systems currently in operation.

Many manufacturers propose their own SCADA solutions and they all do more or less the same thing based on the specifications given by the engineers. If a level gets too high or low, if a current value gets too high or low, if a flow rate gets too high or low, etc., then a warning or an alarm is generated, and an event log is updated in the database. Someone then looks at the reports or screens and decides on the actions to take based on the information. This does not provide for the early detection of abnormal behaviours.

No volumetric flow algorithm programmed in SCADA software has the ability to detect abnormal flow conditions. Understandably, it is a very complex calculation that can be affected by a lot of conditions in the pumping station. Volucalc integrates these capabilities and it takes into account over 100 different variables in doing so.

### SHOULD PUMPS BE ALTERNATED?

Most pumping stations with constant speed pumps alternate between them, attempting to share the load equally. Is this the most efficient way to operate? Usually, the pump with the lowest flow rate is also the least efficient one. Because of its lower flow rate, it has to pump longer. So, the worst pump wears even faster because it is used more, and its capacity continues to be affected negatively with time. Alternating between pumps is the simplest control solution, but it is not the most efficient one.

A smarter system should detect these efficiency problems and adjust the operation of the pumps in order to use more of the best pump and less of the worst pump instead of the opposite. Until the defective pump is serviced, using the best pump when the flow is high and the worst when the flow is low is a simple solution. By doing so, significant energy saving could translate into a lower electrical bill to operate the pumping stations.

Time			Period	Combination		
Date	Day	Time	Duration	Pump 1	Pump 2	Pump 3
M/d/yyyy	dddd	HH:mm:ss	hhh:mm:ss	state	state	state
3/23/2013	Saturday	00:59:32	0:02:54.16	On	Off	Off
3/23/2013	Saturday	01:02:26	0:03:39.87	Off	Off	Off
3/23/2013	Saturday	01:06:06	0:02:58.05	Off	On	Off
3/23/2013	Saturday	01:09:04	0:03:31.97	Off	Off	Off
3/23/2013	Saturday	01:12:36	0:01:45.03	Off	Off	On
3/23/2013	Saturday	01:14:21	0:00:10.00	On	Off	On
3/23/2013	Saturday	01:14:31	0:00:21.01	On	On	On
3/23/2013	Saturday	01:14:52	0:04:06.97	Off	Off	Off
3/23/2013	Saturday	01:18:59	0:01:59.93	On	Off	Off
3/23/2013	Saturday	01:20:59	0:00:10.01	On	On	Off
3/23/2013	Saturday	01:21:09	0:00:13.10	On	On	On
3/23/2013	Saturday	01:21:22	0:00:00.01	Off	Off	On
3/23/2013	Saturday	01:21:22	0:03:44.96	Off	Off	Off
3/23/2013	Saturday	01:25:07	0:02:37.05	Off	On	Off
3/23/2013	Saturday	01:27:44	0:03:28.87	Off	Off	Off
3/23/2013	Saturday	01:31:13	0:02:57.05	Off	Off	On

Real-time monitoring provides valuable information for instantaneous alarms and records all data for detailed event diagnostics.

### DETECTING ABNORMAL CONDITIONS

Abnormalities or intermittent issues are not usually catastrophic, and they occur in about 33% of pumping stations without anyone noticing them. These may lead to expensive repairs that could

have been prevented if the problem had been handled sooner. The issue is not the capacity to correct but the capacity to detect early.

Even if it happens only once, an *continued overleaf...*

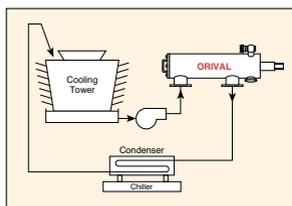
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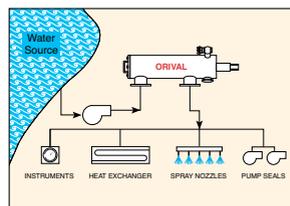
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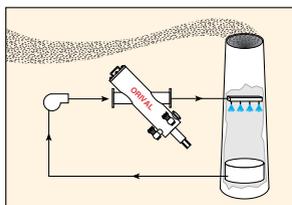
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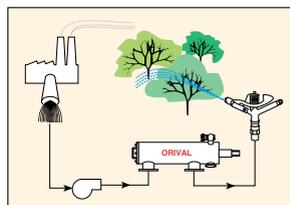
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advanced warning system should detect when:

- A level sensor transmits a signal that isn't physically coherent, such as water level falling with no pump in operation or going up and down 10 centimetres within few seconds.
- Sequence of operations of the pumps' changes, like not alternating at every cycle when they are supposed to do so.
- Capacity of one or all the pumps varies drastically.
- Start and stop levels of the pumps have changed.
- Run time or off time of the pumps does not make sense under normal conditions.
- Improbability in results (e.g., water level falls while pumps are not in operation).

Some of these events are typically non-catastrophic at the time of their first occurrence, but detecting these early means.

- Sending crew to investigate the problem during normal working hours, and when they are available.
- Being able to replace inexpensive components to see if the problem is resolved.
- Not being against the wall with no spare parts in hand or having to procure parts urgently with additional associated costs.

It is a good practice to have a dedicated monitoring device as opposed to a combined control/monitor unit. A defective device often cannot report its own

**Alarm conditions can be texted or emailed, and the operator can visualize the whole pumping station monitoring network at any time.**

defectiveness, while a standalone monitor could report abnormal behaviours of the controller. When selecting a system, ask about their backup solutions. One should exist.

#### WIRELESS MONITORING

With advancing technology driving the cost of remote wireless monitoring down, it has become very easy and cost-effective to bring pumping station monitoring to the desk of the operator. Alarm conditions can be texted or emailed, and the operator can visualize the whole pumping station monitoring network at any time. The MaidMaps interface can provide the plant personnel access to real-time data via a web browser.

Each pumping station is shown on a map with instantaneous readings. Recorded data can be graphed and exported for analysis. A number of pre-formatted reports are available to help visualize and monitor the operation of any pumping station on the territory.

#### CONCLUSION

The easiest way to lower the operational costs of a collection system is to increase the efficiency of the pumps. Changing the operation sequence to use more of the best and less of the worst pumps is part of the solution.

Smart systems should also have the ability to change the level set points dynamically. As pumps become more efficient as levels go up, operating at a higher set point during a rain event could contribute to additional savings.

The return on investment for the appropriate pumping station monitoring system can be very rapid. Real-time alarming and meaningful monthly reports can help point maintenance personnel in the right direction to avoid emergency situations and costly incidents. ■

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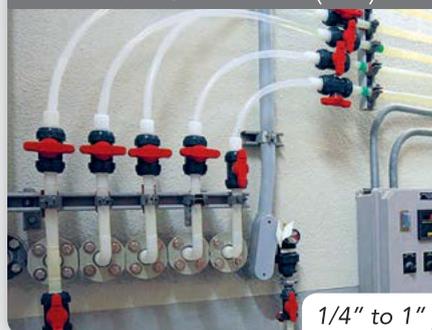
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*The aim of sustainable stormwater practices is to treat stormwater as close to the source as possible, using practices that mimic natural hydrology.*

## NEW TOOL IMPROVES LOW IMPACT DEVELOPMENT STORMWATER SYSTEMS

By **Yuestas David**

The aim of sustainable stormwater practices, also referred to as Low Impact Development (LID), Green Infrastructure (GI), or Best Management Practices (BMPs), is to treat stormwater as close to the source as possible. This can be done by either delaying or reducing the stormwater runoff, and by removing pollutants from it before conveying it downstream. Common goals for these practices include having post-development infiltration volumes and peak flow rates match pre-development values, or creating the capacity to retain runoff from a 12.5 – 25 mm precipitation event.

LID comprises a set of site design strategies that minimize runoff by means of distributed, small-scale structural practices that mimic natural or predevelopment hydrology through the processes of infiltration, evapotranspiration, harvesting, filtration, and detention of stormwater. Usually, because one structure

cannot treat the volume or the variety of pollutants for the entire drainage area, stormwater is conveyed through a treatment train. These practices can effectively remove nutrients, pathogens and metals from runoff, while reducing the volume and intensity of stormwater flows.

The purpose of the LID Treatment Train Tool (LID TTT) is to analyze whether sustainable stormwater management goals can be achieved through the implementation of LIDs. The tool is used to compare hydrology and pollutant loading for the pre- and post-development (with LIDs) scenarios, using annual and event based simulations.

### WHAT IS THE LID TTT?

Free for users, the LID TTT was developed by Sustainable Technologies Evaluation Program (STEP Water), a partnership between Lake Simcoe Region Conservation Authority, Credit

Valley Conservation, and Toronto and Region Conservation Authority. The goal was to streamline the planning and approval process by selecting and organizing results of the model simulations and comparisons in a way that is clear and aligned with Ministry of the Environment and Climate Change guidelines and that eliminates the need for additional downloads or computations.

The LID TTT, conceived as a preliminary design tool, can be used for designing and running a scenario very quickly. To support this, the tool includes a number of default settings, which can be altered, depending on a user's experience and monitoring studies. Also built into it are annual rainfall series, design storm time series, and temperature time series for quicker model setup. The tool also provides preliminary water budget analysis (i.e., surface evapotranspiration, surface runoff, infiltration to soil) and pollutant load removal estimates that can be compared side by side for pre- and post-development scenarios.

It is built upon the widely used and accepted open source US EPA SWMM5 model. While there are a number of models that do this already, the LID TTT provides a very user-friendly interface for novice modelers. Because it is built upon the SWMM5 engine, a preliminary design can be exported directly into SWMM5 for detailed design. Support for users is available through the STEP website where they can access FAQs and contact technical advisors.

### WHO WOULD BENEFIT FROM USING THE LID TTT?

The LID TTT can assist stormwater developers, designers, water resource engineers, municipal staff, landscape architects and planners understand and implement more sustainable stormwater management planning and design practices in their watersheds.

Visit [www.esemag.com/stormwater/LIDTTT/](http://www.esemag.com/stormwater/LIDTTT/) to download the tool, view online webinars and see in-class training opportunities. ■

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# CANADA'S ETV PROTOCOL SETS A HIGH BAR FOR EVALUATING OGS DEVICES

By Joel Garbon

Many professionals within the Canadian stormwater management community are familiar with the use of oil-grit separators (OGS) to remove pollutants. The very name of this class of treatment technology strongly suggests which pollutants are targeted for capture. Certainly, there are many products being marketed as being effective for separation of oil and sediment. However, a closer examination is required to determine if marketing claims really hold up.

For instance, it is reasonable to assume that the terms “separation” and “capture” imply that separated/captured pollutant loads will accumulate within the device over time as more runoff volume is treated, and that these pollutants will be safely stored until cleanout. The expectation of the specifier, regulator and owner is that the captured sediment and oil will remain within the device, even during occasional high-intensity storm events that generate high influent flow rates.

Retention of captured pollutants is a critical performance requirement. Simply capturing pollutants during relatively low-intensity storms, only to have them released during heavy downpours, is hardly effective treatment, and defeats the goal of protecting water resources. Therefore, it is appropriate that any testing programs designed to evaluate OGS performance characteristics include provisions to determine the propensity of a device to re-suspend/re-entrain and washout previously captured sediment and liquid hydrocarbons during high flow rate conditions.

The term “oil-grit separator” is used commonly in Canada, while the same technology is typically referred to as a “hydrodynamic separator” in the U.S. It is interesting to note that standardized laboratory testing protocols in the U.S. (such as the New Jersey Department of Environmental Protection protocol)



*In general, all OGS testing protocols allow the manufacturer to select any of their commercial model sizes as the test unit.*

focus exclusively on capture and retention of sediment, while the recently established Canadian Environmental Technology Verification (ETV) protocol, “*Procedure for Laboratory Testing of Oil-Grit Separators*” contains provisions for evaluating capture and retention of sediment, as well as retention of floatable hydrocarbons.

The advisory committee that developed the Canadian protocol included consultants, municipalities, conservation authorities, academics, and manufacturers. It recognized that testing of OGS devices needs to include provisions related to treatment of oil and fuel, which are pollutants of concern.

After examining the strengths and weaknesses of pre-existing testing protocols for OGS devices, the advisory committee established provisions in the Canadian ETV protocol that make it

more rigorous. It also provides improved comparability of performance results for various OGS devices. A series of laboratory tests is designed to reasonably predict real-world performance, with provisions for evaluating sediment capture, resuspension and washout (“scour”) of captured sediment and re-entrainment and washout of captured light liquids (oil and fuel).

Essential aspects of the comparability objective include specifications for the test sediment used in the capture and scour evaluations, specifications for the floatable plastic beads used as an oil/fuel surrogate in the light liquid re-entrainment evaluation, and provisions for various flow rates expressed as specified surface loading rates for each of the tests.

Additionally, the protocol specifies provisions to ensure that larger OGS sizes are suitably scaled relative to smaller tested devices. It also establishes

the requirement for equivalence in treatment flow rate per unit of sedimentation surface area, as well as provisions for minimum depth of the device. These critical scaling requirements are intended to prevent the installation of poor-performing undersized devices that can result from the use of scientifically unproven scaling methods.

The Canadian ETV protocol specifies a test sediment with particle size distribution (PSD) ranging from 1 – 1000 microns. This is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff, and is commonly known as the “ETV PSD”. This specification is nearly identical to the specification for the test sediment used in the New Jersey lab protocol for the sediment capture test.

The Canadian protocol requires the ETV PSD to be added to the influent during the sediment capture test, and to be pre-loaded in the sump of the device prior to the sediment scour test. Unlike the New Jersey scour test provisions, which specify pre-loading the sump of the device with a coarser test sediment (no particles smaller than 50 microns), the use of the fines-containing ETV PSD and progressive effluent sampling methodology during scour testing is more rigorous and conservative. This is better representative of real-world conditions.

OGS devices primarily target sediment particles larger than 50 microns during inflow events of moderate and high intensity. However, significant capture of particles smaller than 50 microns occurs during the frequent low-intensity events that comprise a substantial portion of the annual runoff volume. It also occurs during the quiescent settling periods between storms.

Therefore, in the real world, a substantial amount of fines may be captured and present in the sump prior to a storm event of high intensity and high influent flow rates. The Canadian ETV scour test appropriately provides insight about fine sediment retention performance during such an event.

Low density polyethylene beads, with a size range of 3.5 – 4.5 mm and specific gravity 0.917, are a convenient surrogate for oil and fuel during the light liquid

re-entrainment simulation test. Unlike hydrocarbon liquids that are messy and pose effluent disposal and system clean-up challenges, these are easy to handle, simple to recover from the OGS device and from the effluent during testing by using a net. Also, they are easily quantified by mass and volume.

A specified volume of beads is pre-loaded into the OGS device prior to testing. Beads washed out during testing are captured and quantified to determine how well the device performs in retaining them during flows that simulate a high-intensity storm event. This test sets the Canadian protocol apart from all other sediment-focused OGS test protocols by providing a simple, practical, and meaningful method for characterizing a very important aspect of OGS performance.

In general, all OGS testing protocols allow the manufacturer to select any of their commercial model sizes as the test unit. For reasons of cost and laboratory hydraulic capacity, smaller model sizes

are most commonly tested. Earlier testing protocols allow each OGS manufacturer to establish the flow rates for testing of their device. Combined with the variability in the size of models tested, this makes it very difficult to establish “apples-to-apples” comparability of performance between various devices.

With comparability as a key objective of the Canadian ETV protocol, provisions were established that specify the influent surface loading rates that must be evaluated for each of the three performance tests.

“Surface loading rate” is defined as the influent flow rate divided by the sedimentation surface area of the device. This is typically the cross-sectional surface area of the treatment chamber and is expressed in metric units as L/min/m<sup>2</sup>. Using a surface loading rate basis allows comparability between devices of various sizes. Seven different surface loading rates, ranging from 40

*continued overleaf...*



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– 1400 L/min/m<sup>2</sup>, are specified for the sediment capture test, representing a range of storm events from low intensity to high intensity.

Five different surface loading rates, ranging from 200 – 2600 L/min/m<sup>2</sup>, are specified for the sediment scour test and the light liquid re-entrainment simulation test, representing a range of storm events.

Manufacturers who test their OGS device according to the Canadian ETV protocol must have testing independently performed by an accredited laboratory, and have the test results verified by an accredited third party. The resulting verification of performance claims is then posted on the Canadian ETV website.

Proper interpretation of OGS performance testing results is important to ensure that the selected device will function as intended. An examination of the sediment capture results for the range of devices tested demonstrates that OGS devices are suitable for pretreatment applications, and can be reasonably sized

to capture 60% of the ETV PSD on an annual basis.

When installed upstream of ponds, detention facilities, bioretention, filters, and infiltration BMPs, OGS devices can remove a substantial portion of the sediment load from stormwater runoff. For sites where capture and retention of oil and fuel spills is important, such as fueling stations, convenience stores, fast food restaurants, accident-prone intersections, and other high traffic areas, it is important to select an OGS device that has demonstrated good performance during light liquid retention testing.

Civil engineers generally prefer to have the OGS device installed in-line with the storm sewer infrastructure. The expectation is that the device has an effective internal bypass to convey excessive flows, and that it will retain accumulated sediment even during very high intensity storm events.

Therefore, it is important that the performance testing demonstrates good

results during scour testing. This is generally lower than 10 or 20 mg/L effluent sediment concentrations at the highest tested surface loading rates.

## CONCLUSION

The Canadian ETV testing protocol has established a high bar for performance evaluation of OGS devices. It provides the opportunity to assess marketing claims in light of verified third-party test results. In the interest of upgrading environmental protection, provincial, regional, and municipal regulatory authorities are encouraged to use this information for their stormwater quality programs. ■

*Joel Garbon is with Imbrium Systems.*

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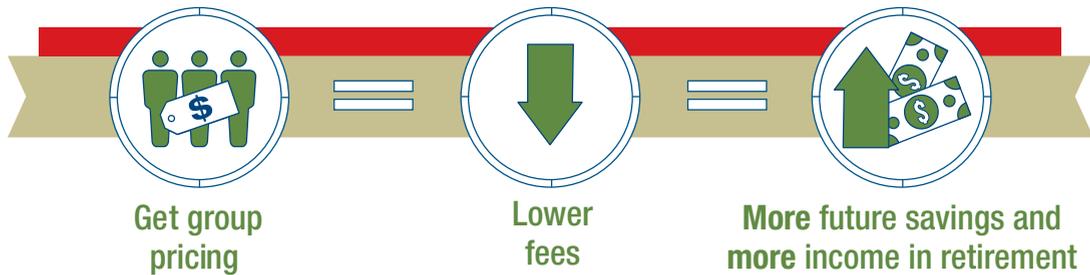
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# EVALUATING THE EFFECTIVENESS OF PUMPING WELL CONFIGURATIONS FOR GROUNDWATER REMEDIATION

By Paul F. Hudak

Low-cost alternatives for remediating contaminated groundwater are becoming increasingly popular. Permeable reactive barriers can treat contaminants without costly pumping of groundwater (EPA, 2002).

Placed hydraulically downgradient of contaminant plumes, pervious barriers have treated arsenic, metals, organics and other contaminants in groundwater (Guerin et al., 2002; Ludwig et al., 2002; Lai et al., 2006; Gilbert et al., 2010). However, installing permeable reactive barriers, especially deep installations, requires specialized and costly excavation equipment. Additionally, monitoring, removing, disposing of, and replacing filter media can be costly over long operational periods.

At some sites, non-pumping wells equipped with removable porous filters could be used instead of permeable reactive barriers (USGS, 1999). Similar to permeable reactive barriers, filter media in non-pumped wells immobilize or transform contaminants. Conventional drilling rigs can reach much greater depths than trenching equipment; thus, non-pumped wells could be used in deep as well as shallow settings (Hudak, 2009).

However, nearly adjacent placement may be necessary to keep contaminants from migrating between non-pumped wells. Installing, monitoring, and maintaining numerous closely-spaced wells may be cost-prohibitive at many sites (Hudak, 2014).

Alternatively, one extraction well and one accompanying injection well, pumping at very low rates, may create a less costly, hydraulic barrier to contain contaminant plumes in some settings (Cunningham and Reinhard, 2002). A typical installation is collinear, along a transect crossgradient to the prevailing hydraulic gradient, located in front of a contaminant plume. One well extracts

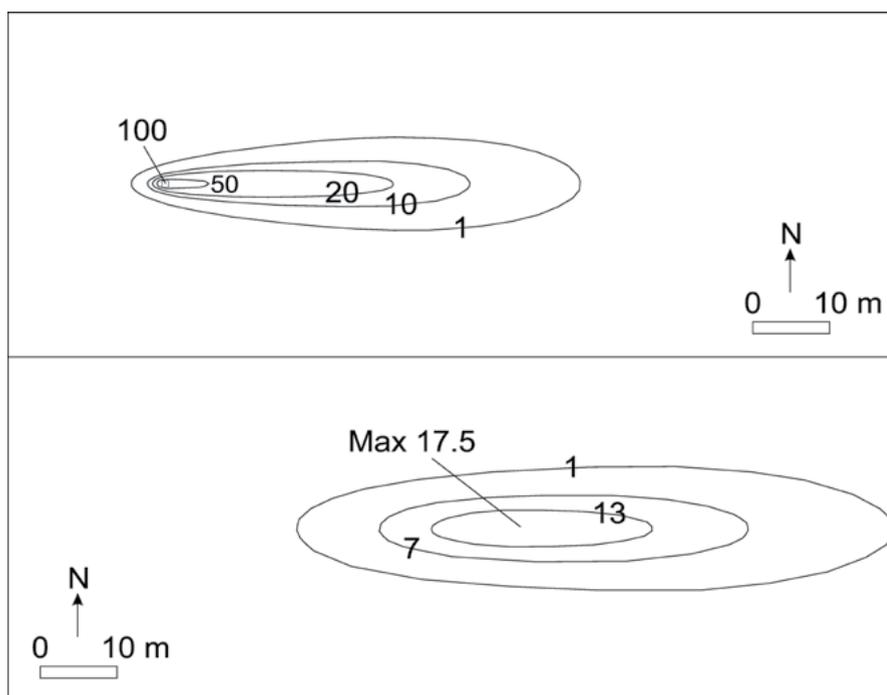


Figure 1. Map of initial (top) and residual (bottom) contaminant plume contacting downgradient boundary without intervention; contours in mg/L.

contaminated groundwater, which is treated above ground and then injected into the aquifer via the other well.

The injection well also dilutes contaminant concentrations in groundwater. Such dilution complements dilution by fresh groundwater in an aquifer. These processes, combined with the effects of hydrodynamic dispersion, contribute to lowering contaminant concentrations in aquifers. Additionally, low-capacity extraction and injection wells do not require excessive amounts of energy. In some settings, solar energy could power them.

While well pairs may be effective at controlling contaminant plumes, using three wells offers a potential advantage. This involves an extraction well placed directly downgradient of the plume's leading tip, with peripheral injection wells for containment. Conversely, a three-well

pattern may include a central injection well and peripheral extraction wells.

Earlier studies involved flow line distributions for evaluating well pairs (Cunningham and Reinhard, 2002; Wu et al., 2008). Hudak (2015a) used modeled advection and hydrodynamic dispersion to evaluate two-well configurations in simulated homogeneous and heterogeneous aquifers. In a previous study, an injection-extraction well pair outperformed a permeable reactive barrier and non-pumped wells with filter media (Hudak, 2015b).

## METHODS

This study examines a no-action scenario, compared with two-well and three-well alternatives for remediating a contaminated aquifer.

A flow and transport model, MT3DMS

(Zheng and Wang, 1999), was used to simulate conditions in a hypothetical unconfined aquifer. MT3DMS involves a finite-difference grid, in this case consisting of 175 rows (oriented east-west), 450 columns (oriented north-south), and one layer. A distance of 0.25 m separated adjacent nodes (centered in cells) along rows and columns. Water table elevation was 5.0000 m and 3.8775 m at nodes in the westernmost and easternmost columns, respectively. The water table sloped eastward, with a regional hydraulic gradient of approximately 0.01.

An elevation of 0 m was set at the base of the aquifer; this was a no-flow boundary, as were the northernmost and southernmost rows of the model. Hydraulic conductivity and effective porosity of aquifer media were set to 0.5 metres/day and 0.25, respectively.

The model generated a flow field and contaminant plume emerging from a 0.56 m<sup>2</sup> source area, with a constant concentration of 100 mg/L. This source area was near the western edge of the model domain (Figure 1). The source was active until the plume was 40 m from the eastern edge of the domain. Concentrations at that time were initial conditions for remediation trials (with the source shut off).

In all mass transport simulations, longitudinal dispersivity was 1.0 m, transverse dispersivity was 0.1 m, and the effective molecular diffusion coefficient was 0.00001 m<sup>2</sup>/d. Plume boundaries coincided with the 1 mg/L concentration contour.

A no-action and three active remediation alternatives were modeled. The active alternatives involved an extraction-injection well pair, with each well pumping at an identical rate, along a linear transect located 5 m downgradient of the initial contaminant plume and oriented perpendicular to the regional hydraulic gradient. The southernmost well injected clean water, considered treated above ground after being extracted from the northernmost well.

Two additional alternatives, each involving three wells along the same transect, were also modeled. One of these alternatives featured a central extraction well and peripheral injection wells. The

other involved a central injection well and peripheral extraction wells. The pumping rate at each peripheral well was half the rate at the central well. Thus, the total extraction rate equaled the total injection rate. Each well was screened across the entire aquifer.

Through an iterative process, the model identified the locations of pumping wells, and minimum volume of pumped water necessary to contain and remove the contaminant plume. Flow and transport simulations used the preconditioned conjugate gradient and generalized conjugate gradient solvers, respectively. Mass balance errors were less than 0.01%.

## RESULTS

After 1,940 days with an active source, the contaminant plume was 40 m from the eastern model boundary. At this stage, the plume had a maximum width of approximately 14 m. Natural attenuation alone did not contain the

contaminant plume on-site. With the source shut off and no intervention, the contaminant plume reached the eastern boundary after 1,660 days. At the time it reached the eastern boundary, the contaminant plume occupied more area, but had lower concentrations, due to the effects of hydrodynamic dispersion and dilution by clean groundwater.

The most efficient well pair capable of containing and removing the contaminant plume had 5 m of separation, with a pumping rate of 0.3 m<sup>3</sup>/d over 3,690 days. After 3,690 days, concentrations at all model cells were below 1 mg/L, and at no time did concentrations exceed 1 mg/L along the eastern site boundary. By this time, the extraction well had removed 1,107 m<sup>3</sup> of water and 5.72 kg of contaminant. The midpoint of the well pair was collinear with the contaminant plume's long axis.

Attenuation by dilution and hydrodynamic dispersion, in addition to pumping

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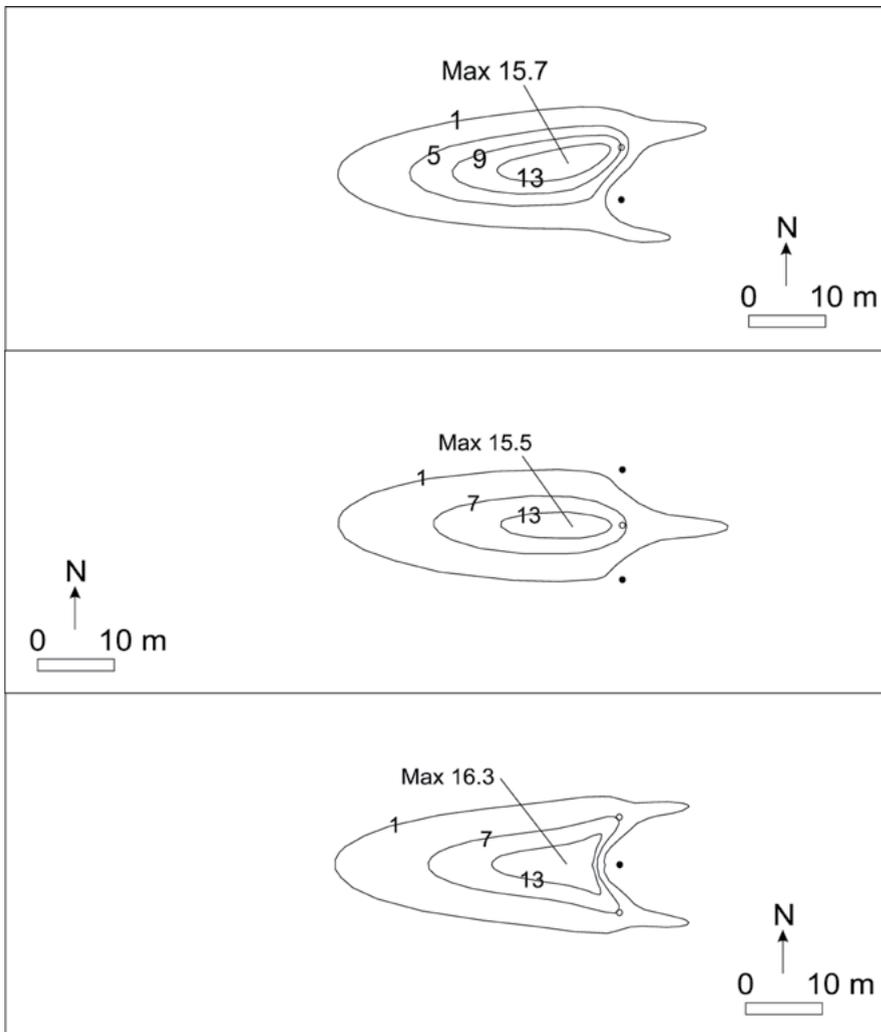


Figure 2. Map of residual contaminant plumes after 2,000 days for two-well and three-well interventions; open circles – extraction wells; dots – injection wells; contours in mg/L.

at low rates, effectively reduced contaminant concentrations within the aquifer while containing the plume on-site. Portions of the contaminant plume moved past the well pair, but not off-site.

The most efficient three-well pattern with a central extraction well and peripheral injection wells had 7 m of separation between neighboring wells and pumped 0.3 m<sup>3</sup>/d over 3,750 days. Over this period, the extraction well removed 1,125 m<sup>3</sup> of water and 5.70 kg of contaminant mass. The extraction well lay along an extension of the initial contaminant plume's long axis.

Finally, the most efficient three-well pattern with a central injection well and peripheral extraction wells had 6 m of separation between neighboring wells. The well pumped 0.4 m<sup>3</sup>/d for 3,960 days. The extraction well removed 1,584 m<sup>3</sup> of water and 5.78 kg of contaminant mass. As in the previous configuration, the central well was collinear with the long axis of the initial contaminant plume. (Figure 2)

Overall, low-capacity pumping well configurations effectively contained and removed the contaminant plume. For each alternative, the most efficient configuration was centered on a downgradient extension of the initial plume's long axis. Separation between wells varied from 5 m – 7 m, or approximately 36% – 50% of the initial plume's maximum width.

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A well pair was the best alternative, closely followed by a three-well configuration with a central extraction well. These removed a similar volume of water and contaminant mass, over a similar time frame. In addition to being most efficient, the smaller two-well configuration would save on installation, monitoring, and maintenance costs.

Slightly less efficient was the three-well pattern, featuring a central injection well. It pumped a similar amount of contaminant mass as the other alternatives to eventually clean the aquifer. However, it had a 33% higher pumping rate and removed 43% more water which required treatment. With a higher pumping rate, the three-well scheme with centralized injection remediated the aquifer in 7% less time than the two-well scheme.

Overall, results suggest that low-capacity well pairs, and three-well configurations with a central extraction well, may be viable options for remediating some aquifers. They require above-ground treatment of contaminated water, but not the costly excavation and disposal of spent media with permeable reactive barriers. Generally, above-ground treatment systems are easier to monitor and maintain than reactive barriers.

However, the simulated alternatives do have limitations. They require groundwater to effectively carry contaminants to an extraction well(s). If the hydraulic conductivity of an aquifer is very low, and/or contaminants insoluble, alternatives considered here would be ineffective. The simulations also relied upon an on-site buffer zone, within which dilution and hydrodynamic dispersion helped lower contaminant concentrations.

In practice, site-specific conditions dictate the suitability of remediation alternatives.

## SUMMARY

The objective of this study was to evaluate the relative performance of alternative two – and three-well strategies for containing and remediating a contaminant plume on-site. Results show that a low-capacity well pair, and a three-well scheme with centralized extraction, may be viable alternatives for remediation in some cases, such as the one considered here. For each scheme, the midpoint of the most effective configuration was collinear with the long axis of the initial contaminant plume. Optimal separation between wells was about half the maximum width of the initial contaminant plume.

For a full list of references cited in this article, visit: [www.esemag.com/article-527](http://www.esemag.com/article-527). ■

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INVENT's distribution partner was able to lay out and recommend suitable mixers to optimize coagulation and flocculation. Also, with the help of high-resolution, realistic flow simulation, processing steps were modeled and optimized.

One challenge during the layout was to improve mixing in the supply tank. The goal is to achieve a spontaneous equalizing of the charge on the particles' surface so that colloiddally present particles can grow into flakes. Cyberpitch mixers mix with high velocity and energy. They use a



INVENT Hyperclass<sup>®</sup> mixers in the flocculation tank



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refined angled-blade, which accelerates water not only in an axial, but also in a radial direction. This helps to evenly stir in the flocculation agent.

Hyperclassic Evolution7 mixers are employed in the flocculation tanks in order to remove, for example, particles causing turbidity or solute organic matter. This is achieved through agglomeration of suspended or colloidal particles. Subsequently, the water passes through sedimentation, flotation and filtration phases.

The design of both mixers meets the requirements of drinking water treatment very well. The power units are dry installed above the water's surface and therefore do not come into contact with it. Food-grade oil in the power units and oil trays prevents water contamination.

With the help of the mixers, all prerequisites for the optimal formation of flakes can be fulfilled and undesirable impurities can be separated. By rotating close to the bottom of the tank, their eight integrated and specifically optimized transport ribs generate a radially external bottom flow. This flow is particularly turbulent close to the bottom, so it efficiently stirs up sediments to prevent sedimentation of particles in the flocculation tank.

Additionally, incidences of short circuit flows are eliminated. Due to the fact that the flow on the water's surface is directed towards the drive shaft, all particles are evenly mixed throughout the tank so that almost all of the particles come into contact with the flocculation agent, agglomerate and form flakes.

Due to the mixer's large diameter, its optimal geometry and low rotational speed, shear forces are minimized. This

enhances agglomeration of the flakes and avoids loading the flakes. The bigger and more stable these flakes are, the more easily they can be separated in the subsequent purification steps. ■

*INVENT is represented in Ontario by Pro Aqua, Inc. For more information, email: [scott@proaquasales.com](mailto:scott@proaquasales.com)*

“Almost all of the particles come into contact with the flocculation agent, agglomerate and form flakes.”



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# PRETREATMENT FOR MEMBRANE BIOREACTORS IS IMPERATIVE FOR PERFORMANCE

By **Kevin Bates**

Toward the end of the 1980s, Professor Kazuo Yamamoto from Tokyo University gave a lecture to a skeptical crowd on immersed hollow fibre membrane bioreactors (MBRs). Since then, much work has been done to make them a common step in the wastewater treatment process.

To maximize the success of MBRs, pretreatment should be a top priority. This is because, even if the smallest solid or debris slips through, the process can be compromised.

Operators can attest to the incredible challenges of operating an MBR when debris accumulates between the membrane sheets or fibres. Nothing better illustrates the need for pretreatment than the numbers on how quickly one piece of hair can disrupt a system. Studies have shown that 1 ppm of debris can quickly add up to 3.8 kg per 3.8 MLD per day.

The benefits of MBRs are only possible when proper pretreatment is put in place. Unprotected units will often require fouling control and membrane cleaning and replacement, all of which increase operating costs. Installing a screening system as pretreatment will ensure performance is maintained.

## SCREENING

Placing a screen upstream is as significant to the treatment process as the MBR itself. Screening protects the membrane from all manner of damage, such as clogs formed from loose hair and fibre that slip through, or debilitating damage inflicted by sharp particles.

A number of screen designs can be used to protect MBRs, including rotary drum and band screens. The key is to ensure the screen is designed for the types of debris it will encounter and that it is sized correctly for the influent.



**Above:** A number of screen designs can be used to protect MBRs, including rotary drum and band screens.

**Right:** MBR fouling.



## EVOLUTION OF MBR PRETREATMENT

In the early days of pretreatment for MBRs, a 3 – 6 mm opening size on the screening media was deemed to be an adequate level of protection. Since then, there have been shifts in both the understanding of MBR pretreatment needs, as well as changes in the influent in waste streams. In recent years, many facilities have fibre contents increase with the popularity of disposable personal hygiene products like wipes. This change in the makeup of typical sewage, along with the experience that the industry has gained shows that finer screening, in the range of 2 mm or less, is a must.

Reaching the necessary level of fine screening is not typically achieved in one step. It is common to have multi-step screening to accomplish the task. For combined sewer applications, some form of coarse screening (greater than 6 mm) is frequently utilized to remove large solids. Even dedicated sanitary sewer flows employ 3 – 6 mm fine screens as the first line of defense to prevent over-loading, or blinding a much finer screen.

A properly sized and designed pretreatment strategy will contribute to less cleanings, a better capture rate and improved operations. Fine screens of 2 mm or less are recommended for pretreatment of

MBRs, but ultra-fine screens are preferable to ensure a higher solids capture rate. Ultra-fine screens of 1 mm are better suited to truly protect MBR systems from even the smallest piece of fibre or hair.

### PROTECTING ALL FLOWS

It is not just the main process flows that must be considered when planning a pretreatment strategy. Plant designers and operators have also learned that they must consider fugitive fibre and debris sources.

Wash down and filter back flushing are some of the more common sources of fugitive debris that, if left unchecked, can foul an MBR. Designers must also look at the potential for less frequent incidents like system repair work or overflow events that can create problems. All such fugitive debris sources must be reintroduced into the process, prior to the pretreatment screening. ■



*Hollow fibre fouling.*

*Kevin Bates is with JWC Environmental.  
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# RADIATION PROTECTION FOR THE REMEDIATION OF HISTORIC LOW-LEVEL RADIOACTIVE WASTE

David Cole and Brandyn Leaper

The Port Hope Area Initiative (PHAI) is the Government of Canada's response to the community-recommended solutions for the remediation and safe, long-term management of historic low-level radioactive waste in the municipalities of Port Hope and Clarington, Ontario.

The waste was the result of uranium and radium processing operations in Port Hope, Ontario, from the 1930s to the 1980s. The Eldorado refinery, on the shores of Lake Ontario, began refining radium-226 from pitchblende ore taken from Port Radium in the Northwest Territories, later transitioning to the refining of uranium ore. Process residues were deposited at the Welcome Waste Management Facility in Port Hope until the mid-1950s, then switching to the Port Granby Waste Management Facility that continued to accept waste until the late 1980s.

The Port Granby Project involves the construction of a new, secure long-term waste management facility and supporting infrastructure. This is in preparation for the excavation and relocation of approximately 450,000 m<sup>3</sup> of historic low-level radioactive waste and marginally contaminated soil from the Port Granby Waste Management Facility to the newly constructed facility. The Project is regulated by a Nuclear Waste Substance Licence granted by the Canadian Nuclear Safety Commission (CNSC), which periodically audits and reviews the progress of the work.

Canadian Nuclear Laboratories (CNL) is delivering the PHAI on behalf of Atomic Energy of Canada Limited, a federal Crown corporation. Wood-Environmental and Infrastructure Solutions has been contracted by CNL to execute this project, ensuring it is within compliance with all Canadian laws and regulations. A comprehensive radiation protection program is a necessary aspect of this remedi-



To prevent airborne contamination, wetting of materials was required at times. Photos courtesy of Port Hope Area Initiative.

ation project and is the key to a successful nuclear remediation project.

## STRUCTURE OF THE PORT GRANBY RADIATION PROTECTION PROGRAM

A radiation protection (RP) program has been developed to meet contractual and regulatory requirements for this project. The scope of the RP program includes:

- A high-level radiation protection plan that specifies responsibilities, authorities, limits, reporting and program assessment requirements.
- A suite of standard operating procedures that describe how the radiation protection program is implemented on a day-to-day basis.
- A comprehensive training program that addresses training needs of both workers and visitors.
- Comprehensive means to measure and record radiation doses and radiation hazards.
- Response to unusual circumstances, incidents and emergencies.
- Ongoing auditing by internal resources, CNL and the CNSC.

## RADIATION HAZARDS AND MITIGATION

The following potential radiation hazards have been identified at the Port Granby Project site as part of this remediation project:

1. External (gamma) radiation fields.
2. Radon.
3. Inhalation hazards.
4. Contamination.
5. Ingestion.

Mitigation methods have been developed in response to each of the identified hazards.

## EXTERNAL (GAMMA) RADIATION FIELDS

Protection from gamma radiation is typically based on three principles: minimizing the *time* spent near the radiation, maximizing the *distance* between the individual and the radioactive material, and having some sort of shielding between the individual and the radioactive material. These principles are implemented to the extent practical and feasible.

For example, excavator operators are

discouraged from holding buckets of waste material near the cab for extended periods of time unless absolutely necessary (reducing the *time* factor and increasing the *distance* from the radioactive source).

No workers are required to be standing immediately in the vicinity of the excavation work (increasing the *distance* factor and reducing their exposure *time*). Workers do not enter the radiation-controlled area unless required to do so (reducing the exposure *time* and *distance* between them and the waste material)

Routine monitoring of the site is performed daily to measure gamma radiation fields. Results of these surveys are used to notify workers of areas of elevated radiation and to determine safe working times.

All workers are provided with dosimeters that provide a permanent record of their radiation dose. Real-time monitoring of worker radiation doses is also performed to gain further insight into the doses that workers receive during their



Computer visualization of the completed Port Granby Project.

daily tasks. This allows on-site radiation protection staff to adjust the RP program in real time.

#### RADON

There are three independent methods

used for monitoring radon levels and the radon hazard.

Environmental radon monitors are placed at strategic locations around the site. These are exchanged quarterly and

*continued overleaf...*

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provide an insight into the radon hazards at key locations within the site.

There is continuous real-time monitoring of radon levels using an electronic radon monitor. Key personnel are provided with individual passive radon monitors. These are provided by a commercial supplier and are exchanged monthly.

**INHALATION**

The project is mandated to operate with the goal of “no visible dust”. As such, in the event that dust is observed, action is promptly taken to eliminate it. Those actions could include wetting of material or stopping any operation that may be producing airborne material.

To enhance visible monitoring, con-

tinuous real-time dust monitoring is provided by the environmental monitoring group. These monitors will provide an alarm if elevated dust levels are detected.

All site heavy equipment has enclosed operator cabins with their own air circulation and filtration system. Operators are required to use these air systems while operating their equipment to prevent material from entering through windows during operations.

A small battery-operated portable air pump and filter is deployed daily to monitor for radioactive airborne particulates. The pump and filter is rotated through various locations on a weekly schedule.

**CONTAMINATION**

All work involving radioactive material is performed within a demarcated “radiation control area”. Personnel access to this area is strictly controlled through a single access control point, which is a dedicated trailer configured to meet the radiation protection needs.

This trailer includes washing and contamination monitoring facilities. Workers don and doff dedicated site clothing that is cleaned and inspected on site before returning to circulation. Site personal protective equipment includes high-visibility coveralls, boots, gloves, and hard hats, hearing and eye protection.

All vehicles and equipment leaving the radiation-controlled area must exit through a controlled gate and are scanned for possible contamination. Two decontamination facilities (capable of accommodating large construction equipment) are available on site. These are essentially vehicle wash facilities that contain all wash water and overspray. In addition, a vehicle wheel wash facility is available for rapid removal of material from the underside and wheels of any equipment. Water from this system is trapped and later treated on site.

Routine monitoring of the dedicated waste haul road between the excavation and emplacement (a distance of about 700 m) is performed using a ScanPlot<sup>SM</sup> trailer. This consists of a large trailer-mounted radiation detector connected to a real-time display. This trailer is routinely pulled along all the roads to measure levels of contamination. All waste hauling is confined to a dedicated roadway within the site. No



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waste is transported on public roads.

### INGESTION

No eating, drinking or smoking is permitted in the radiation-controlled area except for specially designated areas. Routine contamination monitoring is performed in these designated areas to ensure worker safety and that the spread of contamination is not occurring. There is a dedicated lunch room that is routinely monitored for contamination each day and is situated well away from the waste hauling operations.

### RADIATION PROTECTION PROGRAM EFFORT

There is a total staff of five staff dedicated to the site RP program. As of October 2017, the total RP effort included:

- Approximately 1,100 gamma radiation surveys.
- Approximately 2,800 contamination surveys.
- RP training to over 250 individuals.

- Issued over 650 dosimeters (each worn for a one-month period).
- Completed over 156 daily radon checks and deployment of over 200 personal radon dosimeters.
- Placing eight quarterly long-term area radon monitors for a full year.
- Completed over 70 localized air-monitoring samples.

### EFFECTIVENESS OF THE RADIATION PROTECTION PROGRAM

Effectiveness of the RP program is continuously evaluated through audits, oversight and review processes. These reviews have consistently shown the RP program is highly effective at ensuring worker exposure is minimized in keeping with the principle of ALARA (As Low as Reasonably Achievable).

- Measured radon levels were essentially the same as background levels. That is, no consistent elevated levels of radon have been observed.
- Analysis of all filters showed zero

detectable radioactivity in the air.

- There were no contamination incidents. That is, there have been zero incidents of finding contamination in areas beyond the radiation controlled area.
- There has been no detectable contamination measured on the internal haul route roadways and there has been no release of radiological material from the construction site.
- For nearly all (99%) site workers, the yearly dose received has been below a detectable level, with only four individuals receiving a measureable dose. Those doses that were measurable were less than 1% of the permissible annual limit (for individuals who are designated as nuclear energy workers, as all site workers are).

This paper was reviewed by staff at Canadian Nuclear Laboratories. ■

*David Cole and Brandyn Leaper are with Wood – Environmental and Infrastructure Solutions. Email: david.cole3@woodplc.com*

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# NETWORKING IS AN IMPORTANT PART OF BUILDING SUCCESSFUL LONG-TERM CLIENT RELATIONSHIPS

By  
**Linda Drisdelle,**  
Pinchin Ltd.



Growing businesses rely heavily on some staff developing great relationships with a strong client base. These relationships drive business and, often through word of mouth, extend businesses into new markets. Networks take years to nurture and as careers evolve, and over time, companies can find themselves having great relationships with powerful decision makers. These now very senior managers and executives work together on projects that bring benefit to both parties.

Those new to the workforce will come to observe these relationships regardless of where and what industry they are in. These relationships are most notable at the very top of the organization, at levels that have taken incumbents' careers decades to reach. Understanding that these relationships started at points of time when these senior managers and executives were much earlier in their careers is needed in order to foster the skills required to replace them in succession planning.

The importance of these relationships, along with an understanding of their origins, is of interest to most organizations who take succession planning seriously. Succession planning for management, leadership and technical skills is fairly straightforward, particularly for organizations with supportive human resources teams. Relationship succession planning, on the other hand, is often problematic. This is in part because its importance is generally overlooked.

Also overlooked, is that the long-standing senior relationships currently in place are likely not suited for succes-

sion planning. These relationships have evolved over time and inevitably acquire a personal tone, making it unsuitable for a hand off to a successor. What is needed are new relationships among new successors. Companies need to identify those with the skills and interest in this area and support the evolution of the next generation of senior relationships.

Staff showing interest and talent for relationship management are great candidates for consideration and could one day be managers at very senior levels. It takes a keen manager to be on the lookout for these skills that need to be developed through exposure to business problems and strategies. Companies prepared to provide coaching to those with talent will be well positioned for relationship succession planning.

The industrial, commercial and manufacturing sectors have a lot to gain by networking and relationship building at the mid-levels of their organizations. In particular, smaller companies lack the depth of professional skills to solve all of the problems they encounter.

My staff's main point of contact is with operational and plant people with many problems to deal with and talk about. As consultants, my staff are expected to know how to help, and their clients are thankful to have someone knowledgeable in the areas where they lack expertise. Noticing these business opportunities is good practice for staff and young professionals to develop their emerging business development skills.

If staff cannot provide the solutions themselves, they have their own emerging networks of other professionals who can be called upon to provide the relief their clients need. It is great for clients to interact with consultants who can help them navigate a path towards a solution, without the need for hiring their own staff with high levels of expertise.

Fixing problems together sets the foundation for a strong business rela-

tionship that one day will join two companies at very senior levels. Not only does this experience afford opportunities for further business and cross-selling other services, but it expands networks for long-term business growth. My young staff know they always have a budget to take clients for lunch and have the freedom to be creative with developing budding personal relationships.

Senior managers or executives do not see anywhere near the number of operational problems as mid-level staff. If they do, they are not familiar enough with the details that are often required to generate the insights for truly high value suggestions or solutions. Besides, younger staff are better dialed into the latest technologies that give the best solutions anyway.

Modern day business is about solving modern day problems. Technology has shaken things up out there and younger staff know how to fix these problems best. More senior staff are too busy liaising with VPs and C-Suite people to ever be as good or as efficient at solving these operational problems their young staff are so good at. Different types of problems foster differing types of relationships among the varying ranks of the organization, and all are equally important for business growth and succession.

Everyone should notice the relationships young staff develop with clients and encourage them to invest time and resources when it makes sense, even at a personal level. Give them support by offering a budget for client lunches, and, if needed, offer to go with them for their first "business development" lunch. ■

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# DIGESTER OPTIMIZATION HELPED BY NEW THERMAL WET GAS FLOW METERS

By **Ethan Webster**

Wastewater treatment plants are under pressure from growing communities and more demanding regulations. For treatment plants in growing communities, the volume of wastewater that can be treated is in part determined by the capacity of the plant's digesters. Typically, to increase capacity, treatment plants will build additional digesters. This requires large capital expenditures.

New developments in anaerobic digester controls allow a single digester to process a greater volume of solids in a shorter period of time by isolating and treating the phases of digestion separately. With multi-stage anaerobic digestion, the stages of treatment can be optimized for the specific conditions which bacteria prefer. Pre-treatment methods can be used prior to anaerobic digestion to improve digestion efficiency.

Among these, temperature phased anaerobic digestion (TPAD) is one promising method with a relatively low energy input and capital cost. TPAD occurs by separating the digestion process over time and precisely heating the different stages.

The optimized anaerobic bacteria can convert organic matter at a far greater rate than those in a conventional digester.

There are three distinct steps during anaerobic digestion, each performed by a different group of microorganisms:

1. Hydrolysis – proteins and fibres are broken down.
2. Volatile acid fermentation – products of hydrolysis are converted into organic acids.
3. Gas forming step – organic acids produced during the acid phase change the pH and allow methane forming bacteria to proliferate.

Hydrolysis and methane formation can be enhanced by increasing operating temperature. However, acid formation is adversely affected by this.



*The Kurz Wet Gas Flow meter allows multi-phase digestion to be effective and reliable.*

Unanticipated changes in sludge quantity, or content, can create an imbalance of bacteria. The plant may receive industrial or agricultural waste with widely differing properties and the biochemical oxygen demand of different feed stocks can vary greatly, resulting in inconsistent gas production.

Fluctuations in temperature, or sudden changes in the material being fed to the digester, can cause a microorganism imbalance. Foaming can occur due to too little, too much or inconsistent sludge mixing.

Feed fluctuations may cause an imbalance between acid-forming microorganisms and gas-forming microorganisms. The expanding mat of foam from the upset digester can overflow the tank, requiring significant maintenance and cleanup. Taking a digester out of service, without advanced planning, can lead to significant process control issues and

the remaining digesters will have to take on the extra load.

Finally, a “sour” digester can cause odours that the community will be quick to report.

The potential of digester tank upset has made TPAD seem risky. However, the benefits can be achieved with little risk. With proper instrumentation and controls, plant operators can be alerted before upsets occur, allowing them to take action and avoid process upsets.

Gas flow meters typically used in biogas production are slow to respond and may not report minute shifts in flow. For the system to be fully optimized, equipment must respond quickly and reliably. Meters which respond quickly to very small changes in flow can provide the response window necessary to avoid upsets.

Biogas has varying flow rates and contains a great deal of moisture. Moisture in the gas lands on the meter's

thermal sensors. Designed to measure vapour, liquid will cause the sensor to give false flow readings. Up to now, the ability to use phased digestion accurately and effectively has not been possible, simply because digester gas could not be measured with confidence. Most flow meters do not provide both rapid response time and accuracy.

**CASE STUDY**

One regional facility treats 230 MLD of wastewater. In addition to local sewage, it also receives deliveries of organic material from local industries and agriculture. To keep up with demand, a state-of-the-art TPAD system was installed.

However, when minerals clogged the heat exchanger to the acid fermentation vat, the temperature rose, causing a bloom of bacterial growth and an increase in biogas production. Before operators had any warning that something was wrong, the digester was upset. Foam and other digester contents overflowed and caused

the digester lid to tilt into catastrophic failure.

Operators were unable to effectively control the TPAD process. The plant manager heard about Kurz Instruments' new Wet Gas Flow™ technology and installed a 454FTB WGF unit to measure output from the acid fermentation tank.

The sensitivity of the meter was demonstrated when plant operators noticed an unexplained spiking of flow signal. Investigation revealed the sensor was reading flow caused by bubbles coming up through the mat of foam. The efficacy of the meter was shown the next time an upset occurred. It saved the plant from failure by immediately reporting the increase in digester gas flow caused by a temperature increase. This allowed operators time to stop the runaway reaction and regain control of the process.

The Kurz Wet Gas Flow meter allows multi-phase digestion to be effective and reliable, which means wastewater treatment plant operators can increase



A 454FTB WGF unit was installed to measure output from the acid fermentation tank.

biogas production and digest waste more completely with far less capital expenditure. ■

*Ethan Webster is with KURZ Instruments Inc. For more information, visit [www.kurzinstruments.com](http://www.kurzinstruments.com)*

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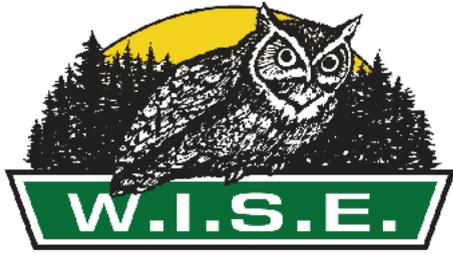
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*On aerial runs, be careful of how much slack is needed between poles.*

## FIBRE OPTIC SCADA NETWORKS NOW AN ECONOMICAL OPTION FOR SMALL WATER PLANT PROJECTS

By **Connor Campbell** and **Graham Nasby**

In recent years, the cost of fibre optic cabling has dropped considerably. What used to be cost prohibitive is now readily available for even the smallest SCADA system project.

Guelph Water depends on its SCADA network as a vital tool for its operations and compliance teams. The SCADA network is critical for complying with the 5 minute logging requirement for online chlorine residual readings outlined in O.Reg. 170 section 6.

This past summer, the final segments of fibre network cable were installed to link several Guelph Water buildings.

Optical fibres have a number of different applications, but in general the tech-

nology is used to send and receive information using only light. This method of communication has a number of advantages over regular copper wires. These include faster speeds, more bandwidth versus copper cables of the same size, no electrical interference between cables, and a lower chance of weakening or losing a signal.

This not only means that fibre optic wires operate more efficiently than copper wires, but they are also cheaper to operate and maintain. This is especially true for long distance high speed Ethernet networks. Copper Ethernet connections are usually limited to around 300 metres, whereas fibre optic links can span over

100 km without the need for repeaters.

Two types of fibre optic cable are typically used in Ethernet networks. The first is multi-mode and the second is single mode. In multi-mode fibre, a large diameter optic strand (50 – 100 microns) is used so that a low intensity laser transmitter can be utilized. This allows for less expensive transmitters to be used. In single-mode fibre, the fibre optic strand is very thin (8 – 10 microns) and requires a more expensive laser transmitter.

The difference is that single mode fibre can be used to cover much longer distances. In the past, it was hard to justify the use of single mode fibre for anything but long distance applications, but now it is cost-effective for most applications.

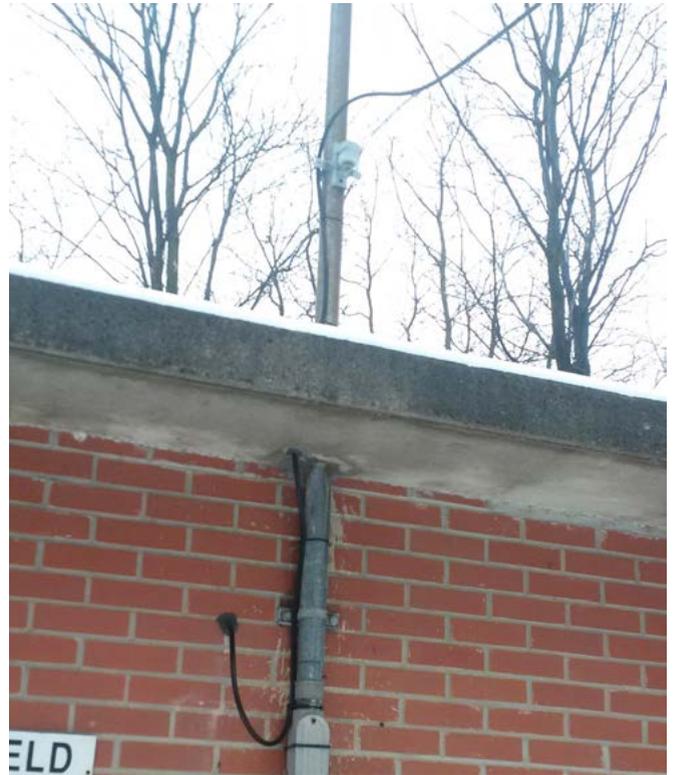
### ROUTING THE FIBRE

Fibre optic strands are fragile and must be protected. In all fibre optic cables, the strands are arranged in plastic tubes to protect them. The use of armoured cable is recommended. If a cable is being installed outdoors it will have a stronger jacket/armouring on it compared to a small indoor fibre patch cable which may have only a thin plastic covering.

When fibre is run for any length, within a building or underground, it should be protected inside conduits. If it is run up the side of a pole, or on the side of a building, a guard, or a conduit, is recommended to protect it.

When fibre cable is strung between poles, a messenger wire is needed to support the cable. In aerial applications, the fibre cable has to be fastened to the messenger wire using light-gauge lashing wire or special clips. For long aerial runs, a special machine is used to affix the lashing wire to the cable as it runs along the messenger wire.

On aerial runs, one also has to be careful of how much slack to use between poles. Too much slack, and the wire will be thrown around in the wind and it will most likely be damaged. However, if the cable is too tight the wire will vibrate quickly in the wind, causing stretching and damage. Lastly, at the end of aerial runs, the messenger wire has to be properly fastened so that it will not fall down. It is possible to purchase fibre cable that has the messenger wire moulded into it, but



**Above:** Always leave several loops of spare cable in the control panel.  
**Right:** If a cable is being installed outdoors it will have a stronger jacket/armouring on it.

it is more common for the messenger wire to have to be installed separately.

### CABLE TERMINATIONS

Terminating fibre cable requires special tools and equipment. Best practice is to only do fibre terminations inside of a network cabinet or control panel. Special manufactured termination boxes are recommended that provide a means to safely secure the end of the cable and expose the individual fibre strands for splicing/termination. Inside a termination box, there are two options to terminate a fibre strand. The first is to splice to another cable and the second is to terminate it with a fibre jack.

The use of fibre jacks is always recommended, as it allows connections from one fibre cable to another to be modified, using short fibre patch cables. Fibre patch cables are also used to connect a fibre jack to a piece of network equipment, such as a switch or fibre transceiver.

Within the network cabinet or control panel, best practice is to always leave several loops of spare cable so that future repairs or relocation of the cabinet is possible. Fibre cables cannot be easily  
*continued overleaf...*

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spliced, so having extra “maintenance loops” of cable makes future work easier. In fact, for fibre optic service providers it is not uncommon to leave 10 – 20 m of extra cable inside cable vaults.

### FIBRE STRAND TERMINATION

The process of terminating fibre cable strands is defined by the cable manufacturer. Specialized tools and equipment, including a splicing machine, are typically used. First, the outer jacket of the fibre cable is removed, followed by the plastic tube covering the fibres. Then, the individual fibres are exposed and wrapped around a jig.

To prepare each fibre, a “boot” for a fibre connector is fed onto the wire and pushed down. Then, a pair of fibre strippers is used to remove the outer jacket and any remaining inner polymer coating. A coating of fibre optic cleaning fluid is then applied to the now exposed fibre, using an appropriate fibre-cleaning material. A device called a cleaver is then used to make a precision trim on the end of the fibre. This trim has to be perfectly perpendicular, or the light won't shine into the connector properly. Next comes the splicing of the fibres. Splicing will usually be done one of two different ways: mechanical splicing or fusion splicing.

For fibre terminations, mechanical splicing is often used as it is the fastest

and easiest to install. For long distance applications, fusion splicing is more common. Mechanical splicing begins by placing the connector into a cradle on a splicing machine, and then inserting a termination coupler into the machine. A visual-fault-locator tool on the splicing machine then indicates if the splice is in alignment. If so, a green light will come on and it is safe to proceed. If not, the fibre end will have to be cut off and re-prepared.

The next step with the splicing machine is to insert the freshly cleaved fibre into the hole at the bottom of the splicer. While keeping some pressure on the fibre, the technician presses a button on the machine and the machine proceeds to complete the splice into the coupler. Once the coupler is attached, the “protective boot” for the connector is slid into place and the coupler placed into the correct part of the termination box.

For termination connectors there is a wide range of available connector types, including ST, SC, FC and LC connectors. The correct type of connector to use depends on the type of network equipment being used. Adapter fibre patch cables are also available if there is a connector type mismatch.

After the strands are terminated, the next step is to finish mounting them into the termination box, close up the box, and ensure the entire fibre cable, includ-

ing maintenance loops, is well secured and protected. If there are multiple fibre cables going into a termination box, the cables and the fibre termination jacks need to be labelled.

### TESTING THE CONNECTION

The last step is to test the newly installed fibre. Usually an end-to-end fibre test meter is used, which consists of a sender module at one end and receiver module at the other end. The test meter will send test light signals down the cable and look for distortion and attenuation of the signal. If the cable performs within manufacturer specified acceptance criteria, then the installation is certified as compliant. If the test does not pass, remedial work is needed.

For most fibre installations, cable manufacturers will provide an installation warranty, provided that the cable has been installed by certified technicians using approved termination products and methods. Make sure to ask for copies of the fibre installation test reports and a copy of the manufacturer's warranty paperwork. ■

*Connor Campbell is a computer science student at the University of Guelph. Email: [ccampb21@uoguelph.ca](mailto:ccampb21@uoguelph.ca). Graham Nasby is with City of Guelph Water Services. Email: [graham.nasby@guelph.ca](mailto:graham.nasby@guelph.ca)*

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# SWAN RIVER LIFT STATION UPGRADED AFTER RAINSTORM CAUSES FLOOD, ELECTRICAL SHORT

Constructed in 1975, Ross Street Station is the main wastewater lift station for the Town of Swan River, Manitoba. By 2012, parts for its original pumps could no longer be easily and readily obtained, so components that failed had to be manufactured, which was costly and made for long lead times.

During the 2012 Manitoba Summer Games, Swan River received a monumental rainstorm that dumped over 76 mm of water on the area. The Town soon discovered that a motor on the dry side of Ross Street Station had shorted out due to excessive moisture. It then had to declare a state of emergency and discharge wastewater directly into the river, to prevent sewage backup into area homes.

Once public utility staff were able to get the immediate issue under control, they started working on long-term solutions to the electrical issues in the dry pit. After speaking with their consulting engineer, Associated Engineering, and Xylem, a decision was made to install three new Xylem Flygt horizontal dry pit, flood-proof NZ-3171 submersible pumps to replace the old equipment. These medium-capacity 600-volt, 30-horsepower pumps include self-cleaning N-impellers.

The old pumps had created a space issue, because they were much larger than the new NZ-3171 pumps, making service in tight quarters a dangerous situation. This is no longer the case, as the new pumps are smaller and sleeker, which makes maintenance easier and safer.

Original voltage to the pump station was 600 volts. However, since the older pumps had 230-volt, three-phase motors, a transformer was required to step the voltage down. Replacement with the Flygt NZ-3171 pumps enabled the town to eliminate the need for a transformer to do this.

During installation of new piping and pumps at Ross Street Station, a bypass system using an external engine driven pump moved wastewater from the approach manhole to the force main. The Flygt diesel backup bypass system



**Top:** The Flygt NZ-3171 pumps installed at Ross Street Station are smaller and sleeker, which makes maintenance easier and safer. **Bottom left:** Parts for the original pumps at Ross Street Station were not readily available, causing long lead times for repairs. **Bottom right:** The project involved completely upgrading mechanical and electrical systems.

now allows the station to be shut down without putting the town at risk of wastewater backup, and provides 100% redundancy. Also, in the future, the station can be bypassed during maintenance, ensuring worker safety.

Now, with completely upgraded mechanical and electrical systems along with the new Flygt pumps, capacity of Ross Street Station is 85 L/s running a single pump, 106 L/s running two pumps in parallel, and 113 L/s with three pumps

running. Installation immediately offered a 25% boost in efficiency over the older pumps.

A wide range of spare parts is now kept on site for speedy replacement if necessary. In addition, other spares can be quickly ordered from Flygt's North America central distribution center. ■

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# NTWWA PONDERES IQALUIT'S WATER SHORTAGE AND DEVELOPING NEW WASTEWATER STANDARD

By **David Nesseth**

An annual conference for waste and water professionals in Canada's North has become a critical opportunity to gather together and focus on how to persevere over the unique challenges ever-present in this remote and bitterly cold climate.

The Northern Territories Water and Waste Association's (NTWWA) annual conference was held in Iqaluit, Nunavut, from November 6-10, 2017 at the Frobisher Inn. This is a scenic spot, where finding a mentor or a spare part may not be easy, and where critical funding can prove elusive and frustrating for professionals devoted to serving their communities.

"It's hard to have everybody of every discipline in one spot. The North is a big place," said Arlen Foster, a civil engineering team lead for Stantec in northern Canada. He has been in Yellowknife, Northwest Territories, since 2004, and is a past president of the NTWWA. "But it's helpful to get to know whose running these facilities in these communities, and networking is a big part of it."

Staff is quite limited in the North and it can be difficult to keep employees from leaving, said Foster.

"It's hard to keep the highly skilled. At the end of the day, you either love it or hate it here," he said, adding that some people enjoy the adventure and opportunity, while others cherish being entrusted with more responsibility and a greater assortment of assignments than they may have had further south.

The other caveat about northern work is how professionals are often unable to take advantage of rapidly evolving wastewater technology. "With that comes complexity, and in the North it's a challenge to operate and maintain these complexities," said Foster. "Sometimes simpler is better."

The 2017 NTWWA conference featured presentations from governments, regula-



Registrants at the 2017 Northern Territories Water and Waste Association's annual conference.  
Photo Credit: NTWWA.

tors, researchers, and industry, as well as a two-day operators' workshop and tradeshow.

While the North may not be able to take full advantage of fast-paced wastewater technology, professionals still look for guidance through regulation. To address the latest on this front, Nelson Pisco from The Standards Council of Canada spoke to attendees about the ongoing work to develop a wastewater standard for the North. It pertains to the planning, design, operation, maintenance and decommissioning of wastewater treatment in northern communities using lagoons and wetland systems. Key aspects to be covered in the standard include:

- Procedures and methods for collecting information and evaluating the conditions of a potential site.
- Potential effects of permafrost warming and active layer depth changes on effluent containment and stability of surrounding soil.

- Impacts from changes in precipitation.
- Piped or truck collected effluent into sewage lagoons.
- Detailed field test methods, sampling protocols and lab requirements.

Work on the standard began in fall 2017 and it's expected to be completed by the summer of 2019, said Pisco. The council is currently recruiting technical committee and working group members.

In a presentation by Matthew Follett, a civil-environmental engineer with Stantec, a question posed to attendees was if Iqaluit could start running out of fresh water by 2024. The city's water system is aging, pipes are beginning to leak, and climate change is impacting how much water is entering the Lake Geraldine Reservoir that serves Iqaluit's water needs.

Follett's data on the reservoir shows that 98% of Iqaluit's water licence of nearly 1.1 million m<sup>3</sup> was used in 2015. A growing population is putting further pressure on the reservoir, to the point that City officials tapped into the Apex

River in 2015 to augment the raw water supply. It's a move that, in the minds of some professionals, needs more research before it can be dubbed as a solution to the water crisis.

In another presentation, Justin Doiron of Dillon Consulting outlined upgrades to the Inuvik water treatment plant in the Northwest Territories, which opened in March 2017. The new \$19-million plant allows Inuvik to have a single source of water year-round as opposed to relying on water from Hidden Lake in the summer and the Mackenzie River in the winter. Additional upgrades to the plant included an addition to the existing facility, new packaged water treatment plant, filtration, disinfection and storage, and a year-round river intake and raw water pump station.

The Town of Inuvik received the 2017 Canadian Association of Municipal Administrators Willis Award in the "Under 20,000 Population" category for the project.



The new Inuvik water treatment plant allows Inuvik to have a single source of water year round as opposed to relying on water from Hidden Lake in the summer and the Mackenzie River in the winter. Photo Credit: Dillon Consulting.

Northern professionals will join together again at the 2018 NTWWA annual conference in Yellowknife from November 12 – 16. For more information, visit [www.ntwwa.com](http://www.ntwwa.com). ■

David Nesseth is a writer for *ES&E Magazine*.

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In October 2011, Lake Erie experienced one of the worst algal blooms in its history.  
Photo credit: NASA Earth Observatory

## ‘MUSCLE AND METRICS’ NEEDED TO REVERSE ONTARIO’S ALGAL BLOOM TREND, ECO REPORT

If Ontario hopes to reverse current trends of harmful algal blooms, it needs a guiding principle around stormwater management to “monitor, quantify and report” how projects at every scale affect phosphorus levels, states a new report from the Environmental Commissioner of Ontario.

While municipal wastewater treatment plants have come a long way on phosphorus controls since the 1970s, runoff from rural, agricultural and urban land has become the new modern threat of raising phosphorus levels to the point where algal blooms can endanger drinking water and cause fish die-offs, states the October 2017 report, *Good Choices, Bad Choices*.

As southern Ontario rapidly urbanizes, construction sites, for example, often add large loads of sediment and phosphorus to waterways, and places like Ontario’s 800-plus golf courses are left to weigh voluntary measures in the face of no phosphorus restrictions.

Meanwhile, Ontario is running several programs to ensure phosphorus reduc-

tion, yet isn’t measuring their efficacy, the report warns, adding that voluntary measures and unevaluated programs may need to be replaced with “muscles and metrics”.

“Of course, good ideas need trial and error phases, and overnight results are not to be expected. But as phosphorus control programs roll out, they will need the rigour of clear targets, and strong, ongoing evaluation,” Environmental Commissioner Dianne Saxe states in the report.

To illustrate the algal bloom trend, Saxe reports on the significant increase of algal blooms in smaller inland lakes, especially on the Canadian Shield, since the mid-1990s, as documented by the Ministry of Environment and Climate Change. If these trends continue, the report suggests that algal blooms could hurt tourism, lower property values and damage other sectors of the economy in the Canadian Lake Erie basin by more than \$270 million. Additionally, the season for algal blooms now appears to be extending to as late as November, states the report.

Saxe uses the term “non-point sources”

to describe the phosphorus impact from places such as farms, construction sites and golf courses. The report notes that erosion rates at construction sites can be three to 100 times greater than crop lands, and that only 5% of Ontario’s golf courses have opted to be certified under a voluntary program offered by the Audubon Society to minimize nutrient run-off and monitor phosphorus.

Saxe notes that the State of Virginia now requires all golf courses to complete nutrient management plans, including soil tests. In contrast to Ontario, Saxe notes that jurisdictions like Manitoba and Indiana have set strong prohibitions on the winter spreading of fertilizer.

The report also highlights programs such as the voluntary Environmental Farm Plan Program, which has a partial mandate to protect soil and water quality, yet does not measure its own impact on phosphorus run-off or other water quality concerns. Additionally, the report looks at *Ontario’s Nutrient Management Act, 2002*, which regulates manure produced by certain livestock farms, yet does not provide data to show whether the law has been effective at reducing nutrient loadings from manure.

Municipalities also have a significant role to play in reducing phosphorus loads, Saxe says. Lawn fertilizers, soil, dust, litter and pet waste all add phosphorus to stormwater “as it races across urban pavements and roofs,” the report states. Regularly monitoring and dredging stormwater management ponds can cut phosphorus loads by 50% – 80%. However, most municipalities tend to underfund their stormwater management programs.

It’s an issue addressed in Saxe’s 2016 report, *Urban Stormwater Fees: How to Pay for What We Need*, where she estimated that Ontario’s municipalities are facing a \$6.8 billion deficit to fix existing stormwater infrastructure and accommodate future growth.

In 2015, Ontario signed an agreement with the governors of Michigan and Ohio, collectively committing to reduce the total load of phosphorus entering Lake Erie’s western basin by 40% as of 2025. ■

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# GEOSMIN IN LAKE WATER MAY BE THE CAUSE OF UNPALATABLE FISH

By **Claire McAuley**, **Nino Devdariani** and **Findlay MacDermid**

**T**raditional foods are an important part of many First Nation communities because they are often more readily available, healthier and less expensive than store-bought convenience items. Also, their harvesting and consumption is important from a nutritional, social and cultural perspective.

Given the harvesting of fish from local lakes by many First Nation communities, and as a frequently consumed food, the health risks of increasing contaminant levels in fish are of greater concern than in the broader Canadian population.

The proximity and potential impact of both oil and gas development and military activities to the traditional territories of Cold Lake First Nations (CLFN) has resulted in a sense of uncertainty and a lack of confidence in the quality of traditional foods. In Cold Lake, Alberta, members of CLFN have expressed concerns regarding the “muddy” taste and soft texture of fish harvested from Primrose Lake. It is located within the Department of National Defence Cold Lake Air Weapons Range and the CLFN territory.

Community members have expressed concerns about the potential impacts of anthropogenic activities on the quality of the surface water and, in turn, the quality of the fish caught from the lake.

## STUDY DETAILS

Intrinsic Corp. and CLFN partnered to investigate the community’s concerns. In the summer of 2016 and winter of 2017, samples of fish and surface water from Primrose Lake were collected and a human health risk assessment was completed. The study was funded by Health Canada’s First Nations Environmental Contaminants Program.

CLFN members, including youth and elders, were engaged in the study from its inception and provided community use



*Samples of fish and surface water from Primrose Lake were taken to investigate concerns about the “muddy” taste and soft texture of fish harvested from the lake.*

and consumption details. Members were trained in sample collection and were involved in harvesting fish and collecting surface water samples for the study.

To address the community’s concerns regarding potential impacts to water quality from anthropogenic activities, surface water samples were collected from the areas of Primrose Lake frequently used by CLFN members. Surface water samples were analyzed for typical water quality parameters, including metals, major ions and pH, in addition to petroleum hydrocarbons (PHCs), energetic compounds (i.e., explosives) and “taste and odour” compounds.

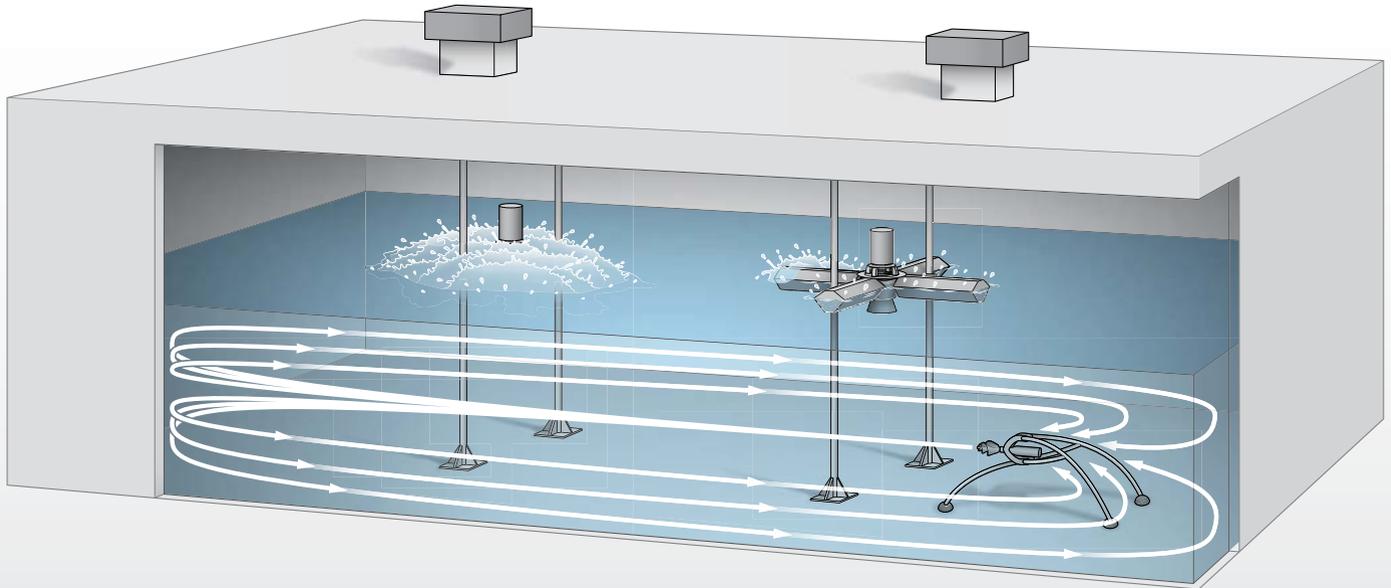
Cyanobacteria and actinomycetes can naturally produce geosmin and 2-methylisoborneol (MIB) compounds that can subsequently accumulate in benthopelagic fish. Benthopelagic fish live and feed near the bottom as well as in midwaters or near

the surface of water bodies. When there are algae blooms such as blue-green and other algae in the lake, both the fish and the water will have increased concentrations of geosmin and MIB. Lake whitefish, in which CLFN members reported a “muddy” taste, have higher levels of exposure to the bacteria than other fish, due to being benthopelagic. When cyanobacteria are metabolized by the fish, residual compounds are left in the tissues which can cause an “off” or “musty” flavour.

These residual metabolite compounds, including geosmin and MIB, are at their highest levels in the fish tissue during the summer and early fall, coincident with the warmer temperatures and lower lake levels that are conducive to algal growth. Geosmin concentrations in the lake water can have considerable seasonal variation. To account for this, the study was designed to

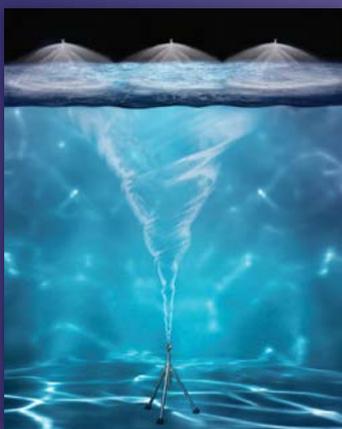
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capture different seasonal concentrations through the collection of water samples in both summer and winter.

## METHODS

Three water samples were obtained in the summer of 2016 (August) and another three were collected in the winter of 2017 (January and February). Approximately six litres of water were collected for each surface water sample. Following collection, the samples were stored to maintain temperature and submitted for analysis to ALS Environmental, a Canadian Association for Laboratory Accreditation laboratory located in Edmonton, Alberta.

Benzene, toluene, ethylbenzene and xylenes (BTEX) and PHCs were analyzed according to methods modified from those developed by the United States Environmental Protection Agency (US EPA) and the Canadian Council of Ministers of the Environment (CCME). Specifically, BTEX and F1 PHCs were quantified using gas chromatography/mass spec-

trometry (GC/MS) according to methods EPA 8260C/5021A and CWS PHC Tier 1, while gas chromatography/flame ionization detection (GC/FID) was used for F2-F4 PHCs according to methods EPA 3511 / CCME PHC CWS GC-FID.

Polycyclic aromatic hydrocarbons (PAHs) were analyzed by GC/MS according to US EPA methods EPA 3511 / EPA 8270D GCMS.

Metals were analyzed by collision/reaction cell inductively coupled plasma mass spectrometry (CRC ICPMS) according to modified US EPA method EPA 200.2/6020A as well as EPA 1631E (mercury) and APHA 3500-Cr C (hexavalent chromium).

The energetic (explosive) compounds were analyzed by high-performance liquid chromatography (HPLC) with UV detection according to US EPA method SW846 8330A.

Geosmin and other taste and odour compounds were analyzed by gas chromatography/high-resolution mass spec-

trometry (GC/HRMS), using an in-house method developed by ALS Environmental.

## RESULTS

No PHCs, BTEX, nor any PAHs were detected in any of the water samples. The detection limit for the F1 and F2 PHC fractions was 0.1 mg/L. Detection limits for benzene, toluene and ethylbenzene were 0.0005 mg/L, and 0.00071 mg/L for xylenes. For PAHs, detection limits ranged from 0.000005 mg/L to 0.00005 mg/L. There were no energetic compounds detected above their limits, which ranged from 0.25 µg/L to 0.50 µg/L.

Metals were detected in the summer and winter water samples at similar levels. Additionally, major ions were detected but were not carried forward in the assessment of surface water on the basis that they are either essential nutrients or are considered non-toxic to humans.

Geosmin was detected in all three summer water samples, at levels ranging from 12.9 ng/L to 18.5 ng/L. However, in



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the winter water samples, geosmin was not detected above its detection limit of 1.0 ng/L. MIB was not detected above its detection limit of 10 ng/L in any of the water samples. Additionally, none of the other odorous chemicals were detected in any of the water samples.

## DISCUSSION

The measured concentrations of metals that were detected in surface water were compared to the human health-based *Guidelines for Canadian Drinking Water Quality*, published by Health Canada. They were below these guidelines and the measured pH values were within the range of acceptable values. Adverse effects to human health are not expected to occur from exposure to a chemical in drinking water at levels below the drinking water guideline.

Although the analytical results identified that the Primrose Lake surface water was within the range of acceptable values, these results are counter to the beliefs and traditional knowledge of many members of CLFN because of the proximity of anthropogenic activities to the Lake and the historical uses of the area.

For those chemicals that were detected in surface water but that did not have drinking water guidelines available from Health Canada, drinking water guidelines were calculated by Intrinsic, consistent with risk-based toxicological values and equations used by Health Canada in calculating their drinking water guidelines. None of the measured concentrations exceed the risk-based toxicological values.

Geosmin has a very low taste and odour threshold, such that the human nose and palate can detect its presence in water at very low concentrations of parts per billion. Measured concentrations of geosmin in all three summer water samples were above the taste threshold of 5 ng/L, and one summer water sample was above the odour threshold of 15 ng/L. Geosmin was detected only in the summer samples.

While geosmin is not toxic to humans, it can impact water and fish, imparting a strong “earthy” and unpalatable “musty” odour and taste. Given that geosmin was detected at levels above the taste and odour thresholds in summer water

samples, and it is known to impact the flavour of fish in a manner that is consistent with the anecdotal reports by CLFN members, the unpalatable taste of fish harvested from Primrose Lake in the summer months may be linked to the presence of geosmin.

This fact is of interest given that indigenous people are particularly vulnerable to the impacts of climate change and often have the longest ecological record of past conditions contained within the oral history of their communities. Tainting of fish taste, as a result of geosmin in the fish muscle tissue, may provide a qualitative measure of the metabolic byproducts of algae blooms that will have a direct impact on the diets of First Nations peoples, as the influence of climate change on lakes increases (and associated algal blooms) with increasing water temperatures.

The surface water at Primrose Lake was not evaluated for microbiological param-

eters such as *E.coli*, coliforms, bacteria and viruses. Therefore, the quality of the untreated surface water with respect to these parameters is not known. Measured water quality from the study with respect to the levels of PHCs, BTEX, PAHs, metals, energetic compounds, geosmin and MIB is not expected to result in adverse effects to human health. There are no health risks anticipated from the consumption of fish that have an unpalatable taste due to geosmin. ■

*Claire McAuley, MSc, M.Eng., P.Eng. and Nino Devdariani, MEnvSc, are with Intrinsic Corp. Findley MacDermid, MSc, is with Cold Lake First Nations Consultation Department. For more information, email: cmcauley@intrinsic.com*

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## MASTER METER AWARDED BEST SMART WATER SOLUTION

The 2017 Smart Water Summit, in cooperation with Zpryme, announced Master Meter as the “Best Smart Water Solution”.

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Tim Hanes, Vice President of Product for Master Meter, describes his company as “a high-service solutions provider specializing in advanced digital water metering, data delivery, and utility intelligence software.”



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The new plant has been providing residents of Saddle Lake with clean drinking water, since it was commissioned in 2011.

# NEW PLANT SOLVED SADDLE LAKE CREE NATION'S WATER QUALITY ISSUES

By **Trevor Johnson**

Located almost 200 km northeast of Edmonton, Alberta, Saddle Lake Cree Nation has close to 10,000 members, with just over 6,000 who live on-reserve. The community is the second largest First Nation in Alberta and has been a meeting place for the Cree Nation for over 200 years. The community is home to Grammy Award winning artists Northern Cree, and Nobel Peace Prize nominee Doreen Spence.

Up until recently, Saddle Lake suffered from poor water quality, like nearly two thirds of Canada's First Nation communities. As of July 2017, there were 102 long-term (over a year) and 48 short-term water advisories in place at First Nations across Canada. Some communities in Alberta have been under such advisories for many years.

## WASTED WATER AND AN INADEQUATE FACILITY

The community draws its water from Saddle Lake, which has 25-30 ppm of organics, as well as large algal blooms in the summer. The old water treatment plant relied on outdated treatment technologies that fouled consistently and required the heavy use of chemicals to treat and disinfect the water.

The water is also cold, especially in winter, which lowers the effectiveness of some treatment processes. High contamination levels required large quantities of treatment chemicals. This cost more than \$15,000 every month, growing from less than \$1,000 per year when the old plant was built in 1982.

Even after treatment, water distributed by the old plant was among the worst

in the country. Community members were so used to the poor water quality that it just became a normal part of life. Nearly half the people in the community required medical attention for gastrointestinal issues.

"The previous system was very high maintenance, and you were always doing calculations. You had to keep watch," said Carl Shirt, plant manager at Saddle Lake's water facility. Constant monitoring in the plant meant he couldn't attend to other issues.

## THE SOLUTION

In 2011, Saddle Lake upgraded its underperforming water treatment system to a Sapphire Integrated Biological Reverse Osmosis Membrane (SIBROM) water treatment system, fed directly from Saddle

Lake. This project replaced the outdated treatment technology and expanded the facility to provide water to up to 10,000 residents. The plant has two trains, each capable of producing up to 2,300 litres per minute.

There are three core treatment phases in a SIBROM system: biological filtration, reverse osmosis membrane filtration, and re-mineralization to optimize pH. The process removes troublesome contaminants, such as the blue-green algae found in Saddle Lake, and produces biologically stable water.

The biological portion of the process acts as a pretreatment step, which results in the reverse osmosis membranes being highly resistant to fouling. The membranes at Saddle Lake have not required a chemical cleaning in over six years of operation.

Since much of Saddle Lake's distribution system was poorly constructed, having biologically stable water run through the pipes is necessary to decrease the chance of post-treatment, in-pipe contamination.



*Pre-treatment removes contaminants, which helps the RO membranes resist fouling.*

Drinking water now meets or exceeds all Health Canada guidelines.

Installation of the new SIBROM system immediately decreased the amount of chemicals required, as anti-scalants and

coagulants are no longer needed. Only 20 litres a week of chlorine is needed for disinfection, resulting in a drastic cut in operating costs.

*continued overleaf...*



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The new plant is also able to handle Alberta's tough winters, as it can continue to treat water at just below freezing temperatures, minimizing water-heating costs even before treatment can begin.

Since the plant can be optimized, Carl Shirt is working with Sapphire to adjust operations as needed based on demand. Being able to read key plant data over the Internet also means updates and routine maintenance can be performed quickly and alerts can be received remotely via smartphone, tablet or computer. ■

*Trevor Johnson, P.Eng., is with Sapphire Water International Corp. For more information, visit [www.sapphire-water.ca](http://www.sapphire-water.ca)*



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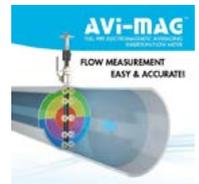
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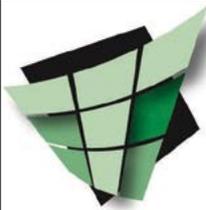
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T: 905-823-7965 F: 905-823-7932

E: catrache@triphasegroup.com

www.triphasegroup.com

Contact: Camille Atrache

**TRIANGLE FLUID CONTROLS LTD.**

399 College St E Belleville ON K8N 5S7

T: 613-968-1100 F: 613-968-1033

E: info@trianglefluid.com

Contact: Mike Shorts

**TRIDENT PROCESSES INC.**

101-2238 Queen St Abbotsford BC V2T 0B7

T: 604-330-2500

E: frank.engel@tridentprocesses.com

www.tridentprocesses.com

Contact: Frank Engel

**TROJAN TECHNOLOGIES**

3020 Gore Rd London ON N5V 4T7

T: 519-457-3400

E: info@trojanuv.com

Contact: Tania Testa

**TROY-ONTOR INC.**

121 Commerce Park Dr Units H - K ON Barrie

T: 705-721-8246 F: 705-721-5851

E: martin.doyle@troy-ontor.ca

www.troy-ontor.ca

Contact: Martin Doyle

**TSI INCORPORATED**

500 Cardigan Rd Shoreview MN 55126 US

T: 651-765-5203

E: kate.franssenhansen@tsi.com

www.tsi.com

Contact: Kate Franssen-Hansen

**UNITED MANUFACTURING INTERNATIONAL 2000**

820 Kimball Rd Ste 1002 Red Bluff CA 96080-

4586 US

T: 530-528-1361 F: 530-528-1361

E: activecarbon@jps.net

Contact: Laurence D'Alberty



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Contact: Julie Quenneville

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200 University Ave W Waterloo ON N2L 3G1

T: 519-888-4567

E: employerevents@uwaterloo.ca

Contact: Eleanor Doe

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432 N Lake St Madison WI 53706 US

T: 800-462-0876 F: 608-263-3160

E: custserv@epd.wisc.edu

Contact: Philip O'Leary

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Contact: Lovella Hebert

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Contact: Lisa Vandepol

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Contact: Bill Dyer



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5889 Summerside Dr Mississauga ON L5M 6L1  
T: 416-527-4396, 416-725-4271  
F: 905-567-8590

E: andre@vectorprocess.com  
www.vectorprocess.com

Contact: André Osborne, Hisham Younis  
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#### VEOLIA WATER TECHNOLOGIES CANADA INC.

4105 Sartelon Saint Laurent QC H4S 2B3  
T: 905-286-4846 / 514-334-7230  
E: salescanada@veolia.com  
www.veoliawatertech.com

Contact: Nadine Mourad, Marketing & Communication Team Leader  
Veolia Water Technologies Canada has helped Canadian municipalities and industries solve water, wastewater and sludge treatment challenges since 1948. We design, manufacture and service over 350 proprietary technologies, offering solutions ranging from mobile and urgent temporary plants, to treatment equipment, to integrated systems delivered under a wide range of procurement methods, including Design Build. By delivering solutions that minimize resource consumption and maximize resource recovery we help customers achieve their sustainability targets.



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E: sales@vfoldinc.com  
www.vfoldinc.com

Contact: Mark Thomas

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Contact: Rhys Jardine

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E: info@viqua.com

www.viqua.com

Contact: Josh Richardson



#### VISSERS SALES CORP.

20 - 220 Industrial Pkwy S Aurora ON L4G 3V6  
T: 905-841-4073 F: 905-841-4018

E: greg@vissers.on.ca

www.visserssales.com

Contact: Greg Vissers

Vissers Sales Corp. serves a wide variety of industrial, municipal, power, oil & gas, and OEM customers. Focusing on liquid handling applications, our process specialists have years of experience in assisting our customers in making: Manufacturing processes operate more efficiently; Drinking water safe; Wastewater safe for discharge; Boilers and cooling towers scale-free; Buildings more energy efficient; Buildings more water efficient; Commercial swimming pools clean and crystal clear.

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T: 905-842-0244 F: 905-845-3009

E: jcarney@vlmotion.com

Contact: John Carney



#### WALKERTON CLEAN WATER CENTRE

20 Ontario Rd Box 160 Walkerton ON N0G 2V0

T: 866-515-0550 F: 519-881-4947

E: inquiry@wcwc.ca

www.wcwc.ca/en/

The Walkerton Clean Water Centre (the Centre) is an agency of the Government of Ontario, established in 2004, to help safeguard drinking water across Ontario. The Centre provides education, training and information to owners, operators and operating authorities of drinking water systems, with a focus on small systems, throughout the province. Through partnerships, the Centre also provides training and continuing education to operators of First Nations drinking water systems. The Centre's Technology Demonstration Facility is an effective platform for hands-on training and pilot testing.

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2800 Thorold Townline Rd Niagara Falls ON L2E 6S4

T: 905-227-4142 F: 905-680-1916

E: contactweg@walkerind.com

www.walkerind.com

#### WASTE 'N WATERTech LTD.

#309 11979 40th St SE Calgary AB T2Z 4M3

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www.watertech.ca

Contact: Dominic Janssen



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Contact: Sales/Engineering

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T: 519-217-3734 F: 705-435-5054

E: sales@watermark.ca

www.watermark.ca

Contact Gray Fricke

**WATERLOO BARRIER INC.**

PO Box 385 Rockwood ON N0B 2K0  
T: 519-856-1352

E: robin@waterloo-barrier.com

www.waterloo-barrier.com

Contact: Robin Jowett

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T: 519-856-0757 F: 519-856-0759

E: geanine@waterloo-biofilter.com

www.waterloo-biofilter.com

Contact: Geanine Zuliani

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E: sales@waterra.com

www.waterra.com

Contact: John Newall

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www.watertapontario.com

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T: 315-569-9974

E: rsettembre@gmail.com

Contact: Rich Settembre

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N5V 0A4

T: 866-952-6523, 519-659-6523

F: 519-659-6941

E: info@wes-cor.ca

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T: 905-813-8190 F: 905-813-8170

Contact: Tom Scott

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E: info@wilo-canada.com

Contact: Steffen Werner

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Contact: Amanda Hubbard

www.wiseenv.com

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www.wolseleyinc.ca

Contact: Linda Cooke-Weaver

**WORLD WATER OPERATOR TRAINING COMPANY INC. (WWOTC)**

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T: 866-622-6535 F: 519-974-9603

E: info@wwotc.ca

www.wwotc.com

Contact: Simone Chisholm

**WTP EQUIPMENT CORP.****WTP EQUIPMENT CORP.**

83 Nuggett Ct Brampton ON L6T 5A9

T: 905-799-3403 F: 905-799-6638

E: sales@wtpcorp.com

www.wtpcorp.com

Contact: Ken Argyle, Engineering Manager  
Canadian manufacturer of wastewater headworks equipment, including: mechanical bar screens, heavy duty deep well bar screens, continuously cleaned fine (to 1 mm) filter belt and perforated plate screens, conveyor screens, septage screens, screenings presses, screw conveyors, aerated tank and vortex chamber grit collectors and grit classifiers. Customer service is provided from our Brampton, Ontario, facility.

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T: 514-428-4875

E: bridgett.rousselle@xyleminc.com

www.xylemwatersolutions.com/ca

Contact: Bridgett Rousselle

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3-3530 Laird Rd Mississauga ON L5L 5Z7

Contact: Roy Lieun-Kie-Song

**YORK FLUID CONTROLS LTD.**

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T: 905-454-4013 F: 905-454-8423

Contact: M. Knapman, President/GM

# ES&E'S GUIDE TO ENVIRONMENTAL PRODUCTS & SERVICES

See 'Suppliers' Section (pg. 83) for address, etc., of any company listed in this section

## Access Hatches

ACG - Envirocan  
BioMaxx Wastewater Solutions  
Can-Am Instruments  
Corix  
Crane Pumps & Systems Canada  
Engineered Pump Systems  
ENV Treatment Systems  
Filamat Composites  
Geomembrane Technologies  
Halliday Products  
MSU Mississauga  
Pro Aqua  
Westech Industrial  
Wolseley Canada

## Activated Carbon Adsorbents

Anthrafilter Media & Coal  
Babcock & Wilcox MEGTEC  
Bl Pure Water  
BioAir Solutions  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
Citto Corporation  
Continental Carbon Group  
E.R.E.  
ENV Treatment Systems  
Jacobi Carbons  
Jurassic Activated Carbon  
Service Filtration Of Canada  
United Manufacturing Int. 2000  
Veolia Water Technologies  
WESCOR

## Actuators

ABB  
Alltork Actuation  
Avensys Solutions  
Cancoppas  
CB Automation  
Chemline Plastics  
Davis Controls  
Delpro Automation  
DeZURIK/APCO/Hilton  
Festo  
Halogen Valve Systems  
Orbinox  
Rotork Controls  
Troy-Ortor  
VL Motion Systems  
Wolseley Canada

## Adsorbents/Absorbents

Absorbents Online  
Albarrie GeoComposites  
BioAir Solutions  
Blue-Zone Technologies  
Canature WaterGroup  
Continental Carbon Group  
CTP Sinto America  
Drain-All  
E.R.E.  
EHS Canada  
ENV Treatment Systems  
Enviro Hazmat Emerg. Response  
Golden Environmental Services  
Loraday Environmental Products  
Minotaur Stormwater Services  
Safe Drain  
Spill Management

## Aeration Systems

ACG - Envirocan  
Aeration Industries International  
Aerzen Canada  
Alfa Laval  
Aqua Technical Sales  
Aquafy Water Technologies  
AWT Technologies  
Bio-Microbics

BioMaxx Wastewater Solutions  
BowRio Water Technologies  
C&M Environmental Technologies  
Canadianpond.ca Products  
Corix  
Directrik  
ELMRIDGE Engineering  
ENV Treatment Systems  
Filamat Composites  
Fluidyne Corporation  
H2Flow Equipment  
Hydro-Logic Environmental  
KSB Pumps  
LimeGREEN Equipment  
Medora Corporation  
Metcon Sales & Engineering  
Napier-Reid  
Nexom  
Parkson Corporation  
Pro Aqua  
Smith & Loveless  
Sulzer Pumps (Canada)  
USABluebook  
Vector Process Equipment  
Waste 'n WaterTech  
Way Cool Product Co.  
Westech Engineering

## Aerobic Digestion

ACG - Envirocan  
ADI Systems  
Aeration Industries International  
Aerzen Canada  
Bio-Microbics  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
C&M Environmental Technologies  
CEMATRIX (Canada)  
ENV Treatment Systems  
Fluidyne Corporation  
Greatario  
H2Flow Equipment  
KSB Pumps  
Lystek International  
Napier-Reid  
Ovivo USA  
Pro Aqua  
SHAC Environmental Products

## Air Emissions Testing

Avensys Solutions  
BioAir Solutions  
BIOREM Technologies  
Cancoppas  
ENV Treatment Systems  
Gasmek Technologies  
MIP Cemtrex  
T. Harris Environmental Mgmt.

## Air Filters

BioAir Solutions  
Blue-Zone Technologies  
CompreVac  
CTP Sinto America  
Davis Controls  
ENV Treatment Systems  
Jurassic Activated Carbon  
Pencor Equipment Company  
Q-VAC Automatic Priming Systems  
R.E. Morrison Equipment  
Rittal Systems  
WESCOR

## Air Pollution Control Equipment

Anguil Environmental Systems  
Aquafy Water Technologies  
Babcock & Wilcox MEGTEC  
BioAir Solutions  
BIOREM Technologies  
Can-Am Instruments

Continental Carbon Group  
CTP Sinto America  
Echelon Environmental  
ENV Treatment Systems  
Fabricated Plastics  
Fluid Components International  
Gasmek Technologies  
Geomembrane Technologies  
Hydroxyl Environmental  
Indachem  
Kusters Water  
MIP Cemtrex  
Nett Technologies  
Northern ANI Solutions  
Scentroid  
Sudbury Lime  
Triangle Fluid Controls  
United Manufacturing Int. 2000  
Veolia Water Technologies  
Westech Industrial

## Air Strippers

Avensys Solutions  
Blue-Zone Technologies  
ENV Treatment Systems  
Industrial Waste Control  
JNE Environmental  
Metcon Sales & Engineering  
SCG Industries

## Anaerobic Digesters

ADI Systems  
Aerzen Canada  
Aqua Technical Sales  
Atlas Dewatering Corporation  
Bio-Microbics  
BowRio Water Technologies  
C&M Environmental Technologies  
Capital H2O Systems  
Claro Environmental Tech.  
ENV Treatment Systems  
Fluidyne Corporation  
H2Flow Tanks & Systems  
KSB Pumps  
Lystek International  
New Leaf Biologics  
Ovivo USA  
Pro Aqua  
SHAC Environmental Products  
Smith & Loveless  
SUEZ  
Tank Connection  
Vector Process Equipment  
Veolia Water Technologies  
Westech Engineering

## Analytical Equipment

ABB  
ACI Instrumentation  
Arizona Instrument  
Avensys Solutions  
Cameron Instruments  
Can-Am Instruments  
Coastal Environmental Systems  
Davis Controls  
Delpro Automation  
Endress+Hauser Canada  
Enviro-Analytical  
Franklin Empire  
Geneq  
Hoskin Scientific  
KISTERS North America  
MANTECH  
Markland Specialty Engineering  
Metcon Sales & Engineering  
MIP Cemtrex  
Northern ANI Solutions  
Osprey Scientific  
Service Filtration Of Canada  
Sheridan Electric Services

SPD Sales  
USABluebook  
Veolia Water Technologies  
Westech Industrial

## Analyzers

ABB  
AMETEK MOCON - Baseline  
Aquafy Water Technologies  
Arizona Instrument  
Avensys Solutions  
BioMaxx Wastewater Solutions  
Can-Am Instruments  
Cancoppas  
Capital H2O Systems  
Concept Controls  
Davis Controls  
Elemental Controls  
Endress+Hauser Canada  
Enviro-Analytical  
Franklin Empire  
Gasmek Technologies  
Hoskin Scientific  
Indachem  
KGO Group  
MANTECH  
Markland Specialty Engineering  
Metcon Sales & Engineering  
MIP Cemtrex  
Northern ANI Solutions  
Osprey Scientific  
Prominent Fluid Controls  
Real Tech  
SPD Sales  
USABluebook  
Veolia Water Technologies  
Westech Industrial

## Aquifers

Atlas Dewatering Corporation  
CEMATRIX (Canada)

## Arsenic Removal

ACG - Envirocan  
Aclarus Ozone Water Systems  
Aqua Technical Sales  
Bl Pure Water  
BQE Water  
C&M Environmental Technologies  
Canature WaterGroup  
Chlorinators  
Continental Carbon Group  
Drain-All  
H2Flow Equipment  
Indachem  
Metcon Sales & Engineering  
SUEZ  
Veolia Water Technologies

## Asbestos Removal

Drain-All  
EHS Canada  
Healthy Environmental  
Itech Environmental Services  
T. Harris Environmental Mgmt.  
TankTek Environmental Services

## Backflow Prevention

Aquanox Water Control Products  
Cameron Instruments  
Chemline Plastics  
Corix  
Drain-All  
Grande Water Management  
Ipex  
Veolia Water Technologies  
Wolseley Canada

## Bacteria

Avensys Solutions

Bishop Water Technologies  
Canadianpond.ca Products  
Echelon Environmental  
Golden Environmental Services  
HydroFLOW Canada  
International Water Supply  
LUMINOR Environmental  
New Leaf Biologics  
SHAC Environmental Products  
USABluebook

## Biodegradable Products

Bio-Microbics  
BioMaxx Wastewater Solutions  
Golden Environmental Services  
Mac & Co Environmental Solutions  
New Leaf Biologics  
SciCorp International Corp.

## Biofilters

ACG - Envirocan  
Aqua Technical Sales  
Aquafy Water Technologies  
BioAir Solutions  
BioMaxx Wastewater Solutions  
BIOREM Technologies  
BowRio Water Technologies  
CEMATRIX (Canada)  
Echelon Environmental  
ENV Treatment Systems  
H2Flow Equipment  
Imbrium Systems  
Premier Tech Aqua  
Pro Aqua  
USABluebook  
Veolia Water Technologies  
Waste 'n WaterTech  
Waterloo Biofilter Systems

## Biological Treatment Processes

ADI Systems  
Aeration Industries International  
Alfa Laval  
Aqua Technical Sales  
Aquafy Water Technologies  
AWT Technologies  
Bio-Microbics  
BioMaxx Wastewater Solutions  
BIOREM Technologies  
Bishop Water Technologies  
BowRio Water Technologies  
C&M Environmental Technologies  
ECCofluid Systems  
ENV Treatment Systems  
Fluidyne Corporation  
H2Flow Equipment  
KSB Pumps  
Kusters Water  
Lystek International  
Mac & Co Environmental Solutions  
MS Filter Systems  
Nexom  
New Leaf Biologics  
Ovivo USA  
Parkson Corporation  
Premier Tech Aqua  
Pro Aqua  
SciCorp International Corp.  
SHAC Environmental Products  
Smith & Loveless  
SUEZ  
Vector Process Equipment  
Veolia Water Technologies  
Waste 'n WaterTech  
Waterloo Biofilter Systems  
Westech Engineering

*continued overleaf...*

**Bioreactor**

ADI Systems  
Aerzen Canada  
AWT Technologies  
Bio-Microbics  
BioMaxx Wastewater Solutions  
Bishop Water Technologies  
BowRio Water Technologies  
C&M Environmental Technologies  
CEMATRIX (Canada)  
ENV Treatment Systems  
Greatario  
KSB Pumps  
Lystek International  
Metcon Sales & Engineering  
Premier Tech Aqua  
Pro Aqua  
Smith & Loveless  
Veolia Water Technologies

**Bioremediation**

Aerzen Canada  
BioMaxx Wastewater Solutions  
Delta Remediation  
E.R.E.  
Focus Environmental Group  
Golden Environmental Services  
KG Services  
Lystek International  
Mac & Co Environmental Solutions  
New Leaf Biologics  
SHAC Environmental Products  
Smith & Loveless  
Solinst Canada  
TankTek Environmental Services  
Terrapure Environmental

**Biosolids Management**

Aquafy Water Technologies  
Babcock & Wilcox MEGTEC  
Bio-Microbics  
Bioform Sewage Mining  
BioMaxx Wastewater Solutions  
BIOREM Technologies  
Bishop Water Technologies  
ENV Treatment Systems  
Fluidyne Corporation  
GeoEnvironment Technologies  
Golden Environmental Services  
H2Flow Tanks & Systems  
Hydro International  
Kusters Water  
Lystek International  
Markland Specialty Engineering  
MetaFLO Technologies  
Metcon Sales & Engineering  
Pace Dewatering Systems  
Parkson Corporation  
Pro Aqua  
Sco-Terra Operations Group  
SHAC Environmental Products  
Terratec Environmental  
Thomas Nutrient Solutions  
Trident Processes  
Veolia Water Technologies  
Walker Environmental Group  
Waste 'n WaterTech  
Wessuc

**Blowers**

Aerzen Canada  
Atlas Copco Compressors Canada  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
Canadian Safety Equipment  
CompreVac  
Directrik  
ENV Treatment Systems  
H2Flow Equipment  
Hydro-Logic Environmental  
Metcon Sales & Engineering  
Pencon Equipment Company  
Pro Aqua  
Q-VAC Automatic Priming Systems  
R.E. Morrison Equipment  
SCG Industries

STANMECH Technologies  
Sulzer Pumps (Canada)  
USABBluebook  
Vector Process Equipment  
Waste 'n WaterTech

**Borehole Clearing**

Aquablast Corp.  
Atlas Dewatering Corporation  
Heron Instruments  
International Water Supply

**Catch Basin Components**

ACO Systems  
Aquablast Corp.  
CB Automation  
CB Shield  
Con Cast Pipe  
DECAST  
ENV Treatment Systems  
Enviro Hazmat Emerg. Response  
Imbrum Systems  
Ipex  
Lafarge  
M Con Pipe & Products  
Nimesh  
Safe Drain  
Veolia Water Technologies

**Centrifuges**

ACG - Envirocan  
Alfa Laval  
Atlas Copco Compressors Canada  
BowRio Water Technologies  
C&M Environmental Technologies  
ENV Treatment Systems  
Flottweg Separation Technology  
Hoskin Scientific  
Indachem  
John Brooks Company  
Metcon Sales & Engineering  
NCS Fluid Handling Systems  
Pace Dewatering Systems  
Sentrimax Centrifuges  
USABBluebook  
Vector Process Equipment  
Waste 'n WaterTech

**Chemical Mixers**

Aquafy Water Technologies  
ASL Roteq  
Directrik  
Echelon Environmental  
ELMRIDGE Engineering  
Hayward Gordon  
Indachem  
JNE Environmental  
John Brooks Company  
KGO Group  
KSB Pumps  
Metcon Sales & Engineering  
Service Filtration Of Canada  
Vissers Sales Corp.  
WESCOR

**Chemicals**

Aclarus Ozone Water Systems  
BioMaxx Wastewater Solutions  
Bishop Water Technologies  
Brook One Corporation  
Citto Corporation  
DWG Process Supply  
Industrial Waste Control  
JNE Environmental  
Kemira  
KSB Pumps  
MetaFLO Technologies  
Service Filtration Of Canada  
Sierra Sales PETanks  
SNF Canada  
Sudbury Lime  
Trojan Technologies  
USABBluebook  
Veolia Water Technologies  
Vfold  
WESCOR

**Chlorination Systems**

Aquafy Water Technologies  
Bio-Microbics  
Blue-White Industries  
C&M Environmental Technologies  
Cancoppas  
Capital H2O Systems  
Chemline Plastics  
Chlorinators  
ENV Treatment Systems  
Fluid Metering  
Grundfos Canada  
KGO Group  
Medora Corporation  
Metcon Sales & Engineering  
SPD Sales  
USABBluebook  
Vissers Sales Corp.

**Clarifiers**

ACG - Envirocan  
ACI Instrumentation  
Aqua Technical Sales  
Aquablast Corp.  
Atlas Dewatering Corporation  
Bio-Microbics  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
C&M Environmental Technologies  
Capital H2O Systems  
Greatario  
H2Flow Equipment  
JNE Environmental  
Kusters Water  
Markland Specialty Engineering  
Napier-Reid  
Pro Aqua  
Protectolite Composites  
Smith & Loveless  
SUEZ  
Vector Process Equipment  
Veolia Water Technologies  
WESCOR  
Wessuc  
WesTech Engineering

**Clearwell Equipment**

Aquanox Water Control Products  
H2Flow Tanks & Systems

**Coagulation Systems**

BowRio Water Technologies  
H2Flow Tanks & Systems  
JNE Environmental  
KSB Pumps  
Metcon Sales & Engineering  
Napier-Reid  
Trident Processes  
Veolia Water Technologies  
WESCOR

**Coatings**

A&A Coatings  
Aquablast Corp.  
Belzona Great Lakes Holdings  
CEMATRIX (Canada)  
Denso North America  
Interprovincial Corrosion Control  
Madok Manufacturing  
Sherwin-Williams  
Source One Environmental/Fernco  
Specialty Products

**Collectors**

Atlas Dewatering Corporation  
BowRio Water Technologies  
C&M Environmental Technologies  
CTP Sinto America  
ENV Treatment Systems  
KSB Pumps  
Kusters Water  
Pro Aqua

**Combined Sewer Overflow Equipment**

ADS Environmental Services  
Atlas Dewatering Corporation

BowRio Water Technologies  
C&M Environmental Technologies  
Can-Am Instruments  
Crane Pumps & Systems Canada  
Echelon Environmental  
ENV Treatment Systems  
Flowmetrix Technical Services  
Grande Water Management  
Huber Technology  
Hydro International  
Ipex  
KSB Pumps  
Pro Aqua  
Smith & Loveless  
SPD Sales  
StormTrap  
SUEZ  
Veolia Water Technologies  
Waste 'n WaterTech  
WesTech Engineering

**Comminutors/Grinders**

Directrik  
G.E.T. Industries  
Grundfos Canada  
H2Flow Equipment  
JWC Environmental  
Napier-Reid  
Pro Aqua  
Smith & Loveless  
USABBluebook

**Communications**

Can-Am Instruments  
Canadian Safety Equipment  
Cancoppas  
KISTERS North America  
Master Meter Canada  
Monitario Technical Services  
Compressed Gases  
Concept Controls  
KSB Pumps

**Compressors**

Aerzen Canada  
Atlas Copco Compressors Canada  
Canadian Safety Equipment  
Claro Environmental Tech.  
CompreVac  
Directrik  
Pencon Equipment Company  
Q-VAC Automatic Priming Systems  
R.E. Morrison Equipment  
Sheridan Electric Services  
USABBluebook

**Computers & Control Systems**

Cancoppas  
CB Automation  
CTP Sinto America  
JNE Environmental  
KISTERS North America  
Sensaphone  
USABBluebook

**Confined Space Entry**

Canadian Safety Equipment

**Containment Walls**

Albarrie GeoComposites  
CEMATRIX (Canada)  
DeWind One Pass Trenching  
Enviro Hazmat Emerg. Response  
Kee Safety  
Nuna Innovations  
SEI Industries  
Sierra Sales PETanks  
Waterloo Barrier

**Contracting**

Aquablast Corp.  
Atlas Dewatering Corporation  
BIOREM Technologies  
Focus Environmental Group  
Golden Environmental Services  
Insitu Contractors  
International Water Supply

KG Services  
Sheridan Electric Services  
Sonic Soil Sampling

**Control Equipment**

ABB  
Aquafy Water Technologies  
Aquanox Water Control Products  
Avensys Solutions  
AWT Technologies  
Can-Am Instruments  
Cancoppas  
CB Automation  
Chemline Plastics  
Crane Pumps & Systems Canada  
CTP Sinto America  
Davis Controls  
Delpro Automation  
ENV Treatment Systems  
Fluid Components International  
Franklin Empire  
Greyline Instruments  
IndustrialZone  
Kemira  
Markland Specialty Engineering  
SCG Industries  
Sensaphone  
Sheridan Electric Services  
Smith & Loveless  
SPD Sales  
Troy-Ontor  
USABBluebook  
Veolia Water Technologies  
Weir Canada  
Westech Industrial

**Control Panels**

ASL Roteq  
Can-Am Instruments  
Cancoppas  
CB Automation  
Engineered Pump Systems  
Franklin Empire  
JNE Environmental  
Metcon Sales & Engineering  
MIP Centrex  
Napier-Reid  
Rittal Systems  
Rotork Controls  
SCG Industries  
Sheridan Electric Services  
Sterling Power Systems  
Telder Engineering  
Troy-Ontor  
Vissers Sales Corp.

**Cooling Towers/Condensers**

Aquablast Corp.  
Atlas Dewatering Corporation  
Babcock & Wilcox MEGTEC  
HydroFLOW Canada

**Corrosion Prevention**

A&A Coatings  
Belzona Great Lakes Holdings  
Chemline Plastics  
Denso North America  
Filamat Composites  
HydroFLOW Canada  
Interprovincial Corrosion Control  
Ipex  
Madok Manufacturing  
Sherwin-Williams  
TankTek Environmental Services

**Covers/Enclosures**

ACG - Envirocan  
C&M Environmental Technologies  
Geomembrane Technologies  
H2Flow Tanks & Systems  
Ovivo USA  
Pro Aqua  
Protectolite Composites  
Rittal Systems  
Sheridan Electric Services  
Tank Connection  
Vector Process Equipment

Westech Industrial  
Wolseley Canada

#### Culverts

Aquablast Corp.  
Atlas Dewatering Corporation  
CB Shield  
CEMATRIX (Canada)  
Con Cast Pipe  
Corrugated Steel Pipe Institute  
DECAST  
M Con Pipe & Products  
Titan Environmental Containment  
Wolseley Canada

#### Custom Metal Fabricating

JNE Environmental  
Kee Safety  
Loraday Environmental Products  
Monitario Technical Services  
MSU Mississauga  
Nett Technologies  
Numesh  
Troy-Ontor  
WESCOR

#### Custom Plastic Fabricating

Chemline Plastics  
Fabco Plastics  
Fabricated Plastics  
Filamat Composites  
Ipx  
Protectolite Composites  
Sierra Sales PETanks  
Wolseley Canada

#### Data

ACG - Envirocan  
Avensys Solutions  
Cancoppas  
CB Automation  
e.RIS  
Endress+Hauser Canada  
ERIS  
Flowmetrix Technical Services  
Franklin Empire  
Geneq  
Heron Instruments  
KISTERS North America  
Lakes Environmental Software  
Master Meter Canada  
Osprey Scientific  
Real Tech  
SCG Industries  
Sensaphone  
SPD Sales  
USABluebook  
Watermark Solutions

#### Dechlorinators

Blue-White Industries  
C&M Environmental Technologies  
Canature WaterGroup  
Chlorinators  
Metcon Sales & Engineering  
Prominent Fluid Controls  
SPD Sales  
USABluebook

#### Decommissioning

Aquablast Corp.  
Atlas Dewatering Corporation  
CEMATRIX (Canada)  
Focus Environmental Group  
International Water Supply  
KG Services  
KSB Pumps  
Sierra Sales PETanks  
TankTek Environmental Services

#### Degritters

Aqua Technical Sales  
BowRio Water Technologies  
C&M Environmental Technologies  
Claro Environmental Tech.  
Directrik  
Fluidyne Corporation

Huber Technology  
Hydro International  
Napier-Reid  
Pro Aqua  
Smith & Loveless  
Vector Process Equipment  
Veolia Water Technologies  
Waste 'n WaterTech  
WTP Equipment Corp.

#### Demineralizers

Canature WaterGroup  
Pro Aqua  
Smith & Loveless

#### Demolition

CEMATRIX (Canada)  
Focus Environmental Group  
Itech Environmental Services  
KG Services  
T. Harris Environmental Mgmt.  
TankTek Environmental Services

#### Dewatering Services

Atlas Dewatering Corporation  
Bioform Sewage Mining  
Bishop Water Technologies  
Capital H2O Systems  
DeWind One Pass Trenching  
Drain-All  
E.R.E.  
Golden Environmental Services  
Grundfos Canada  
Insitu Contractors  
JNE Environmental  
KONTEK Ecology Systems  
KSB Pumps  
Kusters Water  
LimeGREEN Equipment  
Mersino Dewatering  
MetaFLO Technologies  
Minotaur Stormwater Services  
NCS Fluid Handling Systems  
Pace Dewatering Systems  
SCG Industries  
Terrapure Environmental  
Trojan Technologies  
Vfold  
WESCOR  
Wessuc

#### Dialers

Avensys Solutions  
Can-Am Instruments  
Franklin Empire  
Metcon Sales & Engineering  
SPD Sales  
USABluebook

#### Digesters

ADI Systems  
Atlas Dewatering Corporation  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
C&M Environmental Technologies  
Claro Environmental Tech.  
Greatario  
H2Flow Tanks & Systems  
KSB Pumps  
Napier-Reid  
Ovivo USA  
Pro Aqua  
SHAC Environmental Products  
Smith & Loveless  
SUEZ  
Tank Connection  
Veolia Water Technologies  
Wessuc  
WesTech Engineering

#### Disinfection Equipment

ACG - Envirocan  
Aqua Technical Sales  
Aquafy Water Technologies  
Bio-Microbics  
BowRio Water Technologies  
C&M Environmental Technologies

Chlorinators  
ENV Treatment Systems  
Fluid Metering  
Force Flow  
Good Harbour Laboratories  
Grundfos Canada  
H2Flow Equipment  
Indachem  
KGO Group  
LUMINOR Environmental  
Metcon Sales & Engineering  
MS Filter Systems  
Pro Aqua  
Prominent Fluid Controls  
Smith & Loveless  
SPD Sales  
SUEZ  
Trojan Technologies  
USABluebook  
UV Pure Technologies  
VIQUA  
Vissers Sales Corp.

#### Dissolved Air Flotation

ACG - Envirocan  
Aeration Industries International  
Aqua Technical Sales  
BowRio Water Technologies  
C&M Environmental Technologies  
Capital H2O Systems  
ELMRIDGE Engineering  
ENV Treatment Systems  
H2Flow Equipment  
H2Flow Tanks & Systems  
JNE Environmental  
John Brooks Company  
KONTEK Ecology Systems  
Kusters Water  
Markland Specialty Engineering  
Metcon Sales & Engineering  
Napier-Reid  
Ovivo USA  
Pro Aqua  
Smith & Loveless  
SUEZ  
Trident Processes  
Vector Process Equipment  
Waste 'n WaterTech  
WESCOR  
WesTech Engineering

#### Dredges/Dredging

Atlas Dewatering Corporation  
Bishop Water Technologies  
Markland Specialty Engineering  
Mersino Dewatering  
SHAC Environmental Products  
Terrapure Environmental  
Way Cool Product Co.

#### Drilling Services

Insitu Contractors  
International Water Supply  
Mersino Dewatering  
Rittal Systems  
Sonic Soil Sampling

#### Drinking Water Treatment Equipment

ACG - Envirocan  
Aclarus Ozone Water Systems  
Aqua Technical Sales  
Aquafy Water Technologies  
AWI (Anthrathex Western)  
BI Pure Water  
BowRio Water Technologies  
C&M Environmental Technologies  
Canature WaterGroup  
Cancoppas  
Capital H2O Systems  
Chemline Plastics  
Chlorinators  
Continental Carbon Group  
DECAST  
DWG Process Supply  
Fluid Metering  
Franklin Empire

Good Harbour Laboratories  
H2Flow Equipment  
Indachem  
John Brooks Company  
KSB Pumps  
Markland Specialty Engineering  
Medora Corporation  
Membrane Specialists  
Metcon Sales & Engineering  
Napier-Reid  
Osprey Scientific  
Ovivo USA  
Principal Water Filtration  
Pro Aqua  
Prominent Fluid Controls  
Sco-Terra Operations Group  
Smith & Loveless  
SPD Sales  
SUEZ  
Sulzer Pumps (Canada)  
Triangle Fluid Controls  
Trojan Technologies  
Veolia Water Technologies  
VIQUA  
Vissers Sales Corp.  
WesTech Engineering

#### Dust Collection

Aquablast Corp.  
Babcock & Wilcox MEGTEC  
Cancoppas

#### E-Waste

Anachem

#### Educational Materials

American Public University  
Corrugated Steel Pipe Institute  
ES&E Magazine  
Global Training Solutions  
TEAM-1 Academy  
The Swamp School

#### Eductors

Anthraxfilter Media & Coal  
Atlas Dewatering Corporation  
ELMRIDGE Engineering  
Fabco Plastics  
Insitu Contractors  
John Brooks Company  
Mersino Dewatering  
Metcon Sales & Engineering  
Pro Aqua  
Service Filtration Of Canada  
USABluebook  
Vissers Sales Corp.

#### Ejectors

Aqua Technical Sales  
ELMRIDGE Engineering  
Metcon Sales & Engineering  
Smith & Loveless  
Vissers Sales Corp.

#### Electric Motors

ASL Roteq  
Franklin Empire  
International Water Supply  
Pencon Equipment Company  
Service Filtration Of Canada  
SEW-Eurodrive  
Sheridan Electric Services  
Sterling Power Systems  
USABluebook  
VL Motion Systems

#### Emergency Gas Shutoff Systems

Aquafy Water Technologies  
ENV Treatment Systems  
Halogen Valve Systems  
Indachem  
Rotork Controls

#### Emergency Response

Anachem  
Aquablast Corp.  
Belzona Great Lakes Holdings

Coastal Environmental Systems  
Drain-All  
EHS Canada  
Enviro Hazmat Emerg. Response  
Golden Environmental Services  
Itech Environmental Services  
KG Services  
LimeGREEN Equipment  
Loraday Environmental Products  
Mersino Dewatering  
NCS Fluid Handling Systems  
QM Environmental  
SCG Industries  
SEI Industries  
Spill Management  
TankTek Environmental Services  
Terrapure Environmental  
Wessuc

#### Environmental Site Assessments & Remediation

Albarrie GeoComposites  
Avensys Solutions  
Cambium Aboriginal  
Can-Am Instruments  
CB Shield  
DeWind One Pass Trenching  
Drain-All  
EHS Canada  
Enviro Hazmat Emerg. Response  
ERIS  
Golden Environmental Services  
Healthy Environmental  
Itech Environmental Services  
KG Services  
Northern ANI Solutions  
Nuna Innovations  
S2S Environmental  
SHAC Environmental Products  
T. Harris Environmental Mgmt.  
TankTek Environmental Services  
Way Cool Product Co.

#### Environmental Software

Can-Am Instruments  
ERIS  
Global Training Solutions  
Hoskin Scientific  
KISTERS North America  
Lakes Environmental Software  
Erosion Control Products  
Atlas Dewatering Corporation  
Belzona Great Lakes Holdings  
Corix  
Golden Environmental Services  
Nuna Innovations  
Titan Environmental Containment

#### Evaporators

Aquablast Corp.  
Babcock & Wilcox MEGTEC  
H2Flow Tanks & Systems  
John Brooks Company  
KONTEK Ecology Systems  
Madok Manufacturing

#### Expansion Joints

Aquablast Corp.  
Belzona Great Lakes Holdings  
Devine & Associates  
Pencon Equipment Company  
Runnalls Industries  
Source One Environmental/Fernco  
Wolseley Canada

#### Fall Protection

Concept Controls  
Kee Safety  
TEAM-1 Academy

#### Fans

CTP Sinto America  
Rittal Systems  
Sheridan Electric Services

*continued overleaf...*

**Feeders (Chemical)**

Aquafy Water Technologies  
 Blue-White Industries  
 Canature WaterGroup  
 Cancoppas  
 Capital H2O Systems  
 Echelon Environmental  
 Indachem  
 JNE Environmental  
 KGO Group  
 KSB Pumps  
 Pro Aqua  
 Prominent Fluid Controls  
 SPD Sales  
 Sudbury Lime  
 USABluebook  
 WESCOR

**Filter Equipment**

ACG - Envirocan  
 Acme Engineering Products  
 Aqua Technical Sales  
 Atlas Dewatering Corporation  
 AWI (Anthratech Western)  
 Bioform Sewage Mining  
 BioMaxx Wastewater Solutions  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Canature WaterGroup  
 CompreVac  
 Continental Carbon Group  
 DWG Process Supply  
 ENV Treatment Systems  
 Fluidyne Corporation  
 Goslyn Environmental  
 H2Flow Equipment  
 Hoskin Scientific  
 Imbrium Systems  
 Insitu Contractors  
 John Brooks Company  
 KGO Group  
 KONTEK Ecology Systems  
 LimeGREEN Equipment  
 MS Filter Systems  
 Napier-Reid  
 NCS Fluid Handling Systems  
 Nova Filtration Technologies  
 Orival Water Filters  
 Ovivo USA  
 Pro Aqua  
 R.E. Morrison Equipment  
 SCG Industries  
 Service Filtration Of Canada  
 Smith & Loveless  
 Trojan Technologies  
 USABluebook  
 WESCOR

**Filter Media/Maintenance**

Albarrie GeoComposites  
 Anthrafilter Media & Coal  
 Aquablast Corp.  
 AWI (Anthratech Western)  
 BI Pure Water  
 BioMaxx Wastewater Solutions  
 BIOREM Technologies  
 Canature WaterGroup  
 Continental Carbon Group  
 E.R.E.  
 HydroFLOW Canada  
 Imbrium Systems  
 John Brooks Company  
 LimeGREEN Equipment  
 SCG Industries  
 Storm Trap

**Filter Presses**

Alfa Laval  
 Echelon Environmental  
 ENV Treatment Systems  
 Industrial Waste Control  
 John Brooks Company  
 KONTEK Ecology Systems  
 Pro Aqua  
 Service Filtration Of Canada  
 WESCOR

**Filter Underdrains**

ACG - Envirocan  
 Aqua Technical Sales  
 C&M Environmental Technologies  
 Continental Carbon Group  
 Goslyn Environmental  
 Pro Aqua  
 Safe Drain

**Filters**

ACG - Envirocan  
 Aclarus Ozone Water Systems  
 Albarrie GeoComposites  
 Alfa Laval  
 Aqua Technical Sales  
 Atlas Dewatering Corporation  
 AWI (Anthratech Western)  
 BioMaxx Wastewater Solutions  
 C&M Environmental Technologies  
 Canature WaterGroup  
 Citto Corporation  
 CompreVac  
 Continental Carbon Group  
 E.R.E.  
 Echelon Environmental  
 Fluidyne Corporation  
 Forterra Pipe  
 Good Harbour Laboratories  
 H2Flow Tanks & Systems  
 Imbrium Systems  
 John Brooks Company  
 Jurassic Activated Carbon  
 LimeGREEN Equipment  
 Membrane Specialists  
 MS Filter Systems  
 Napier-Reid  
 NCS Fluid Handling Systems  
 Nexom  
 Nett Technologies  
 Nova Filtration Technologies  
 Orival Water Filters  
 Ovivo USA  
 Parkson Corporation  
 Pro Aqua  
 R.E. Morrison Equipment  
 Rittal Systems  
 Safe Drain  
 SCG Industries  
 Sealogic Innovations Corp.  
 Service Filtration Of Canada  
 Trojan Technologies  
 USABluebook  
 VIQUA  
 Vissers Sales Corp.  
 Waterra Pumps  
 WESCOR  
 Westech Engineering

**Financial Services**

Great-West Life

**Flocculators/Mixers**

ASL Roteq  
 C&M Environmental Technologies  
 Directrik  
 Echelon Environmental  
 Geneq  
 Hayward Gordon  
 Indachem  
 JNE Environmental  
 Napier-Reid  
 Ovivo USA  
 Pro Aqua  
 Smith & Loveless  
 Trident Processes  
 Vector Process Equipment  
 Vissers Sales Corp.  
 WESCOR

**Flotation Systems**

ACG - Envirocan  
 Aqua Technical Sales  
 C&M Environmental Technologies  
 H2Flow Tanks & Systems  
 JNE Environmental  
 Kusters Water  
 Napier-Reid

Pro Aqua  
 WESCOR

**Flow Meter Calibration**

Cameron Instruments  
 Concept Controls  
 Fluid Components International  
 Flowmetrix Technical Services  
 Franklin Empire  
 Monitario Technical Services  
 NCS Fluid Handling Systems

**Flow Meters**

ABB  
 ACG - Envirocan  
 ACI Instrumentation  
 ADS Environmental Services  
 Atlas Dewatering Corporation  
 Avensys Solutions  
 BioMaxx Wastewater Solutions  
 Blue-White Industries  
 Can-Am Instruments  
 Cancoppas  
 CB Automation  
 Chemline Plastics  
 Davis Controls  
 Delpro Automation  
 Endress+Hauser Canada  
 Fluid Components International  
 Flowmetrix Technical Services  
 Franklin Empire  
 Geneq  
 Greyl ine Instruments  
 Hoskin Scientific  
 Hydrovision GmbH  
 Insitu Contractors  
 LimeGREEN Equipment  
 Master Meter Canada  
 Monitario Technical Services  
 Neptune Technology Group  
 Osprey Scientific  
 SEI Industries  
 Service Filtration Of Canada  
 Singer  
 SPD Sales  
 USABluebook  
 Vissers Sales Corp.  
 Watermark Solutions  
 Wolseley Canada

**Flumes**

Avensys Solutions  
 Can-Am Instruments  
 Cancoppas  
 CB Automation  
 Claro Environmental Tech.  
 ENV Treatment Systems  
 Flowmetrix Technical Services  
 Geneq  
 Monitario Technical Services  
 SPD Sales  
 USABluebook

**Flushing Equipment**

BirkSCO

**Gas Detection**

ACI Instrumentation  
 Acme Engineering Products  
 Arizona Instrument  
 Avensys Solutions  
 Cameron Instruments  
 Canadian Safety Equipment  
 Cancoppas  
 Chlorinators  
 Concept Controls  
 Davis Controls  
 E.R.E.  
 EHS Canada  
 Enviro-Analytical  
 Franklin Empire  
 Gasmex Technologies  
 Geneq  
 Hoskin Scientific  
 Mil-Ram Technology  
 MIP Centrex  
 Osprey Scientific

Scentroid  
 SPD Sales  
 T. Harris Environmental Mgmt.  
 Westech Industrial

**Gases (Calibration)**

ACI Instrumentation  
 Cancoppas  
 Concept Controls  
 Endress+Hauser Canada  
 Mil-Ram Technology  
 Osprey Scientific  
 SPD Sales

**Gates (Shear, Sluice, Etc.)**

Alfa Laval  
 Aquanox Water Control Products  
 Avensys Solutions  
 B.N.W. Valve Manufacturing  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Devine & Associates  
 Floval Equipment  
 Halliday Products  
 Orbinox  
 Pro Aqua  
 USABluebook  
 Vector Process Equipment  
 Wolseley Canada

**Generators (Electrical)**

Atlas Dewatering Corporation  
 eV FERN  
 Insitu Contractors  
 John Brooks Company  
 Sheridan Electric Services

**Geomembranes**

Albarrie GeoComposites  
 Firestone Building Products  
 Geomembrane Technologies  
 H2Flow Tanks & Systems  
 Nuna Innovations  
 Titan Environmental Containment

**Geosynthetics**

Albarrie GeoComposites  
 Bishop Water Technologies  
 Corix  
 Nuna Innovations  
 Titan Environmental Containment

**Geotextiles**

Albarrie GeoComposites  
 Corix  
 Titan Environmental Containment  
 Wessuc

**Grit Collection/Removal**

ACG - Envirocan  
 Aqua Technical Sales  
 Aquablast Corp.  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 CB Shield  
 Claro Environmental Tech.  
 Directrik  
 Echelon Environmental  
 ENV Treatment Systems  
 Fluidyne Corporation  
 Forterra Pipe  
 Good Harbour Laboratories  
 H2Flow Equipment  
 Huber Technology  
 Hydro International  
 IPEC - JWC Environmental  
 KSB Pumps  
 Kusters Water  
 Ovivo USA

Pro Aqua  
 Smith & Loveless  
 StormTrap  
 Waste 'n WaterTech  
 Wessuc  
 Westech Engineering  
 WTP Equipment Corp.

**Groundwater Modeling**

CB Automation  
 KISTERS North America

**Groundwater Monitoring**

Atlas Dewatering Corporation  
 CB Automation  
 Concept Controls  
 Heron Instruments  
 Hoskin Scientific  
 International Water Supply  
 Real Tech  
 S2S Environmental  
 Solinst Canada  
 T. Harris Environmental Mgmt.  
 TankTek Environmental Services  
 Waterra Pumps

**Groundwater Remediation**

Aclarus Ozone Water Systems  
 Albarrie GeoComposites  
 Atlas Dewatering Corporation  
 Continental Carbon Group  
 DeWind One Pass Trenching  
 E.R.E.  
 ELMRIDGE Engineering  
 Golden Environmental Services  
 H2Flow Tanks & Systems  
 Hoskin Scientific  
 HydroFLOW Canada  
 Insitu Contractors  
 Ittech Environmental Services  
 KG Services  
 KSB Pumps  
 LimeGREEN Equipment  
 Northern ANI Solutions  
 Osprey Scientific  
 R.E. Morrison Equipment  
 Safe Drain  
 SCG Industries  
 Sensaphone  
 Sierra Sales PETanks  
 Solinst Canada  
 TankTek Environmental Services  
 UV Pure Technologies  
 Waterloo Barrier  
 Westech Engineering

**Hazardous Waste**

Absorbents Online  
 Anachem  
 Aquablast Corp.  
 BI Pure Water  
 Drain-All  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Ittech Environmental Services  
 Loraday Environmental Products  
 SEI Industries  
 Sierra Sales PETanks  
 Spill Management  
 T. Harris Environmental Mgmt.  
 Terrapure Environmental

**Heat Exchangers**

Aquablast Corp.  
 Babcock & Wilcox MEGTEC  
 C&M Environmental Technologies  
 Claro Environmental Tech.  
 CTP Sinto America  
 Directrik  
 HydroFLOW Canada  
 Madok Manufacturing  
 Napier-Reid  
 Pro Aqua  
 Rittal Systems  
 Vector Process Equipment

**Hoses**

Atlas Dewatering Corporation  
Canadian Safety Equipment  
CompreVac  
LimeGREEN Equipment  
Runnalls Industries  
Wolseley Canada

**Hydropneumatic Surge**

Hydro-Logic Environmental

**Incinerator Systems/Equipment**

Aqua Technical Sales  
Babcock & Wilcox MEGTEC  
CTP Sinto America  
SUEZ

**Instrumentation**

ABB  
ACI Instrumentation  
Aquafy Water Technologies  
Arizona Instrument  
Avensys Solutions  
Blue-White Industries  
Cameron Instruments  
Can-Am Instruments  
Cancoppas  
CB Automation  
Coastal Environmental Systems  
Concept Controls  
Davis Controls  
E.R.E.  
Elemental Controls  
Endress+Hauser Canada  
Enviro-Analytical  
Fluid Components International  
Flowmetrix Technical Services  
Franklin Empire  
Geneq  
Greyline Instruments  
Heron Instruments  
International Water Supply  
KGO Group  
Markland Specialty Engineering  
Mil-Ram Technology  
MIP Centrex  
Monitario Technical Services  
Osprey Scientific  
Real Tech  
Rotork Controls  
Schonsted Instrument Company  
Siemens Canada  
Solinst Canada  
SPD Sales  
TSI  
Westech Industrial

**Ion Exchange Systems**

BI Pure Water  
BQE Water  
C&M Environmental Technologies  
DWG Process Supply  
H2Flow Equipment  
Jacobi Carbons  
John Brooks Company  
KONTEK Ecology Systems  
Napier-Reid  
Pro Aqua  
Service Filtration Of Canada  
Smith & Loveless  
SUEZ  
United Manufacturing Int. 2000

**Iron Removal Plants**

ACG - Envirocan  
Aqua Technical Sales  
C&M Environmental Technologies  
H2Flow Tanks & Systems  
Pro Aqua  
Smith & Loveless

**Iron Removal Systems**

ACG - Envirocan  
Aclarus Ozone Water Systems  
Aqua Technical Sales  
AWI (Anthratch Western)  
BI Pure Water

Canature WaterGroup  
H2Flow Equipment  
John Brooks Company  
KONTEK Ecology Systems  
Pro Aqua  
Safe Drain  
Smith & Loveless  
SUEZ  
World Water Operator Training Co.

**ISO 9001 Quality Management Systems**

Good Harbour Laboratories

**Laboratories (Analytical)**

Cancoppas  
Endress+Hauser Canada  
Industrial Waste Control  
MANTECH  
Northern ANI Solutions  
T. Harris Environmental Mgmt.  
USABluebook  
World Water Operator Training Co.

**Laboratory Supplies**

Cancoppas  
E.R.E.  
Fluid Metering  
Geneq  
Hoskin Scientific  
IDEXX Water  
MANTECH  
Northern ANI Solutions  
Osprey Scientific  
Sierra Sales PETanks  
USABluebook

**Lagoons**

Aquablast Corp.  
Aquanox Water Control Products  
AWT Technologies  
Bishop Water Technologies  
C&M Environmental Technologies  
CEMATRIX (Canada)  
Geomembrane Technologies  
Golden Environmental Services  
Hydro-Logic Environmental  
HydroFLOW Canada  
Markland Specialty Engineering  
MetaFLO Technologies  
Nexom  
SciCorp International Corp.  
SHAC Environmental Products  
Terratec Environmental  
Titan Environmental Containment  
Vector Process Equipment  
Wessuc  
World Water Operator Training Co.

**Landfill**

CEMATRIX (Canada)  
Scarborough Supply  
Sco-Terra Operations Group  
SHAC Environmental Products  
Sheridan Electric Services  
Terrapure Environmental  
Titan Environmental Containment  
Walker Environmental Group

**Leak Detection**

ACI Instrumentation  
Arizona Instrument  
Cameron Instruments  
Can-Am Instruments  
Cancoppas  
Chlorinators  
Davis Controls  
Enviro Hazmat Emerg. Response  
Fluid Components International  
Flowmetrix Technical Services  
Franklin Empire  
Ingu Solutions  
IpeX  
Master Meter Canada  
Mil-Ram Technology  
Rittal Systems

Sensaphone  
USABluebook  
Watermark Solutions

**Level Controls**

ABB  
ACI Instrumentation  
ADS Environmental Services  
Avensys Solutions  
Can-Am Instruments  
CB Automation  
Chemline Plastics  
Davis Controls  
Delpro Automation  
Endress+Hauser Canada  
Engineered Pump Systems  
Fluid Components International  
Franklin Empire  
Grande Water Management  
Greyline Instruments  
Markland Specialty Engineering  
SmartCover Systems  
SPD Sales  
USABluebook  
Westech Industrial  
Xylem

**Lime Slakers**

Aquafy Water Technologies  
Capital H2O Systems  
DWG Process Supply  
Indachem  
Smith & Loveless  
Sudbury Lime

**Liners**

Belzona Great Lakes Holdings  
BowRio Water Technologies  
C&M Environmental Technologies  
CEMATRIX (Canada)  
Geomembrane Technologies  
H2Flow Tanks & Systems  
SEI Industries  
Titan Environmental Containment  
Wise Environmental Solutions

**Locators**

Cameron Instruments  
Interprovincial Corrosion Control  
Schonsted Instrument Company  
Sonic Soil Sampling  
Watermark Solutions

**Lone Worker Monitors**

Canadian Safety Equipment

**Maintenance Holes**

Aquablast Corp.  
CEMATRIX (Canada)  
Con Cast Pipe  
DECAST  
Lafarge  
M Con Pipe & Products

**Manganese Removal Systems**

ACG - Envirocan  
Aclarus Ozone Water Systems  
Aqua Technical Sales  
AWI (Anthratch Western)  
C&M Environmental Technologies  
Canature WaterGroup  
Continental Carbon Group  
H2Flow Equipment  
John Brooks Company  
Napier-Reid  
Pro Aqua  
SUEZ  
World Water Operator Training Co.

**Material Handling**

ACG - Envirocan  
Aerzen Canada  
Claro Environmental Tech.  
DWG Process Supply  
Loraday Environmental Products  
Wessuc  
WTP Equipment Corp.

**Measurement Systems**

Avensys Solutions  
CB Automation  
Endress+Hauser Canada  
Fluid Components International  
Hoskin Scientific  
KISTERS North America  
Markland Specialty Engineering  
MIP Centrex  
Monitario Technical Services  
Scentroid

**Mechanical Transmission Equipment**

SEW-Eurodrive  
Sterling Power Systems  
VL Motion Systems

**Membranes**

ACG - Envirocan  
ADI Systems  
Albarrie GeoComposites  
Alfa Laval  
Aqua Technical Sales  
Aquablast Corp.  
Belzona Great Lakes Holdings  
BI Pure Water  
Bio-Microbics  
BowRio Water Technologies  
C&M Environmental Technologies  
DWG Process Supply  
ECOfluid Systems  
H2Flow Equipment  
Huber Technology  
Imbrium Systems  
John Brooks Company  
KONTEK Ecology Systems  
LG Water Solutions  
Membrane Specialists  
Nova Filtration Technologies  
Ovivo USA  
Premier Tech Aqua  
Pro Aqua  
Smith & Loveless  
USABluebook  
Vector Process Equipment  
Wildcat Water Technologies  
World Water Operator Training Co.

**Meter Testing Equipment**

Master Meter Canada  
Neptune Technology Group

**Meters (Equip.)**

ABB  
ADS Environmental Services  
Can-Am Instruments  
Chemline Plastics  
Davis Controls  
Endress+Hauser Canada  
Fluid Components International  
Franklin Empire  
Geneq  
Greyline Instruments  
Hoskin Scientific  
KGO Group  
Markland Specialty Engineering  
Master Meter Canada  
Monitario Technical Services  
Neptune Technology Group  
Osprey Scientific  
Real Tech  
SEI Industries  
Sheridan Electric Services  
SPD Sales  
Watermark Solutions  
Watterra Pumps  
Westech Industrial  
Wolseley Canada

**Meters (Service & Installation)**

ADS Environmental Services  
Can-Am Instruments  
Endress+Hauser Canada  
Flowmetrix Technical Services  
Master Meter Canada  
Neptune Technology Group

Sheridan Electric Services  
Watermark Solutions  
World Water Operator Training Co.

**Mixers/Agitators**

ACG - Envirocan  
Aeration Industries International  
Aquablast Corp.  
ASL Roteq  
BowRio Water Technologies  
Capital H2O Systems  
Claro Environmental Tech.  
Directrik  
ELMRIDGE Engineering  
Engineered Pump Systems  
Fluidyne Corporation  
Greatario  
H2Flow Tanks & Systems  
Hayward Gordon  
Hoskin Scientific  
Hydro-Logic Environmental  
Medora Corporation  
Ovivo USA  
Pro Aqua  
Revolmix Processing  
Service Filtration Of Canada  
Sulzer Pumps (Canada)  
USABluebook  
Vector Process Equipment  
Vissers Sales Corp.  
WESCOR  
Xylem

**Monitoring Well Supplies**

Atlas Dewatering Corporation  
E.R.E.  
Heron Instruments  
International Water Supply  
Osprey Scientific  
Solinst Canada  
SPD Sales  
Watterra Pumps

**Monitors**

ABB  
Acme Engineering Products  
ADS Environmental Services  
Arizona Instrument  
Atlas Copco Compressors Canada  
Avensys Solutions  
Can-Am Instruments  
Chemline Plastics  
Davis Controls  
Flowmetrix Technical Services  
Franklin Empire  
Markland Specialty Engineering  
Mil-Ram Technology  
MIP Centrex  
Monitario Technical Services  
Real Tech  
Sensaphone  
SmartCover Systems  
Sonic Soil Sampling  
Syrinx  
T. Harris Environmental Mgmt.  
USABluebook  
Xylem

**Mould Removal**

EHS Canada  
Golden Environmental Services  
Healthy Environmental  
Hydroxyl Environmental  
Itech Environmental Services  
Loraday Environmental Products  
T. Harris Environmental Mgmt.

**Noise Control**

Aerzen Canada  
CEMATRIX (Canada)  
Concept Controls  
Nett Technologies

**Occupational Health & Safety**

Avensys Solutions  
Canadian Safety Equipment

*continued overleaf...*

Concept Controls  
 Enviro-Analytical  
 Global Training Solutions  
 Hydroxyl Environmental  
 Mil-Ram Technology  
 MSU Mississauga  
 Northern ANI Solutions  
 TEAM-1 Academy

**Odour Control**

ACG - Envirocan  
 Aclarus Ozone Water Systems  
 Aeration Industries International  
 Aquafy Water Technologies  
 Aquanox Water Control Products  
 Arizona Instrument  
 Babcock & Wilcox MEGTEC  
 BioAir Solutions  
 BIOREM Technologies  
 BowRio Water Technologies  
 Capital H2O Systems  
 Citto Corporation  
 Continental Carbon Group  
 CTP Sinto America  
 Echelon Environmental  
 Engineered Pump Systems  
 ENV Treatment Systems  
 Geomembrane Technologies  
 Golden Environmental Services  
 Greatario  
 H2Flow Equipment  
 Hydro-Logic Environmental  
 Hydroxyl Environmental  
 Indachem  
 Ipex  
 Jurassic Activated Carbon  
 Kemira  
 Kusters Water  
 Loraday Environmental Products  
 Mac & Co Environmental Solutions  
 Medora Corporation  
 Scentroid  
 SciCorp International Corp.  
 SHAC Environmental Products  
 Trojan Technologies  
 USABluebook  
 Waste 'n WaterTech

**Oil Clean-Up Equipment**

Aquablast Corp.  
 Atlas Dewatering Corporation  
 Boerger  
 Can-Am Instruments  
 Canadian Safety Equipment  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Itech Environmental Services  
 KG Services  
 Loraday Environmental Products  
 NCS Fluid Handling Systems  
 Sierra Sales PETanks  
 Spill Management

**Oil In Water Detectors**

Can-Am Instruments  
 E.R.E.  
 Endress+Hauser Canada  
 Heron Instruments  
 Imbrium Systems  
 MIP Cemtrex  
 Northern ANI Solutions  
 Osprey Scientific

**Oil/Water Separators**

ACG - Envirocan  
 ACO Systems  
 Albarrie GeoComposites  
 Alfa Laval  
 BioMaxx Wastewater Solutions  
 Can-Am Instruments  
 CB Shield  
 CompreVac  
 Con Cast Pipe  
 E.R.E.  
 Echelon Environmental  
 ENV Treatment Systems  
 Filamat Composites

Forterra Pipe  
 Good Harbour Laboratories  
 Goslyn Environmental  
 H2Flow Equipment  
 H2Flow Tanks & Systems  
 Imbrium Systems  
 Indachem  
 JNE Environmental  
 John Brooks Company  
 KG Services  
 Lafarge  
 M Con Pipe & Products  
 Minotaur Stormwater Services  
 Parkson Corporation  
 Q-VAC Automatic Priming Systems  
 Safe Drain  
 SCG Industries  
 Smith & Loveless  
 StormTrap  
 WESCOR  
 WesTech Engineering

**Ozonization Equipment**

ACG - Envirocan  
 Aclarus Ozone Water Systems  
 BowRio Water Technologies  
 ELMRIDGE Engineering  
 ENV Treatment Systems  
 H2Flow Equipment  
 KGO Group  
 OZONATOR Industries  
 SUEZ  
 Xylem

**Package Effluent Control Systems**

Bio-Microbics  
 Engineered Pump Systems  
 KSB Pumps  
 NCS Fluid Handling Systems  
 Smith & Loveless  
 WESCOR

**Package Sewage Lift Stations**

Aqua Technical Sales  
 ASL Roteq  
 Atlas Dewatering Corporation  
 Crane Pumps & Systems Canada  
 Directrik  
 Engineered Pump Systems  
 Gorman-Rupp Canada  
 Grundfos Canada  
 John Brooks Company  
 KSB Pumps  
 Smith & Loveless  
 Vissers Sales Corp.  
 Weir Canada

**Package Sewage Treatment Plants**

ACG - Envirocan  
 Alfa Laval  
 Aqua Technical Sales  
 Atlas Dewatering Corporation  
 AWT Technologies  
 BI Pure Water  
 Bio-Microbics  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Capital H2O Systems  
 Echelon Environmental  
 ECOfluid Systems  
 ENV Treatment Systems  
 Insitu Contractors  
 KSB Pumps  
 Kusters Water  
 Lystek International  
 Make-Way Environmental Tech.  
 Premier Tech Aqua  
 Pro Aqua  
 Prominent Fluid Controls  
 Smith & Loveless  
 Waste 'n WaterTech  
 Waterloo Biofilter Systems  
 WesTech Engineering  
 Wildcat Water Technologies

**Package Water Treatment Systems**

ACG - Envirocan  
 Aclarus Ozone Water Systems  
 Aqua Technical Sales  
 AWI (Anthratech Western)  
 BI Pure Water  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Capital H2O Systems  
 Continental Carbon Group  
 Crane Pumps & Systems Canada  
 DWG Process Supply  
 HydroFLOW Canada  
 JNE Environmental  
 John Brooks Company  
 KGO Group  
 KSB Pumps  
 Membrane Specialists  
 MS Filter Systems  
 Pro Aqua  
 Prominent Fluid Controls  
 SEEPEX  
 Sheridan Electric Services  
 Sierra Sales PETanks  
 Smith & Loveless  
 SUEZ  
 Vissers Sales Corp.  
 Waste 'n WaterTech  
 WESCOR  
 WesTech Engineering  
 Wildcat Water Technologies

**PCB Treatment/Storage**

KG Services  
 LimeGREEN Equipment  
 Loraday Environmental Products

**Pipe Design**

Con Cast Pipe  
 DECAST  
 Ipex  
 Lafarge  
 SCG Industries  
 Sigma Engineering  
 Victaulic

**Pipe Equipment**

Chemline Plastics  
 DECAST  
 McElroy  
 Runnalls Industries  
 Triangle Fluid Controls  
 USABluebook  
 Victaulic

**Pipe Fittings**

Atlas Dewatering Corporation  
 Cambridge Brass  
 Chemline Plastics  
 Con Cast Pipe  
 Corix  
 DECAST  
 Fabco Plastics  
 Ipex  
 Mersino Dewatering  
 Mueller Canada  
 Pipe Specialties Canada  
 Runnalls Industries  
 Scarborough Supply  
 Source One Environmental/Fernco  
 Victaulic  
 Wolseley Canada  
 Xylem

**Pipe Rehabilitation**

Atlas Dewatering Corporation  
 CEMATRIX (Canada)  
 DECAST  
 Denso North America  
 HydroFLOW Canada  
 Ipex  
 Source One Environmental/Fernco

**Pipe Rentals**

Atlas Dewatering Corporation  
 NCS Fluid Handling Systems

**Pipeline Inspection**

DECAST  
 Drain-All  
 Ingu Solutions  
 NCS Fluid Handling Systems  
 PICA Corporation  
 Source One Environmental/Fernco

**Piping**

Atlas Dewatering Corporation  
 Chemline Plastics  
 CompreVac  
 Con Cast Pipe  
 Corix  
 Corrugated Steel Pipe Institute  
 DECAST  
 Fabco Plastics  
 Fabricated Plastics  
 Filamat Composites  
 Ipex  
 Lafarge  
 M Con Pipe & Products  
 Nett Technologies  
 Pipe Specialties Canada  
 Runnalls Industries  
 Scarborough Supply  
 Victaulic  
 Wolseley Canada

**Plant Operations**

DECAST  
 HydroFLOW Canada  
 Lystek International  
 Sco-Terra Operations Group  
 Sheridan Electric Services  
 World Water Operator Training Co.

**Plate Settlers**

ACG - Envirocan  
 Aqua Technical Sales  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 ENV Treatment Systems  
 Pro Aqua  
 Vector Process Equipment  
 WESCOR

**Pneumatic Lift Stations**

Aqua Technical Sales  
 Smith & Loveless

**Polymer Blend & Prep Systems**

Aquafy Water Technologies  
 Bishop Water Technologies  
 BowRio Water Technologies  
 Directrik  
 DWG Process Supply  
 Hayward Gordon  
 HydroFLOW Canada  
 Indachem  
 JNE Environmental  
 John Brooks Company  
 Netzsch Canada  
 Pro Aqua  
 Prominent Fluid Controls  
 SNF Canada  
 VFold  
 Waste 'n WaterTech  
 WESCOR

**Pump Design**

Hydro-Logic Environmental

**Pump Design**

ASL Roteq  
 Crane Pumps & Systems Canada  
 Directrik  
 Engineered Pump Systems  
 Fluid Metering  
 Franklin Empire  
 Gorman-Rupp Canada  
 International Water Supply  
 John Brooks Company  
 KSB Pumps  
 Netzsch Canada  
 Smith & Loveless  
 Sulzer Pumps (Canada)

Xylem

**Pump Drives**

Crane Pumps & Systems Canada  
 Davis Controls  
 Directrik  
 Engineered Pump Systems  
 Grundfos Canada  
 International Water Supply  
 John Brooks Company  
 Netzsch Canada  
 SEW-Eurodrive  
 Sheridan Electric Services  
 Sterling Power Systems  
 Syntec Process Equipment  
 USABluebook  
 Wilo Canada  
 Xylem  
 Yaskawa Canada

**Pump Motors**

ASL Roteq  
 CompreVac  
 Crane Pumps & Systems Canada  
 Directrik  
 International Water Supply  
 John Brooks Company  
 SEW-Eurodrive  
 Sheridan Electric Services  
 Sterling Power Systems  
 USABluebook  
 Wilo Canada  
 Xylem

**Pump Protection Systems**

ASL Roteq  
 Belzona Great Lakes Holdings  
 Crane Pumps & Systems Canada  
 Directrik  
 John Brooks Company  
 KSB Pumps  
 Syntec Process Equipment  
 Xylem

**Pump Rentals**

ASL Roteq  
 Atlas Dewatering Corporation  
 CompreVac  
 DeWind One Pass Trenching  
 Engineered Pump Systems  
 Gorman-Rupp Canada  
 Hoskin Scientific  
 Insitu Contractors  
 International Water Supply  
 Mersino Dewatering  
 NCS Fluid Handling Systems  
 Netzsch Canada  
 Xylem

**Pump Repairs**

ASL Roteq  
 Atlas Dewatering Corporation  
 Belzona Great Lakes Holdings  
 CompreVac  
 Crane Pumps & Systems Canada  
 Directrik  
 Engineered Pump Systems  
 Gorman-Rupp Canada  
 Hayward Gordon  
 International Water Supply  
 KSB Pumps  
 Netzsch Canada  
 Q-VAC Automatic Priming Systems  
 Sealogic Innovations Corp.  
 Service Filtration Of Canada  
 Smith & Loveless  
 Sulzer Pumps (Canada)  
 Vissers Sales Corp.  
 World Water Operator Training Co.  
 Xylem

**Pump Replacement Parts**

ASL Roteq  
 Atlas Dewatering Corporation  
 CompreVac  
 Crane Pumps & Systems Canada  
 Directrik

Engineered Pump Systems  
Gorman-Rupp Canada  
Grundfos Canada  
Hayward Gordon  
John Brooks Company  
KSB Pumps  
Netzsch Canada  
Pro Aqua  
Q-VAC Automatic Priming Systems  
Service Filtration Of Canada  
Smith & Loveless  
Wilo Canada  
Xylem

#### Pump Stations & Components

Crane Pumps & Systems Canada  
DECAST  
Directrik  
Engineered Pump Systems  
Filamat Composites  
Fluid Metering  
Gorman-Rupp Canada  
John Brooks Company  
KSB Pumps  
Mersino Dewatering  
MSU Mississauga  
Netzsch Canada  
Q-VAC Automatic Priming Systems  
Sco-Terra Operations Group  
Service Filtration Of Canada  
Smith & Loveless  
Solar Pumps Canada  
Sulzer Pumps (Canada)  
Xylem

#### Pumps

Aqua Technical Sales  
Atlas Copco Compressors Canada  
Atlas Dewatering Corporation  
BioMaxx Wastewater Solutions  
Boerger  
Cameron Instruments  
Canadian Safety Equipment  
Claro Environmental Tech.  
Corix  
Crane Pumps & Systems Canada  
Directrik  
E.R.E.  
ELMRIDGE Engineering  
Engineered Pump Systems  
ENV Treatment Systems  
Fabco Plastics  
Fluid Metering  
Gorman-Rupp Canada  
Grundfos Canada  
Hayward Gordon  
Insitu Contractors  
International Water Supply  
John Brooks Company  
KGO Group  
KSB Pumps  
LimeGREEN Equipment  
Mersino Dewatering  
NCS Fluid Handling Systems  
Netzsch Canada  
Pro Aqua  
Prominent Fluid Controls  
Q-VAC Automatic Priming Systems  
R.E. Morrison Equipment  
Sealogic Innovations Corp.  
SEEPEX  
SEI Industries  
Service Filtration Of Canada  
Smith & Loveless  
Solar Pumps Canada  
Solinst Canada  
Sulzer Pumps (Canada)  
Syntec Process Equipment  
USABluebook  
Vector Process Equipment  
Vissers Sales Corp.  
Wastecorp Pumps  
Waterra Pumps  
Weir Canada  
Wilo Canada  
World Water Operator Training Co.

Xylem

#### Rainwater Harvesting

Crane Pumps & Systems Canada  
StormTrap  
UV Pure Technologies  
Vissers Sales Corp.  
Waterloo Biofilter Systems

#### Recorders

ABB  
ACI Instrumentation  
Cameron Instruments  
Davis Controls  
Endress+Hauser Canada  
Franklin Empire  
Monitario Technical Services  
Solinst Canada  
SPD Sales  
USABluebook  
Watermark Solutions

#### Renewable Energy

ADI Systems  
Babcock & Wilcox MEGTEC  
Bioform Sewage Mining  
Claro Environmental Tech.  
eV FERN  
Geomembrane Technologies  
Huber Technology  
Lystek International  
SciCorp International Corp.  
Solar Ontario  
Solar Pumps Canada  
Solar PV Heat  
TEAM-1 Academy  
Trojan Technologies  
Walker Environmental Group  
Westech Engineering

#### Rescue Equipment

Canadian Safety Equipment

#### Reverse Osmosis

BowRio Water Technologies  
Canature WaterGroup  
DWG Process Supply  
HydroFLOW Canada  
John Brooks Company  
KONTEK Ecology Systems  
KSB Pumps  
Membrane Specialists  
Nova Filtration Technologies  
SUEZ  
USABluebook  
Westech Engineering

#### Safety Equipment

Albarrie GeoComposites  
Aquaify Water Technologies  
Canadian Safety Equipment  
E.R.E.  
EHS Canada  
Indachem  
Itech Environmental Services  
Kee Safety  
Loraday Environmental Products  
Mil-Ram Technology  
Northern ANI Solutions  
Safe Drain  
TEAM-1 Academy  
USABluebook

#### Samplers & Sampling Equipment

BioMaxx Wastewater Solutions  
Birkasco  
Can-Am Instruments  
E.R.E.  
ELMRIDGE Engineering  
Endress+Hauser Canada  
Enviro Hazmat Emerg. Response  
Fluid Metering  
Industrial Waste Control  
Markland Specialty Engineering  
Mil-Ram Technology  
Monitario Technical Services

Osprey Scientific  
Solinst Canada  
SPD Sales  
USABluebook

#### SCADA Systems

CB Automation  
e.RIS  
KONTEK Ecology Systems  
Sensaphone  
SmartCover Systems  
USABluebook  
Xylem

#### Seals

Capital H2O Systems  
Chlorinators  
Force Flow  
Hoskin Scientific  
Vissers Sales Corp.

#### Screenings

ACG - Envirocan  
C&M Environmental Technologies  
Claro Environmental Tech.  
Duperon Corporation  
ENV Treatment Systems  
Evoqua Water Technologies  
H2Flow Tanks & Systems  
Huber Technology  
IPEC - JWC Environmental  
John Brooks Company  
Kusters Water  
Pro Aqua  
WTP Equipment Corp.

#### Screens

ACG - Envirocan  
Aggregates Equipment  
Aqua Technical Sales  
Aquaablast Corp.  
Bio-Microbics  
BioMaxx Wastewater Solutions  
BowRio Water Technologies  
C&M Environmental Technologies  
Claro Environmental Tech.  
Duperon Corporation  
Echelon Environmental  
ENV Treatment Systems  
Evoqua Water Technologies  
Grande Water Management  
Huber Technology  
Hydro International  
International Water Supply  
IPEC - JWC Environmental  
John Brooks Company  
JWC Environmental  
Kusters Water  
Parkson Corporation  
Pro Aqua  
Smith & Loveless  
StormTrap  
SUEZ  
Vector Process Equipment  
Waste 'n WaterTech  
Westech Engineering  
WTP Equipment Corp.

#### Scrubbers/Washers

Aquaablast Corp.  
Aquaify Water Technologies  
Babcock & Wilcox MEGTEC  
CTP Sinto America  
ELMRIDGE Engineering  
ENV Treatment Systems  
Indachem  
JNE Environmental  
KSB Pumps  
Smith & Loveless  
Westech Industrial

#### Seals

Atlas Dewatering Corporation  
Directrik  
Sealogic Innovations Corp.  
Service Filtration Of Canada  
Triangle Fluid Controls

Xylem

#### Secondary Containment

Albarrie GeoComposites  
Atlas Dewatering Corporation  
EHS Canada  
Enviro Hazmat Emerg. Response  
Geomembrane Technologies  
Greatario  
H2Flow Tanks & Systems  
Ipex  
LimeGREEN Equipment  
Loraday Environmental Products  
Nuna Innovations  
Safe Drain  
Spill Management  
Tank Connection  
Titan Environmental Containment

#### Security Products

Calgary Alarm  
Safe Drain

#### Sedimentation Systems

Aqua Technical Sales  
Atlas Dewatering Corporation  
Bio-Microbics  
C&M Environmental Technologies  
CB Shield  
Claro Environmental Tech.  
Directrik  
Good Harbour Laboratories  
Imbrium Systems  
Insitu Contractors  
Kusters Water  
LimeGREEN Equipment  
Safe Drain  
Smith & Loveless  
StormTrap

#### Separators

ACG - Envirocan  
Boerger  
Can-Am Instruments  
CompreVac  
Filamat Composites  
Goslyn Environmental  
Imbrium Systems  
John Brooks Company  
KG Services  
Kusters Water  
Pace Dewatering Systems  
Smith & Loveless  
Westech Industrial  
WTP Equipment Corp.

#### Septage Receiving Systems

ACG - Envirocan  
Birkasco  
BowRio Water Technologies  
Claro Environmental Tech.  
Directrik  
ENV Treatment Systems  
Huber Technology  
IPEC - JWC Environmental  
KG Services  
SPD Sales  
Waste 'n WaterTech  
WTP Equipment Corp.

#### Septic Tanks & Equipment

Bio-Microbics  
Engineered Pump Systems  
KG Services  
Lafarge  
Premier Tech Aqua  
SHAC Environmental Products  
Waterloo Biofilter Systems  
Wildcat Water Technologies

#### Sequencing Batch Reactors (SBR)

ACG - Envirocan  
ADI Systems  
Aeration Industries International  
Alfa Laval  
AWT Technologies

BowRio Water Technologies  
Capital H2O Systems  
ENV Treatment Systems  
Fluidyne Corporation  
Markland Specialty Engineering  
Parkson Corporation  
Premier Tech Aqua  
Xylem

#### Service Contracting

ACI Instrumentation  
Aquaablast Corp.  
Cambium Aboriginal  
CD Genomics  
Continental Carbon Group  
CTP Sinto America  
Delpro Automation  
Drain-All  
Endress+Hauser Canada  
Golden Environmental Services  
Good Harbour Laboratories  
Industrial Waste Control  
KG Services  
Sheridan Electric Services  
WTP Equipment Corp.

#### Sewage Gas Equipment

Can-Am Instruments  
Westech Industrial

#### Sewer Equipment & Products

Aquanox Water Control Products  
Atlas Dewatering Corporation  
Bioform Sewage Mining  
Canadian Safety Equipment  
CB Automation  
Goslyn Environmental  
KSB Pumps  
Monitario Technical Services  
SHAC Environmental Products  
Source One Environmental/Fernco  
Wildcat Water Technologies  
Wilo Canada

#### Shredders/Compactors

ACG - Envirocan  
Boerger  
BowRio Water Technologies  
Directrik  
IPEC - JWC Environmental  
Sheridan Electric Services  
WTP Equipment Corp.

#### Site Remediation

Albarrie GeoComposites  
Atlas Dewatering Corporation  
Continental Carbon Group  
Drain-All  
Focus Environmental Group  
Golden Environmental Services  
Insitu Contractors  
Itech Environmental Services  
KG Services  
S2S Environmental  
SCG Industries  
Spill Management  
T. Harris Environmental Mgmt.  
TankTek Environmental Services  
Trojan Technologies

#### Sludge - Level Control

ABB  
ACI Instrumentation  
Aeration Industries International  
Can-Am Instruments  
Davis Controls  
Endress+Hauser Canada  
Mac & Co Environmental Solutions  
Markland Specialty Engineering  
SciCorp International Corp.  
SHAC Environmental Products  
SPD Sales  
Syntec Process Equipment  
Terrapure Environmental

*continued overleaf..*

**Sludge Dewatering**

ACG - Envirocan  
 Alfa Laval  
 Aqua Technical Sales  
 Aquablast Corp.  
 Atlas Dewatering Corporation  
 Bioform Sewage Mining  
 BioMaxx Wastewater Solutions  
 Bishop Water Technologies  
 Boerger  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 E.R.E.  
 ENV Treatment Systems  
 Flottweg Separation Technology  
 Golden Environmental Services  
 Huber Technology  
 HydroFLOW Canada  
 Indachem  
 IPEC - JWC Environmental  
 Itech Environmental Services  
 JNE Environmental  
 KONTEK Ecology Systems  
 KSB Pumps  
 Kusters Water  
 Linkon Technology  
 Medora Corporation  
 MetaFLO Technologies  
 NCS Fluid Handling Systems  
 Netzsch Canada  
 Parkson Corporation  
 Smith & Loveless  
 SNF Canada  
 SUEZ  
 Terrapure Environmental  
 Terratec Environmental  
 Trident Processes  
 Trojan Technologies  
 VFold  
 Waste 'n WaterTech  
 WESCOR  
 Wessuc  
 Wise Environmental Solutions  
 Xylem

**Sludge Disposal**

Advantek Waste Mgmt. Services  
 Anachem  
 Aquablast Corp.  
 Bioform Sewage Mining  
 Drain-All  
 IPEC - JWC Environmental  
 Itech Environmental Services  
 KSB Pumps  
 Linkon Technology  
 Lystek International  
 MetaFLO Technologies  
 SHAC Environmental Products  
 Terrapure Environmental  
 Terratec Environmental  
 Way Cool Product Co.  
 Wessuc

**Sludge Drying**

ACG - Envirocan  
 Aqua Technical Sales  
 Bioform Sewage Mining  
 C&M Environmental Technologies  
 Huber Technology  
 HydroFLOW Canada  
 Indachem  
 IPEC - JWC Environmental  
 Itech Environmental Services  
 KSB Pumps  
 Lystek International  
 MetaFLO Technologies  
 Parkson Corporation  
 SUEZ  
 Terrapure Environmental  
 Vector Process Equipment  
 Walker Environmental Group

**Sludge Handling Equipment**

ACG - Envirocan  
 Aqua Technical Sales  
 AWT Technologies

Boerger  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Claro Environmental Tech.  
 Directrik  
 DWG Process Supply  
 Echelon Environmental  
 ENV Treatment Systems  
 Franklin Empire  
 Huber Technology  
 IPEC - JWC Environmental  
 KGO Group  
 KSB Pumps  
 Linkon Technology  
 Lystek International  
 MetaFLO Technologies  
 Netzsch Canada  
 Ovivo USA  
 SEEPEX  
 Trojan Technologies  
 Waste 'n WaterTech  
 Weir Canada  
 Wessuc  
 WTP Equipment Corp.

**Sludge Removal Equipment**

ACG - Envirocan  
 Aquablast Corp.  
 Bioform Sewage Mining  
 Directrik  
 ENV Treatment Systems  
 Hydro-Logic Environmental  
 IPEC - JWC Environmental  
 Itech Environmental Services  
 Kusters Water  
 Linkon Technology  
 Netzsch Canada  
 Terrapure Environmental  
 Wessuc  
 WTP Equipment Corp.

**Soil Remediation**

Aclarus Ozone Water Systems  
 Atlas Dewatering Corporation  
 DeWind One Pass Trenching  
 Drain-All  
 E.R.E.  
 Elemental Controls  
 Focus Environmental Group  
 Itech Environmental Services  
 KG Services  
 Lystek International  
 MetaFLO Technologies  
 New Leaf Biologics  
 Q-VAC Automatic Priming Systems  
 SCG Industries  
 SHAC Environmental Products  
 T. Harris Environmental Mgmt.  
 Terrapure Environmental

**Soil Stabilization**

Itech Environmental Services  
 Lystek International  
 MetaFLO Technologies  
 Source One Environmental/Fernco

**Solvent Recovery Systems**

Babcock & Wilcox MEGTEC  
 Blue-Zone Technologies  
 Drain-All  
 Spill Management

**Solvent Recycling Services**

Anachem  
 Blue-Zone Technologies  
 Jurassic Activated Carbon

**Spill Containment**

Albarrie GeoComposites  
 Aquablast Corp.  
 Atlas Dewatering Corporation  
 Canadian Safety Equipment  
 Drain-All  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Imbrium Systems  
 Itech Environmental Services

KG Services  
 Loraday Environmental Products  
 Safe Drain  
 SCG Industries  
 SEI Industries  
 Spill Management  
 Trans Environmental Systems  
 USABluebook  
 Wessuc  
 Wise Environmental Solutions  
 WTP Equipment Corp.

**Spill Response**

Anachem  
 Aquablast Corp.  
 Atlas Dewatering Corporation  
 Canadian Safety Equipment  
 Continental Carbon Group  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Itech Environmental Services  
 KG Services  
 LimeGREEN Equipment  
 Loraday Environmental Products  
 NCS Fluid Handling Systems  
 Safe Drain  
 TankTek Environmental Services  
 Trans Environmental Systems  
 Way Cool Product Co.  
 Wessuc  
 WTP Equipment Corp.

**Spill Response Equipment**

Albarrie GeoComposites  
 Atlas Dewatering Corporation  
 Can-Am Instruments  
 Coastal Environmental Systems  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Itech Environmental Services  
 Loraday Environmental Products  
 NCS Fluid Handling Systems  
 Osprey Scientific  
 Safe Drain  
 SCG Industries  
 SEI Industries  
 Spill Management  
 TEAM-1 Academy  
 Wessuc  
 WTP Equipment Corp.

**Spill Response Training**

Drain-All  
 EHS Canada  
 Enviro Hazmat Emerg. Response  
 Global Training Solutions  
 Itech Environmental Services  
 SCG Industries  
 Spill Management  
 TEAM-1 Academy  
 Terrapure Environmental

**Stand Pipes**

Filamat Composites  
 H2Flow Tanks & Systems  
 VIQUA

**Storage Buildings**

Can-Am Instruments  
 Loraday Environmental Products  
 Megadome Buildings

**Storage Containers**

Enviro Hazmat Emerg. Response  
 Filamat Composites  
 LimeGREEN Equipment  
 Loraday Environmental Products  
 SEI Industries  
 Sierra Sales PETanks  
 Tank Connection

**Storage Tanks**

Albarrie GeoComposites  
 Aquablast Corp.  
 Assman Corporation of America  
 Atlas Dewatering Corporation  
 Can-Am Instruments

Drain-All  
 Engineered Pump Systems  
 Enviro Hazmat Emerg. Response  
 Fabco Plastics  
 Fabricated Plastics  
 Filamat Composites  
 Focus Environmental Group  
 Greatario  
 H2Flow Tanks & Systems  
 Indachem  
 KG Services  
 Lafarge  
 LimeGREEN Equipment  
 Loraday Environmental Products  
 Poly Processing Company  
 Premier Tech Aqua  
 SCG Industries  
 SEI Industries  
 Sierra Sales PETanks  
 Tank Connection  
 TankTek Environmental Services  
 Titan Environmental Containment  
 USABluebook  
 Vector Process Equipment  
 Vissers Sales Corp.  
 Wise Environmental Solutions

**Stormwater Management**

ACO Systems  
 Albarrie GeoComposites  
 Aquanox Water Control Products  
 Atlas Dewatering Corporation  
 Bio-Microbics  
 C&M Environmental Technologies  
 Can-Am Instruments  
 CB Shield  
 Continental Carbon Group  
 Corrugated Steel Pipe Institute  
 Duperon Corporation  
 Echelon Environmental  
 ENV Treatment Systems  
 Enviro Hazmat Emerg. Response  
 Filamat Composites  
 Forterra Pipe  
 Good Harbour Laboratories  
 Grande Water Management  
 Greyline Instruments  
 Hoskin Scientific  
 Hydro International  
 Imbrium Systems  
 Ipex  
 KISTERS North America  
 Lafarge  
 M Con Pipe & Products  
 Minotaur Stormwater Services  
 NCS Fluid Handling Systems  
 Nuna Innovations  
 Safe Drain  
 Sco-Terra Operations Group  
 SmartCover Systems  
 Smith & Loveless  
 StormTrap  
 USABluebook  
 Weir Canada

**Strainers**

Acme Engineering Products  
 Claro Environmental Tech.  
 Devine & Associates  
 Directrik  
 Fabco Plastics  
 Goslyn Environmental  
 Hayward Gordon  
 John Brooks Company  
 Orival Water Filters  
 Singer  
 Syntec Process Equipment  
 Wolsley Canada

**Tank Cleaning**

Aquablast Corp.  
 Atlas Dewatering Corporation  
 Drain-All  
 EHS Canada  
 Focus Environmental Group  
 Grande Water Management

Greatario  
 Itech Environmental Services  
 John Brooks Company  
 KG Services  
 TankTek Environmental Services  
 Terrapure Environmental  
 Way Cool Product Co.  
 Wessuc  
 WTP Equipment Corp.

**Tank Design**

Albarrie GeoComposites  
 Canature WaterGroup  
 CEMATRIX (Canada)  
 Filamat Composites  
 Greatario  
 Indachem  
 John Brooks Company  
 KGO Group  
 Loraday Environmental Products  
 Poly Processing Company  
 SEI Industries  
 Sigma Engineering  
 Tank Connection  
 TankTek Environmental Services

**Tank Inspection**

Greatario  
 NCS Fluid Handling Systems  
 Poly Processing Company  
 SEI Industries  
 Tank Connection  
 TankTek Environmental Services  
 Way Cool Product Co.

**Telemetry Equipment**

ADS Environmental Services  
 Aquasmart Technologies  
 Can-Am Instruments  
 Devine & Associates  
 Endress+Hauser Canada  
 Flowmetrix Technical Services  
 Franklin Empire  
 KISTERS North America  
 Monitorio Technical Services  
 Sensaphone  
 SPD Sales  
 Watermark Solutions

**Thickeners**

ACG - Envirocan  
 Aqua Technical Sales  
 BowRio Water Technologies  
 C&M Environmental Technologies  
 Echelon Environmental  
 ENV Treatment Systems  
 Flottweg Separation Technology  
 Huber Technology  
 IPEC - JWC Environmental  
 Kusters Water  
 Ovivo USA  
 Smith & Loveless  
 Trident Processes  
 Trojan Technologies  
 VFold  
 Waste 'n WaterTech  
 WESCOR  
 WesTech Engineering

**Training**

AESAC  
 Cole Training and Operations  
 EHS Canada  
 Endress+Hauser Canada  
 Enviro Hazmat Emerg. Response  
 ES&E Magazine  
 Flowmetrix Technical Services  
 Franklin Empire  
 Global Training Solutions  
 Itech Environmental Services  
 Lakes Environmental Software  
 Prominent Fluid Controls  
 Royal Roads University  
 Source One Environmental/Fernco  
 Spill Management  
 T. Harris Environmental Mgmt.  
 TEAM-1 Academy

The Swamp School  
University of Toronto Scarborough  
University of Wisconsin-Madison  
Walkerton Clean Water Centre  
Watermark Solutions  
World Water Operator Training Co.  
Xylem

#### Trenchless Technology

Atlas Dewatering Corporation  
M Con Pipe & Products  
Mersino Dewatering  
Source One Environmental/Fernco

#### Utility Locating

Cameron Instruments  
Schonstedt Instrument Company  
Sonic Soil Sampling

#### Vacuum Equipment

Aquablast Corp.  
Atlas Copco Compressors Canada  
CompreVac  
ELMRIDGE Engineering  
Environmental Rental Service  
Insitu Contractors  
Itech Environmental Services  
NCS Fluid Handling Systems  
R.E. Morrison Equipment  
SCG Industries  
Wessuc  
Wise Environmental Solutions  
WTP Equipment Corp.

#### Valve Accessories

Alltork Actuation  
Canature WaterGroup  
Chemline Plastics  
Delpro Automation  
Devine & Associates  
DeZURIK/APCO/Hilton  
Festo  
Franklin Empire  
Ipex  
Mueller Canada  
Rotork Controls  
Singer  
Syntec Process Equipment  
Troy-Ontor  
USABluebook  
VL Motion Systems  
Wolseley Canada  
Xylem

#### Valve Servicing

Chemline Plastics  
Delpro Automation  
Devine & Associates  
DeZURIK/APCO/Hilton  
Syntec Process Equipment  
Troy-Ontor

#### Valves

B.N.W. Valve Manufacturing  
Cambridge Brass  
Canature WaterGroup  
Chemline Plastics  
Corix  
Delpro Automation  
Devine & Associates  
DeZURIK/APCO/Hilton  
Engineered Pump Systems  
Fabco Plastics  
Festo  
Flovac Equipment  
Hydro International  
Hydro-Logic Environmental  
Ipex  
Mueller Canada  
Orbinox  
Runnalls Industries  
Safe Drain  
Singer  
SPD Sales  
Syntec Process Equipment  
Triangle Fluid Controls  
Troy-Ontor

USABluebook  
Victaulic  
Watrerra Pumps  
Weir Canada  
Westech Industrial  
Wilo Canada  
Wolseley Canada  
World Water Operator Training Co.

#### Variable Speed Drives

ACG - Envirocan  
ASL Roteq  
Atlas Dewatering Corporation  
CB Automation  
Crane Pumps & Systems Canada  
Davis Controls  
Franklin Empire  
Grundfos Canada  
International Water Supply  
SEW-Eurodrive  
Sterling Power Systems  
USABluebook  
VL Motion Systems  
WesTech Engineering

#### Waste Disposal And Recycling

ACG - Envirocan  
Advantek Waste Mgmt. Services  
Anachem  
Aquablast Corp.  
Drain-All  
Enviro Hazmat Emerg. Response  
GeoEnvironment Technologies  
Goslyn Environmental  
KG Services  
Lystek International  
MetaFLO Technologies  
Sheridan Electric Services  
Terrapure Environmental

#### Waste Management

Advantek Waste Mgmt. Services  
Anachem  
Babcock & Wilcox MEGTEC  
DECAST  
Drain-All  
Enviro Hazmat Emerg. Response  
Focus Environmental Group  
Ford Hall Company  
GeoEnvironment Technologies  
Goslyn Environmental  
KSB Pumps  
Lystek International  
MetaFLO Technologies  
OZONATOR Industries  
Sheridan Electric Services  
Sierra Sales PETanks  
TankTek Environmental Services  
Terrapure Environmental  
Walker Environmental Group  
Wise Environmental Solutions  
World Water Operator Training Co.

#### Waste Removal Equipment

Aquablast Corp.  
DECAST  
GeoEnvironment Technologies  
Goslyn Environmental  
MetaFLO Technologies  
Sheridan Electric Services

#### Waste-to-Energy

Huber Technology

#### Wastewater Collection Systems

Atlas Dewatering Corporation  
Bio-Microbics  
DECAST  
DeWind One Pass Trenching  
Engineered Pump Systems  
Flowmetrix Technical Services  
GeoEnvironment Technologies  
Goslyn Environmental  
Grande Water Management  
Greatario  
KG Services  
KSB Pumps

LimeGREEN Equipment  
Mac & Co Environmental Solutions  
Make-Way Environmental Tech.  
Sco-Terra Operations Group  
SEI Industries  
SHAC Environmental Products  
Sheridan Electric Services  
Smith & Loveless  
Sulzer Pumps (Canada)  
World Water Operator Training Co.

#### Wastewater Neutralizing

Bioform Sewage Mining  
Golden Environmental Services  
JNE Environmental  
KSB Pumps  
Lystek International  
Vissers Sales Corp.  
WESCOR

#### Wastewater Treatment Systems

ACG - Envirocan  
Aclarus Ozone Water Systems  
Acme Engineering Products  
ADI Systems  
Aeration Industries International  
Alfa Laval  
Anguil Environmental Systems  
Aqua Technical Sales  
Aquanox Water Control Products  
Atlas Dewatering Corporation  
AWI (Anthrathex Western)  
AWT Technologies  
Babcock & Wilcox MEGTEC  
Bio-Microbics  
BIOREM Technologies  
Bishop Water Technologies  
Blue-White Industries  
Boerger  
BowRio Water Technologies  
BQE Water  
C&M Environmental Technologies  
Capital H2O Systems  
Chemline Plastics  
Chlorinators  
Claro Environmental Tech.  
Continental Carbon Group  
DWG Process Supply  
E.R.E.  
Echelon Environmental  
ECOfluid Systems  
ENW Treatment Systems  
Fluidyne Corporation  
Ford Hall Company  
GeoEnvironment Technologies  
Good Harbour Laboratories  
Goslyn Environmental  
Greatario  
Huber Technology  
Hydro International  
HydroFLOW Canada  
Industrial Waste Control  
JNE Environmental  
John Brooks Company  
Kemira  
KONTEK Ecology Systems  
KSB Pumps  
Kusters Water  
LimeGREEN Equipment  
Lystek International  
Mac & Co Environmental Solutions  
Make-Way Environmental Tech.  
Medora Corporation  
MetaFLO Technologies  
Napier-Reid  
NCS Fluid Handling Systems  
Nexom  
Ostara Nutrient Recovery Tech.  
Ovivo USA  
Parkson Corporation  
Premier Tech Aqua  
Prominent Fluid Controls  
Protectolite Composites  
Q-VAC Automatic Priming Systems  
Sco-Terra Operations Group  
Service Filtration Of Canada

Sheridan Electric Services  
Sierra Sales PETanks  
Smith & Loveless  
SUEZ  
Sulzer Pumps (Canada)  
Tank Connection  
Telder Engineering  
Trident Processes  
Trojan Technologies  
United Manufacturing Int. 2000  
UV Pure Technologies  
VFold  
VIQUA  
Vissers Sales Corp.  
Waste 'n WaterTech  
Waterloo Biofilter Systems  
Way Cool Product Co.  
WESCOR  
WesTech Engineering  
Wildcat Water Technologies  
Wilo Canada  
World Water Operator Training Co.

#### Water Conservation/Management

BQE Water  
Can-Am Instruments  
CB Shield  
Forterra Pipe  
Nuna Innovations  
SciCorp International Corp.  
SHAC Environmental Products  
Telder Engineering  
The Swamp School  
Watermark Solutions

#### Water Level Indicators

ABB  
ACI Instrumentation  
Can-Am Instruments  
CB Automation  
Chemline Plastics  
Davis Controls  
Endress+Hauser Canada  
Flowmetrix Technical Services  
Franklin Empire  
Geneq  
Greylines Instruments  
Heron Instruments  
Hoskin Scientific  
Osprey Scientific  
Solinst Canada  
SPD Sales  
USABluebook  
Watermark Solutions  
Watrerra Pumps

#### Water Meters

ABB  
ACI Instrumentation  
Atlas Dewatering Corporation  
Can-Am Instruments  
Delpro Automation  
Endress+Hauser Canada  
Flowmetrix Technical Services  
Heron Instruments  
Hoskin Scientific  
Master Meter Canada  
Neptune Technology Group  
Osprey Scientific  
Prominent Fluid Controls  
Real Tech  
Watermark Solutions  
Wolseley Canada  
World Water Operator Training Co.

#### Water Quality Monitors

ABB  
Can-Am Instruments  
Capital H2O Systems  
E.R.E.  
Enviro-Analytical  
Flowmetrix Technical Services  
Franklin Empire  
Hoskin Scientific  
IDEXX Water  
Industrial Waste Control

International Water Supply  
KISTERS North America  
MANTECH  
Mil-Ram Technology  
Mueller Canada  
Osprey Scientific  
Real Tech  
Solinst Canada  
SPD Sales  
USABluebook

#### Water Quality Test Kits

Canature WaterGroup  
Franklin Empire  
Geneq  
Hoskin Scientific  
IDEXX Water  
MANTECH  
Osprey Scientific  
USABluebook

#### Water Towers

Greatario  
KSB Pumps  
Tank Connection

#### Water Use & Treatment Optimization

Aclarus Ozone Water Systems  
Aquamart Technologies  
AWI (Anthrathex Western)  
Bio-Microbics  
BQE Water  
DECAST  
HydroFLOW Canada  
Industrial Waste Control  
Markland Specialty Engineering  
Medora Corporation  
Membrane Specialists  
MS Filter Systems  
NCS Fluid Handling Systems  
Ovivo USA  
SCG Industries  
SciCorp International Corp.  
SHAC Environmental Products  
StormTrap  
Trojan Technologies  
Wildcat Water Technologies  
Wilo Canada  
World Water Operator Training Co.

#### Waterproofing

Aquablast Corp.  
Belzona Great Lakes Holdings  
Denso North America  
KG Services  
Nuna Innovations

#### Weirs

Aquablast Corp.  
Aquanox Water Control Products  
C&M Environmental Technologies  
Can-Am Instruments  
Claro Environmental Tech.  
Filamat Composites  
Flowmetrix Technical Services  
Grande Water Management  
Monitario Technical Services  
Nuna Innovations  
Protectolite Composites  
Sigma Engineering  
Smith & Loveless  
Spill Management

#### Zebra Mussel Control

Aquafly Water Technologies  
CEMATRIX (Canada)  
Chlorinators  
Prominent Fluid Controls



# ACE<sup>18</sup>

ANNUAL CONFERENCE & EXPOSITION

American Water Works Association  
**California-Nevada Section**

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[www.AquaNereda.com](http://www.AquaNereda.com) | 815-654-2501

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## PRIMARY TREATMENT

- Complete line of fine screening equipment
- Self-cleaning perforated plate screens
- FlexRake® front-raked fine screens
- FlexRake® front-raked bar screens
- FlexRake® Low Flow
- Self-Cleaning trashracks
- Muffin Monster® grinder (for sludge, scum, septage, screenings & wastewater)
- Channel Monster® grinder for pump stations and sewage treatment plant headworks
- Honey Monster® septage receiving station
- Auger Monster® fine screen system
- Monster® fine screen & band screen perforated plate fine screens with 2, 3 & 6mm perforations
- Screenings washer/compactors
- Rotating drum screens (down to 2mm perfs)
- Raptor screenings washer press
- Grit removal
- Rotary drum screens

## SECONDARY TREATMENT

- AquaNereda® Activated Granular Sludge Technology
- Aqua-Jet® direct drive floating aerator
- Aqua DDM mechanical floating mixer
- Fine bubble aeration systems using membrane or ceramic diffusers with gas cleaning systems
- Stainless steel coarse bubble aeration systems
- Multi stage activated biological process (MSABP)
- Two & three rotary lobe P/D blowers
- Centrifugal multistage blowers
- Hybrid screw/lobe compressors
- Floating diversion curtains (for aerated lagoons, activated sludge systems & clear wells)
- Subsurface jet aeration/mixing systems
- Spiraflo & Spiravac peripheral feed clarifiers
- Closed loop reactor oxidation ditch systems
- Rotary brush aerators
- High efficiency single stage integrally geared blowers
- Direct drive turbo type blowers
- Aeration system controls & instrumentation
- Chain & flight clarifier systems & components (plastic, cast iron or stainless steel)
- Half bridge, centre feed, circular clarifiers
- Spiral blade clarifiers

## TERTIARY TREATMENT

- AquaDisk® - cloth media tertiary filter
- AquaDiamond® tertiary cloth media for traveling bridge filters
- Filter Underdrain Systems

## HIGH EFFICIENCY MIXING TECHNOLOGY

- High Performance Centrifugal Dispersing Impeller (HPCDI™) mixers

## ADJUSTABLE SPEED DRIVES

- Eddy current drives

## TANK COVERS & DOMES

- Aluminum geodesic domes
- Flat aluminum and FRP tank covers
- Aluminum channel and launder covers
- Aluminum hatch covers

## DISINFECTION

- UV disinfection systems
- Package & custom ozone systems

## BIOSOLIDS PROCESSING/HANDLING

- Sludge storage bins & live bottom dischargers
- Rotary Drum Thickeners
- Gravity Belt Thickeners
- Belt filter presses & screw presses
- Centrifuges for thickening & dewatering

## ODOUR CONTROL

- Biofilters
- Bioscrubbers
- Carbon adsorbers
- Chemical wet scrubbers
- Ionized air

## BULK MATERIAL HANDLING

- Shaftless & shafted screw conveyors
- Screw pumps (open & closed designs)
- Industrial grinders

## FLOWMETERS

- Open channel flow metering (portable & permanent); wireless data transmission
- Non-contact radar & submerged sensor area velocity flow metering (portable & permanent); wireless data transmission
- Insertion mag flow meters with wireless data transmission
- Data loggers with wireless data transmission

## INDUSTRIAL WASTEWATER TREATMENT

- PCI Series DAF with corrugated plates
- PWI Series DAF low profile, from 20-800 GPM
- Pipe flocculators
- Industrial wastewater treatment systems
- Coalescing oil/water separators
- Inclined plate clarifiers

## PACKAGE TREATMENT PLANTS

- Package potable water treatment plants
- Package sanitary wastewater treatment plants
- Package industrial wastewater treatment plants
- Package industrial process water treatment plants

## WATER TREATMENT

- Pressure filtration systems (removal of iron & manganese, arsenic, fluoride, radium, uranium)
- Filter Underdrain Systems



Ontario Pollution Control Equipment Association

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