INFLUENTS
OFFICIAL PUBLICATION OF THE
WATER ENVIRONMENT ASSOCIATION OF ONTARIO

FALL 2014 • VOLUME 9

SWEATING the ASSETS:
Capacity Assessments, Plant Audits, Optimization Studies

PLUS

IN THE SPOTLIGHT:
EUAN FERGUSON

OPERATOR PROFILE:
WADE HUNT

OPCEA PROFILE:
GRAHAM SIMPSON
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WHAT WE STRIVE FOR

By John Duong, M.Eng., P.Eng., Region of Halton, WEAO President

As you read this, your summer vacation may already be a distant memory. You may have enjoyed hot, sunny days on the dock and long nights by the campfire or traveled to some exotic destination, testing the durability and strength of your stomach. I look forward to all these wonderful experiences myself, whether in the near future or somewhere down the road. However, while I was writing this message (and perhaps doing a little sweating of my own assets), the board, committees and, especially staff, continued to do an incredible job serving the members of WEAO, even during the summer months.

Strategic Plan
In the few short months after our Annual Conference in April 2014, we began our journey of developing a strategic plan for WEAO, with a workshop that included the Executive Director, office staff, Board of Directors, Past Presidents (of WEAO and WEF) and, of course, a smattering of Young Professionals. The workshop was graciously facilitated by Vincent Nazareth of R.V. Anderson Associates Ltd., who was WEAO President not so long ago.

As many of you have experienced, or even developed strategic plans, you can fully appreciate the time and effort required. The purpose of the workshop was not only to update our previous strategic plan but also to reassess its relevance, and ask, “Does it make sense?” Developing a strategy that considers current and anticipated trends will help set goals and priorities to guide WEAO and the activities that you, our members, have identified as important.

At the workshop, several significant decisions were made, including finalization of a new vision statement, which, although typically short, may involve a long development process. It was also thought that it should align with WEF’s Vision Statement: “WEF – Essential to water professionals around the world.”

After a lengthy discussion WEAO’s new vision statement is the following: “Essential to Ontario professionals dedicated to a safe and sustainable water environment”.

This statement is short, but holds true to the purpose of our organization. To realize this vision, WEAO will be engaged in a number of key areas of interest and actions, as specified in its new mission statement:

Advance the water environment industry by:
- providing bold leadership;
- connecting water environment professionals;
- leveraging knowledge;
- encouraging innovation; and
- enhancing public understanding.

While we were overjoyed by our accomplishments so far, our long journey is not yet complete. Next, we must finalize the strategic planning document and follow up with a business or operational plan to deliver on the mission statement.

Member Survey
Our actions in the coming months will be aligned with our strategic plan and informed by feedback from our members’ survey. I would like to thank our staff for developing the questions as well as everyone who took a few minutes out of their busy schedule to complete this successful survey. We achieved a completion rate of 27% (I have been advised that a 20% response for such surveys is considered a success).

Unfortunately, however, information gleaned from the survey validates concerns of an aging workforce, lack of qualified professionals and overall epidemic of diminishing senior level professionals. More than 41% of respondents have more than 20 years of experience as water or wastewater environment professionals. A further 22% have 11 to 20 years of experience and 37% have 10 years or less. Of that 37%, more than 25% have less than five years of experience and are Young Professionals.

Not surprisingly, the top three reasons our members join WEAO or WEF are:
1. connection with others,
2. WEAO workshops/seminars; and
3. WEAO’s conference.
LinkedIn is by far the most popular social media outlet used by our members, but many respondents do not use social media at all:
- LinkedIn (60.4%)
- Facebook (43.5%)
- None (24.9%)
- Twitter (18.0%)
- Google Plus (10.7%)

Undoubtedly, Young Professionals continue to lead in use of social media, challenging boundaries from ‘nice-to-have’ into ‘must-have.’ On the subject of pushing boundaries, congratulations to the Young Professionals on their new partnership with Ministry of the Environment and Climate Change for the Student Design Competition, which will be exploring new resource recovery-related technologies at wastewater treatment plants for the next two years.

Sweat the Assets
Pushing the envelope is also integral to asset management principles, the focus of this edition of INFLUENTS. Capacity assessments and optimization further illustrates the growing trend in our industry toward making use of every last element, whether it be flow, volume or biological bacteria. All of this activity is meant to move towards performing at the most optimal and efficient level. After all, this is the goal of all systems and what we strive for.
As I sit down to write this article, it’s sunny outside and a beautiful 24 degrees. When things are running well, and when everyone just feels like being outside and enjoying the summer, it is tough to think about audits, assessments and optimization. But actually, that is exactly the time to be thinking about it. Trying to audit or optimize our facility in a time of stress, crisis, or upheaval is not.

At the WEAO office, summer is a quieter time for us. We have taken some time to look at the activities, programs and services of WEAO to see how we can optimize or improve them. Our goal is to serve our members better, and we are taking steps to deliver more value through our programs and activities. Change and improvement can be a difficult process at times, but the summer is a great time to take a look at our work and see what we can do to improve things such as staff resource management, budgeting, communications and, of course, evaluating our many programs offered throughout the year.

The exercise of review, be it an audit, an assessment or simply quiet consideration of how to do things better, is a very healthy one. One of my favorite examples of success in optimization comes from Japan and the Toyota Motor Corporation, where the practice of ‘Kaizen,’ (which literally means ‘good change’), engages employees to participate in a culture of continuous improvement in their work. Kaizen works. It encourages employees and stakeholders at all levels to think about the company as their home, and to speak up about small changes or ideas they have for doing their work more effectively or efficiently. When you have every employee engaged in the process of assessment and improvement, every aspect of the company goes under the microscope. The results can be amazing.

The process of assessment and improvement can often break down when it is only done from the top down. Managers and executives may not always have a clear picture of all the day-to-day aspects of the operations. Therefore, it is natural for them to focus on the things they know, like budgets, staffing, resources and equipment costs and maintenance. But reducing costs and stretching dollars is only a small part of the equation. For a truly effective audit or assessment, people at all levels need to be included in the process.

Many of you completed our recent Member Survey and, perhaps without knowing it, contributed to WEAO’s improvement. The survey provided us with some tremendous insight into the needs of our members and yielded some great ideas for ways in which we can improve our programs and services. These changes and improvements will not happen overnight, but many great ideas were raised and it is our hope that we will be able to continue effecting incremental change and improvements as we grow our Association and serve our industry better.

Surveys are only one means by which we hope to learn from you and
garner feedback. If you have a good idea, criticism or even just a comment about our work, please do not hesitate to share it with us via phone, email or our website. We have said it before: WEAO is your Association. You can play a role in making it better.

Assessments and audits are a necessary part of our work. They help us make our work easier, our workplaces happier, and improve products and services. The results can often help to inform decision-making and enable us to speak with authority when the need arises. I am sure that the pages that follow will offer a multitude of ideas for improving your workplaces, removing obstacles and managing change.

Have a great idea for WEAO? Drop me a line at lyle.shipley@weao.org.

We have said it before: WEAO is your Association. You can play a role in making it better.

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Associated Engineering announces
Strengthened Water Leadership Team

In support of Associated Engineering’s “One Water” focus and aligning with our client needs in the areas of water supply, treatment, operations support, wastewater management and water resource recovery, we have strengthened our water practice leadership team. Kerry Rudd, P.Eng., President & CEO of the Associated Engineering group of companies, is pleased to announce the following staff appointments:

Ian Wright, P.Eng. - Senior Water Specialist. Ian has served the company and our clients for many years as Vice President, Water. To promote succession, Ian has taken on the new role of Senior Water Specialist. In this role, Ian continues to assist staff and clients in our Water Practice. He will also provide support to the President & CEO on strategic corporate initiatives. Ian is a Senior Process Engineer with 37 years of experience on water and wastewater planning and engineering projects across North America.

Doug Olson, P.Eng. - Senior Vice President, Water. Doug leads marketing, technical and strategic development of our Water Practice. He supports and provides guidance to our staff and clients on water and wastewater projects. Doug is a Senior Process Engineer with 25 years of experience specializing in planning, project management, design and construction of water conveyance and treatment facilities. Doug specializes in multi-barrier treatment approaches to improve water quality and reduce operational risks.

Garry Drachenberg, P.Eng. - Vice President, Water Solutions. Garry provides support and guidance to staff and clients to develop leading edge, sustainable treatment solutions for water and wastewater projects. Garry is a Senior Process Engineer with over 30 years of experience specializing in the design and optimization of water and wastewater facilities. Garry excels at process optimization and trouble-shooting to help clients make the most of their infrastructure assets.

Dean Shiskowski, Ph.D., P.Eng. - Vice President, Water Resource Recovery. Dean provides technical advice and guidance on water planning, wastewater management, and water resource recovery strategies. Dean is a Senior Environmental and Process Engineer with 20 years of experience specializing in water resource recovery planning and technology. Dean brings global industry perspective on nutrient removal and recovery, with a specific focus on biological nitrogen technologies.

Associated Engineering provides consulting services in planning, engineering, environmental science, landscape architecture, project management, and asset management. We specialize in the infrastructure, water, transportation, environmental, energy, and buildings sectors.

Our goal is to build better communities by delivering sustainable solutions. We are a carbon neutral company - this is part of our commitment to reducing our carbon footprint and improving our global environment. For more information, see our website at www.ae.ca.
Euan Ferguson likens his work to the art of plate spinning, whereby several plates are successively launched into action. Just as the last one is set in motion, it is time to revisit the first.

“I joined York Region early in 2003 and, with my knowledge of wastewater treatment, subsequently inherited ongoing optimization projects at the Duffin Creek WPCP,” says Ferguson, the Region’s Manager of Engineering. “It soon became apparent to me that with flows of sewage steadily increasing due to population growth, any expansion would need to be operational before mid-2011.”

York Region updates its official Master Plan every five years. Prior to Ferguson’s arrival, the Region had launched a two-stage optimization and expansion program that would see Duffin Creek improve its effluent quality to meet – in fact, exceed – anticipated changes in guidelines from the Ministry of the Environment (MOE), while addressing growth in the Durham and York regions served by the WPCP.

“Both Durham and York Regions take their commitment to the environment very seriously,” notes Ferguson. Stages 1 and 2 of the optimization/expansion project included a new liquids’ secondary treatment process to achieve nitrogen/ammonia removal in the secondary system to a level of 5 mg/l in the effluent. The process would result in some biological phosphorus removal as well.

During the design phase, it became apparent that, in order for the facility to meet the stricter effluent criteria – including a nine-day solids retention time – the existing liquids treatment process would need to be de-rated from 420 MLD to 320 MLD, thus reducing the overall capacity of the plant. At the same time, growth predictions for York Region indicated demand would exceed current capacity within 10 years. As a result, overall capacity would have to increase from the originally-intended 210 MLD to 310 MLD, requiring a 50% increase in the physical size of the plant and the scope of the project.

When Ferguson joined the region as Senior Project Manager he assumed responsibility for the delivery of the capital works program at the Duffin Creek WPCP on behalf of York. This included all the ongoing facets of the liquids process project: a new influent pumping station, preliminary treatment, secondary treatment, disinfection, a new electrical substation, and enhanced phosphorus removal works. As well, the expansion and improvements at the plant included a solids process project: a new boiler building; digester modifications; a new incinerator and dewatering building; and a temporary dewatering installation project.

At the same time, preparations had to be made to file an Environmental Assessment for the Stage 3 Process Expansion Project. To keep the project on track and on time, York simultaneously spearheaded the preparation of the design assessment for Stage 3. The project managers also decided to issue separate contracts for the excavation and to pre-purchase the mechanical components, which they knew would require a long lead-time to manufacture.

“Brad Dobson, my Durham Region counterpart, and I realized the Stage 3 Expansion was going to be a complex and extremely challenging project,” recalls Ferguson, “not only due to the size, but also because of the need to maintain the current uninterrupted operation of the plant.”

At the same time, the projects managers continued to deal with ongoing maintenance and equipment upgrade issues. As anticipated, the construction and commissioning of these works was accompanied by significant upgrading associated with Stages 1 and 2 of the project. For instance, existing grit removal detritors and screenings equipment were dated and obsolete.

In all, over the past decade, Ferguson has been involved in managing the design and construction of 56 capital works contracts at Duffin Creek WPCP, with a total value of more than $885 million. “This work has not only brought challenges but also tremendous personal rewards,” he says. “To stand back and say I did that will be an honour I’ll carry for the rest of my life.”

Ferguson’s career has come a long way from his time as a draftsman with Scotland’s Edinburg City Engineers, just as the Main Drainage and Sewage Department abandoned its practice of dumping raw sewage into the North Sea in favour of collection and treatment. Equipped with a degree in Mechanical Engineering, he was one of 4,000 engineers who were put out of work by the collapse of Rolls Royce in the United Kingdom.

In 1975, he immigrated to Canada and joined Gore and Storrie Ltd. (now CH2M HILL). During his six years as a consultant with Toronto’s Ashbridges Bay wastewater treatment plant, Ferguson learned the inner workings of wastewater treatment processes by building and commissioning several large projects. “In particular, my interest was drawn to the mechanical equipment and its role in these processes,” he recalls.

Then in the late 1980s, Ferguson became the project manager responsible for designing a new wastewater treatment facility for the Town of Gravenhurst. It was a unique opportunity, encompassing the design of everything from a pumping station, forcemain, and gravity sewer to a treatment plant and a new outfall. “The biggest challenge of that project was where to place the first line on a blank piece of paper!” laughs Ferguson.

In contrast, the plates at Duffin Creek had already started spinning, with many more waiting to be hoisted and spun. Flow projections indicated...
the plant’s rated capacity of 420 MLD would be exceeded in 2011. To avoid any development freeze or non-compliance charges, the expansion deadline was set for December 2010. It was poised to be a challenging juggling act.

Since York was the main driver for the expansion works, the Region assumed responsibility for issuing all the proposals and tenders as well as administering all the agreements and contracts. Initially, Ferguson was solely responsible for these functions, but as the project progressed, the team grew to a total of four.

Another challenge for the team involved addressing the relocation of a wetland. “Where we wished to place the preliminary treatment facility encroached on the Duffins Marsh floodplain and wetland area,” explains Ferguson. In cooperation with the Toronto Region Conservation Authority, the team created a greening/biodiversity plan, with rolling berms and a wetland. Trees and boulders removed during excavation were used to create stump thickets, raptor poles and basking mounds. Since its completion, the project has been certified by the Wildlife Habitat Council, in recognition of its “outstanding environmental stewardship and community leadership.”

But by far the project’s greatest challenge was meeting the December 2010 deadline for increasing the capacity of the Duffin Creek WPCP. The project team was able not only to meet this deadline but to incorporate several other enhancements to the projects as well. For instance, the dewatering building has been awarded a LEED Gold Certification for excellence in environmental building design – the first wastewater process building in Canada to achieve this designation.

At the same time, the project included an energy recovery system whereby the biosolids disposal facilities will provide approximately 2.6 MW of power to the plant. The energy savings will translate into lower operational costs for the Regions’ taxpayers.

Most of all, the expansion projects have delivered what they promised: a safe and secure wastewater treatment facility for the current and future residents of York and Durham Regions. “The clean, treated effluent is one of the best, if not the best, discharging to the open waters of Lake Ontario,” notes Ferguson.

“The Regions are proud of this. The WPCP provides sufficient capacity to accommodate provincially-mandated growth, currently predicted to 2031.”

Ironically, the increased capacity for influent and outflow of effluent has created its own challenges. To address the discrepancy between an increase in the Duffin Creek WPCP outfall and the limitations/mixing guidelines set by the MOE, York Region recently filed an environmental assessment study report. “Through the EA process, we have determined that adding variable orifice diffuser ports to the existing outfall is the most environmentally, socially and fiscally responsible means of bringing our capacity from the current 520 MLD allowed by the MOE up to our rated capacity of 630 MLD,” explains Ferguson.

He adds that there are bound to be more refurbishment projects on the horizon. After all, optimization and expansion is a continuous process, with ongoing opportunities for enhancements and for engineers to learn and develop new and increasingly sophisticated approaches to the challenges they encounter along the way.

Ferguson hopes to have the opportunity to pass on the knowledge and experience he has gained during more than 40 years in the wastewater industry. For now, his immediate plans revolve around seeing the Duffin Creek’s current construction project through to completion. “Afterward,” he says, “I look forward to contributing back somehow to the industry that has provided my livelihood.”

His career has also afforded ample opportunities to visit and be involved in projects across the world and throughout North America. “The people I have met in the wastewater treatment industry are vastly individual,” adds Ferguson, “but each is tremendously dedicated to ensuring we continue to do better and better at protecting the environment for years to come. It is a privilege to know you have the capability to do the right thing for the public good.”
EAO currently offers two scholarships on a yearly basis to help support students interested in pursuing careers in the water environment field. The WEAO Scholarship is for post-secondary students currently enrolled in an Ontario University or College. The Kelman Scholarship is for students in their final year of high school who plan to attend a post-secondary institution the following year. Both scholarships aim to provide financial assistance to outstanding students interested in the preservation and enhancement of Ontario’s water environment.

2014 Kelman Scholarship Recipient

The Kelman Scholarship was established in 2012 to support an outstanding student in his or her final year of high school. To be eligible for the scholarship, the student needs to demonstrate an interest in the protection of water quality and plan on attending a post-secondary institution in a related field of study the following year. Requirements for consideration include a short essay and a teacher reference form.

Allison Kennington, a student from Burlington, Ontario is the recipient of this year’s Kelman Scholarship for 2014. Her strong interest in geology and water issues was particularly apparent in the eloquent essay she submitted. On the academic front she is also very interested in history and math and she has been volunteering with FIRST Robotics for the past three years. She also volunteers with elementary VEX Robotics. Allison will be pursuing a post-secondary degree in Geological Engineering at the University of Waterloo.

The scholarship is in the amount of $500, provided by Craig Kelman and Associates Ltd. of Winnipeg, Manitoba, the publisher of WEAO’s INFLUENTS magazine. In addition to the scholarship, Allison will receive a one-year free student membership for the Water Environment Federation (WEF) and Water Environment Association of Ontario (WEAO).

Applications for the 2015 Kelman Scholarship will be available at www.weao.org/scholarships in February 2015.

Thank you

The WEAO Young Professionals committee would like to thank Julie Vincent and Anne Baliva of WEAO for all of their assistance with administering the WEAO Scholarship program as well as Neil Awde, Michael Newbigging and Erin Longworth from the Board of Directors for their support.

About the Author:

Heather Murdock is an Engineer-in-Training with Hatch Mott MacDonald and holds a Bachelor’s degree in Civil Engineering from Queen’s University. Since joining Hatch Mott MacDonald she has had the opportunity to work on numerous wastewater, storm water management, and environmental assessment projects. She is also a long-time volunteer with Engineers Without Borders and is passionate about water management issues in Canada and Internationally. She is also the 2014 recipient of the Professional Engineers Ontario Sterling Award. You can reach her at heather.murdock@hatchmott.com.
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by the WEAO Student Design Competition Subcommittee

The Water Environment Association of Ontario (WEAO) and the Ontario Ministry of the Environment and Climate Change (MOECC) are pleased to announce a two-year partnership for the WEAO Student Design Competition (SDC). The groups have joined forces because of a mutual interest in sustainable infrastructure - creating two SDCs on the topic of resource recovery at wastewater plants. The 2015 and 2016 SDCs will be hosted at Ashbridges Bay and Duffin Creek wastewater treatment plants, respectively.

The Global Paradigm Shift: Around the world, wastewater is increasingly viewed as a resource rather than waste. Value can be extracted from wastewater in the form of resources including reclaimed water, energy, nutrients, and metals. Ontario has the opportunity to be on the leading edge of the paradigm shift by seeking innovative ways of managing and extracting resources from wastewater. Key to this shift will be engaging and preparing the next generation of water professionals, increasing awareness of emerging environmental challenges, changing the perception of wastewater and beginning to think about innovative water solutions.

How the Competition Works: The SDC is organized to allow students to take on a real world water environment problem provided by a sponsoring municipality. In doing so, students will learn about emerging technologies, perform practical research, and experience some of the challenges faced by water environment professionals. The winners of the competition represent Ontario on the world stage with their innovative design at the Water Environment Federation’s Technical Exhibition and Conference (WEFTEC).

SDC 2015: Focusing on the shift from ‘wastewater treatment plant’ to ‘resource recovery facility,’ WEAO and the Ministry sought out a host facility whose challenge could be resolved through a resource recovery solution. We are delighted that the Ashbridges Bay Treatment Plant in the City of Toronto, Ontario has generously agreed to serve as this year’s host facility and project sponsor. Students will be asked to solve a process problem at the facility through innovative design that takes into consideration resource recovery in an economically sensible manner. The winning team will take their design to Chicago for WEFTEC 2015, and show the world Ontario’s commitment to water innovation and resource recovery.

Get involved: The project statement will be released in early September 2014 and project submissions will be due in late March 2015. The competition will be open to all full time post-secondary students in Ontario – both college and university students are encouraged to form teams. The project will be designed so that it makes a suitable and challenging final year project. Interested professors are encouraged to contact the organizers to see how we can help you integrate the project into your capstone course.

Witness the potential future of Ashbridges Bay Treatment Plant when the students present their design solutions at the WEAO conference in April 2015. For 2016, the competition will move to the Duffin Creek Water Pollution Control Plant in the Region of Durham.

For More Information: See www.weao.org/student-design-competition for competition updates. Email Natasha.niznik@gmail.com or tchai@dillon.ca with questions or to be put on WEAO’s mailing list.
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[www.ca.endress.com/CYZ71D](http://www.ca.endress.com/CYZ71D)
n WEAO INFLUENTS’ Fall 2009 issue, I published a 1,000-word article titled What I Did Last Summer: My Conference-Filled Experience (weao.org/past-issues). As a fresh, unemployed graduate of McMaster University, I chronicled my 2009 summer of water industry conferences that I had attended to jump-start my career. In this Fall 2014 issue, I offer an update to that article.

Hidden behind my previous article were the real struggles of: (a) how an introverted 23-year-old survived eight conferences (attended by 200 to 18,000 strangers each) in five months, (b) a long and frustrating road to securing a job in a recession year, and (c) the fear and excitement of any post-job offer situation.

Through the summer, I did prevail: I secured multiple interviews, and steadily converted my new relationships into a job offer by November 2009.

My fairytale story of how I exchanged my Apple iPod Touch© for a career was only made possible through the solid principle of networking for a job. Six months after I graduated, I started a satisfying three and a half year stint as a Water / Wastewater Engineer-in-Training with AECOM’s Kitchener, Ontario office. By June 2013, I accepted an offer with GHD as an Infrastructure Asset Management Consultant in Mississauga, Ontario.

Through my five years working in the consulting sector and working directly with municipalities, regulators, and equipment suppliers, I have learned five key lessons that I respectfully share:

**Lesson 1: Plant your feet, and be OK with being uncomfortable.**

After graduating from McMaster - a culmination of 18+ years of schooling, summer jobs, and a consistent social network – I was finally ‘free,’ which actually meant that I suddenly had an unstructured lifestyle of job hunting, career uncertainty, and rarely seeing the friends whom I had seen 12+ hours a day. My summer of conferences involved crowded hostel stays, awkward meals alone or with strangers, and daunting freedom to explore some of USA’s and Canada’s largest cities. ‘Uncomfortable’ was an understatement.

But over the last five years, I learned to embrace every ‘uncomfortable situation’ as a growth opportunity. I learned how to complement my nature as an introvert by learning extrovert skills. With every awkward approach, bumbling small talk, and heart-thumping follow-up call, I gained confidence. I accepted that I will always be a work in progress.

My advice: do not run away from awkwardness. Plant your feet, and be OK with it. It will pass, and you will troubleshoot through it with the right attitude.

**Lesson 2: A-Diamond Networking is Forever.**

After that summer of energy-sapping conferences, and finally securing that job offer for which I had strived so hard, I thought that it was now time to set down, observe, and work hard at my new work situation. To burst my bubble, the most insightful advice that I received from one of my mentors, Jeremy Kraemer (former WEAO YP Committee Chair) was: “Getting good work within your firm is a lot like finding a job. It’s all about the networking.”

I admit that I did not quite understand this motto at first. I thought that once you are in, you will naturally be fed with good work. Networking during my job hunt was mostly a ‘give me a job’ exercise. As soon as I started working, it became a ‘how can I help you?’ mission. Willingness and enthusiasm to help colleagues solve problems and complete tasks became a currency.

Over the last five years, I learned that networking should always be about what YOU can offer to people in terms of your time and, and not vice versa. Valuing people, and helping them get what they want, is the fastest way to triggering a repetitive loop of positive feelings and energy.

Instead of networking at times when one really needs something, we should nurture and cultivate relationships before we can expect to reap any benefits. Networking (i.e., beneficial relationships), not diamonds, are forever.

**Lesson 3: Get involved.**

If you are a student, recent graduate or unemployed Young Professional, getting involved is a ‘no-brainer’. Per my point on networking above, you cannot expect to immediately reap the benefits and score interviews and jobs. The best time to get involved was yesterday, and the next best time is today. For me, the stepping stone was WEAO’s Student Chapter Program, and I eventually moved up to the WEAO YP Committee. The rest is history.

If you are an employed Young Professional, you should get involved as above, but it is highly recommended to consider getting actively involved with, or even initiating, your local office activities. These range from park cleanups and bowling nights, to Tough Mudder and CANstruction events.

Over the last five years, I learned that no matter how introverted one is, no professional should ever be an island. No matter how much you may want to avoid any inter-office politics (thanks to human nature), organizational re-structuring, and personnel changes, it WILL affect you in your isolated bubble.

Apart from the fun and camaraderie benefits, getting involved internally, and externally, will give you the advantage of being fully informed of industry trends, who the players are, people’s values, and who respects whom. YOU do not need to play dirty politics to get ahead, but...
Every lesson weaves into the other; much like how our water weaves seamlessly into the fabric of our society.

awareness is key. Awareness allows one to identify mentors, the energy givers, and the energy takers. It allows one to make smarter career decisions.

Lesson 4: Whatever your title is, you are in sales.
Your title will range from unemployed to Project Assistant, from Engineer-in-Training to Project Manager, from Designer to Regional Sales Manager. Whatever role you have, remember that there is a salesperson in all of us. When job hunting, you have to sell yourself – your capabilities, your attitude, and your energy. When at work, you have to sell ideas, products, influence … and yourself (again).

Ever since I was a kid playing Lego®, I’d always wanted to be an Engineer. The thought of approaching people to sell them things was scary. Sales – in its most traditional sense – was never in my DNA.

Over the last five years, I learned that much like networking is forever, that so is the act of being a salesperson. I learned that identifying and maintaining your preferred ‘personal brand’ takes a lot of consistency, determination, and patience with oneself. What impact will you make in the first five minutes of people meeting you? Why should they believe you, and remember you?

If you need further convincing, watch Simon Sinek’s TED Talk titled, “How Great Leaders Inspire Action”. In the pursuit of becoming a successful professional, our ability to communicate effectively is paramount.

Lesson 5: The Water Environment industry is small, tight-knit, and down-to-earth.
My summer of conferences taught me that the water environment industry is a small community. Prior to securing my position at AECOM’s Kitchener office, I had met seven of the key staff, weeks or months earlier. My current opportunity with GHD was only made available because my CV was passed along by another of my mentors, Bill White (past WEAO Student Chapter Program Manager).

Over the past five years, I learned that Ontario’s water environment industry is full of passionate and down-to-earth individuals. They believe in the significant role that the industry plays in maintaining the health of our modern society, and the protection of our natural environment – without taking themselves too seriously.

Those of us who have worked on wastewater projects will undoubtedly have heard, and made, countless jokes and puns regarding a four-letter word beginning with the letter ‘s.’ Jokes aside, these professionals (whom WEAO represents in the Province of Ontario) are inspiring yet unappreciated. I am proud to be joining their ranks.

Conclusion:
Each of the five lessons that I learned above is not independent of the others. Every lesson weaves into the other, much like how our water weaves seamlessly into the fabric of our society. To be better networkers, we need to be better sales people. To be better with dealing with people, we need to get socially involved, and embrace awkward situations that eventually lead to great professional (and personal) relationships. These relationships are what make the water environment industry tight-knit.

Alvin Pilobello is an Asset Management Consultant with GHD’s Mississauga, Ontario office. He is Past-Chair of the WEAO Young Professionals (YP) Committee, and currently involved with WEF as a Delegate-at-Large, and Vice-Chair of the YP Summit Organizing Committee. Alvin credits his extrovert skills to two things: WEAO, and salsa dancing.

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Ms. Hayley Todesco, a senior at Queen Elizabeth Junior Senior High School in Calgary, Alberta won the 2014 Canadian Stockholm Junior Water Prize. She will be travelling to Sweden to present her project ‘Waste to Water: Biodegrading Naphthenic Acids with Novel Sand Filter Bioreactors’ at the international Stockholm Junior Water Prize competition in Stockholm.

Hayley carried out studies to design, construct, and investigate the use of slow sand filters newly applied as novel aerobic bioreactors to the microbial degradation of naphthenic acids. This treatment process could help deal with contaminated water in oil sands tailing ponds at a faster rate than typical processes and recover water for reuse. Hayley is an enthusiastic scientist in training and very proud to be representing Canada at this international competition.

The Canadian winner was selected from projects at the 2014 Canada Wide Science Fair held in Windsor, Ontario in May 2014. Three finalists were selected to prepare detailed scientific papers to determine the 2014 winner. The other two Canadian finalists, who each received a prize of $300 CAD, were Stéphane Chenard, of Glenmary School in Peace River, Alberta, for his project, ‘Fertilizer Fiasco: Is Denitrification the Answer?’ and Theresa DeCola, Bayside Secondary School in Belleville, Ontario, for her project, ‘Implications of Dreissena Mussel Death and Degradation on Water Quality’. Each student project presented sound scientific study to address an issue to help our water environment.

Every year the Canadian Member Associations of the Water Environment Federation select a high caliber scientific student project to travel all expenses paid to Stockholm, Sweden to represent Canada at the prestigious international competition.

**About the SJWP**
The Stockholm Junior Water Prize (SJWP) final will be held during the 2014 World Water Week from August 31 - September 5, organized and hosted by the Stockholm International Water Institute.

This competition is open to young people between 15-20 years of age, who have conducted water-related projects focusing on local, regional, national or global topics of environmental, scientific, social or technological importance. As a result of national competitions in 30 countries, thousands of young people around the world develop personal interests, undertake academic study, and often pursue careers in the water or environmental fields. The winner of the international Prize receives an award of $15,000 USD, and a custom-made blue crystal sculpture crafted by Swedish glass artisans. An award of $5,000 USD will be given to the winner’s school.

**Canadian Organizers and Sponsors:**

For more information please visit the Canadian Stockholm Junior Water Prize website at [www.sjwp.ca](http://www.sjwp.ca).
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In the 1980s and 1990s, designers, owners and operators of sewage works recognized that there were opportunities to optimize in order to reduce the capital cost of expansions, improve the effluent quality, and reduce the cost of energy, chemicals, sludge disposal and other operational requirements. Over the past 25 years, the concept of sewage works optimization has evolved from a single study, undertaken prior to an expansion of the works, to a process of continuous improvement or an operational philosophy that is championed by the operating authority at all levels.

Optimization of sewage works is an iterative process that includes four major steps as illustrated in Figure 1.

Often, optimization of a sewage works to achieve one goal can result in improvements in other areas. For example, optimization with the purpose to achieve lower chemical use and lower chemical cost for phosphorus removal will also result in lower sludge production and lower sludge management costs. Similarly, improving the reliability and flexibility of the works can also result in improvements in effluent quality and reduced odour emissions.

In the United States, optimization of sewage treatment plants (STPs) became a priority when the US Environmental Protection Agency (EPA) recognized that many new or expanded facilities that had been constructed in the 1970s, with federal funding assistance, were not performing as intended (EPA, 1979; EPA, 1980). To address this issue, the US supported the development of the Composite Correction Program (CCP) as a means of evaluating STPs to determine the underlying cause(s) of poor performance (EPA, 1984; EPA, 1985). In several US jurisdictions, an STP owner was required to undertake a CCP if the STP was not in compliance with regulatory requirements.

In Canada, at about the same time, Environment Canada's Wastewater Technology Centre (WTC) developed the Process Audit as a comprehensive performance evaluation and energy conservation tool (Speirs and Stephenson, 1985). This optimization approach was not specifically driven by poor performance; rather, it was seen as an effective means of evaluating the capacity of an existing sewage works. As a result, some government capital works assistance programs gave consideration for funding to works that had been subject to an optimization program such as a Process Audit.

Over time, optimization of sewage works (and other municipal infrastructure) has become more common and, in some instances, has been adopted by municipalities with multiple facilities (both water and sewage treatment plants), as a routine part of their operation (Wilson, 2009; Wheeler, 2009). Optimization as a tool to achieve continuous improvement is now widely accepted; however, the following activities may warrant a more detailed optimization study of a specific works or process:

- recurring non-compliance or poor performance, particularly as mandated by a Provincial Officer's Order(s);
- a need to increase rated capacity due to growth in the service area;
- a requirement or desire to achieve a higher level of treatment in terms of effluent quality; or
- a need to reduce operating cost due to escalating cost for energy, chemicals or other operational requirements.

Optimization of sewage works in Ontario, across Canada and internationally has been shown to deliver benefits to the owner/operator, ranging from capital cost savings during plant expansions, to improvements in performance and reliability, and operating cost reductions.

It is important to recognize that, when a sewage works is optimized to increase capacity or meet more stringent effluent limits than the works were originally designed to perform, the capacity assessments, plant audits, and optimization studies (SWEATING the ASSETS) need to be repeated and updated.
achieve, the safety margin that was included in the original design will be reduced. Increased attention to the operating conditions may be required to ensure that the optimized works continue to consistently meet the new requirements.

Design guidelines for sewage works are, by necessity, conservative as they are intended to ensure that the works are capable of achieving an appropriate level of performance on a consistent basis by providing a margin of safety in the design, particularly when adequate historic data are lacking. Some of the tools used for plant optimization, such as stress tests, can be effectively used to document that a unit process can achieve the required performance level at hydraulic or organic loading higher than typically stated in design guidelines. If such is the case, significant capital cost savings can be realized when the facility is expanded or an expansion could be deferred. In some cases, the facility could be re-rated to a higher capacity with no or minimal construction of new works.

Optimization approaches have been used to demonstrate that new or more stringent effluent quality limits for parameters such as total phosphorus (TP) and total ammonia-nitrogen (TAN) can be achieved at some facilities without costly capital works. This is particularly relevant now, as concerns regarding nutrients discharged to the receiving water environment have become more significant.

Improvements in performance through operational improvements or improved process control can often bring a sewage works into compliance with its regulatory requirements or improve the reliability of the works. The EPA’s CCP was developed specifically to address plants that were unable to achieve their regulatory requirements (EPA, 1984) and this same approach has been widely used in Ontario (Wheeler et al., 1994). There are many successful examples of using this approach that demonstrated that STPs have been appropriately designed to produce an acceptable effluent quality.

A number of tools can be used to assist with the plant optimization process. A review of historical data and the development of a performance potential chart can establish current conditions at typical or guideline limits. Process testing can provide actual capacities to further refine the plant potential or capacity. Process testing can include numerous existing and new test methodologies such as stress testing, dye testing, oxygenation capacity testing, and jar testing to name a few. Photos 1 and 2 show some of these procedures. Modelling can also be a useful tool.

Optimization can identify opportunities to reduce chemical cost and/or improve energy use efficiency. Energy use reduction in STPs can help to mitigate the factors leading to climate change.
The benefits of plant optimization are demonstrated in the following case studies:

- Newcastle WPCP – Re-Rating
- Innisfil Lakeshore WPCP – Re-Rating
- Windsor Little River PCP – Maintaining Capacity with Effluent Limit Changes
- St. Thomas WPCP – Energy Savings

Newcastle WPCP Re-Rating Study

A Re-rating Feasibility Study was initiated by the Region of Durham to explore the feasibility of re-rating the existing Newcastle Water Pollution Control Plant (WPCP), from its current equivalent average daily flow (ADF) of 4,086 m$^3$/d to a higher flow in order to provide additional near term capacity for growth and to defer the capital costs associated with expansion (Fernandes et al., 2014).

The Study was conducted in two parts. In Part 1, a desktop analysis of the Newcastle WPCP was conducted to estimate the capacity of individual unit processes at the facility. In Part 2, extensive bench and field tests were undertaken to better define the process capacity of various unit processes that had been estimated during Part 1 of the study. Field testing included alum jar testing to determine optimum dosages. The recommended dosages were then implemented at full-scale prior to secondary clarifier stress testing and dye testing. Secondary clarifier stress testing confirmed that additional capacity is available within the existing infrastructure and dye testing showed no evidence of non-ideal flow or solids distribution. Chlorine jar testing proved that adequate disinfection could be achieved at chlorine contact times less than the minimum recommended time through super-chlorination.

Figure 2 presents a summary of the capacities of key unit processes at the Newcastle WPCP on an ADF basis, as recommended in the CCP. The capacities summarize the findings of the desktop capacity assessment and field test results.

Based on Figure 2, the unit processes that have equivalent ADF capacities less than the proposed re-rated capacity of 7,200 m$^3$/d are raw sewage pumping, screening, and oxygenation (blowers and diffusers). To support a re-rating of the Newcastle WPCP, the following key capital upgrades were recommended:

- replacement and upgrade of raw sewage pumps equipped with variable frequency drives and increased discharge piping for each pump;
- installation of a second screen in the unused available channel;
- replacement and upgrade of blowers and installation of additional diffusers, doubling the number of existing diffusers in each bioreactor’s swing and aerobic zones; and
- secondary clarifier weir modifications to address hydraulic limitations.

In addition to upgrades of processes that limit the potential re-rated capacity of the WWTp, other optimization opportunities were identified, namely disinfection system upgrades and a new alkalinity addition system. Operational modifications were also recommended to optimize the performance of the existing infrastructure.

The study concluded that through the implementation of the recommended capital upgrades and operational modifications, the Newcastle WPCP could be re-rated at a cost of $2,275 per cubic meter per day of extra capacity, compared to the typical cost of $10,000 per cubic meter per day of extra capacity.

Lakeshore WPCP Re-Rating

The Town of Innisfil’s Lakeshore WPCP has a current rated capacity of 14,370 m$^3$/d and discharges to Lake Simcoe. To accommodate growth, a Class Environmental Assessment (Class EA) for the Lakeshore WPCP was performed. The Class EA recommended a phased increase in capacity to 25,000 m$^3$/d in the first phase of expansion and ultimately to 40,000 m$^3$/d.

The Town’s primary objective in undertaking the Optimization Study (XCG, 2012) was to develop an approach to increasing the capacity of the Lakeshore WPCP to an interim value between the existing capacity and the Class EA proposed first stage capacity of 25,000 m$^3$/d, through optimization of the existing unit processes. Through this approach, the first stage of expansion could be deferred and potentially achieved in smaller, less capital intensive increments.

A capacity assessment of the existing unit processes was performed using traditional desktop analytical methods and biological process modelling software. Figure 3 presents the equivalent ADF capacity of the unit processes at the Lakeshore WPCP.
Based on the desktop capacity assessment, the Lakeshore WPCP has an ADF capacity of about 10,133 m$^3$/d, limited based on the oxygenation capacity. However, the oxygenation system can be readily upgraded to address capacity limitations. Based on the capacities of the bioreactors, RAS pumping and secondary clarifiers, the secondary treatment train has capacity in excess of 20,000 m$^3$/d. The additional secondary treatment capacity identified will defer the upgrades to the biological treatment unit processes and will reduce secondary treatment upgrade costs by up to $4.7M as estimated in the Environmental Study Report. Stress testing of the tertiary filters and disinfection system will be undertaken to confirm the capacities of these unit processes. Based on the results of the field testing, the potential re-rated capacity of the Lakeshore WPCP liquid treatment train will be confirmed.

Little River Pollution Control Plant (PCP) – Maintaining Capacity with More Stringent Effluent Requirements

The Little River PCP is a conventional activated sludge facility, with capacity evenly split between two activated sludge plants. The PCP’s rated capacity is 72,000 m$^3$/d. However, Plant No. 1 (older plant) was designed for carbonaceous BOD removal only and an updated CofA required the entire facility to nitrify. Based on the requirement to nitrify in the existing plant, the plant was expected to be down-rated to half its original rated capacity of 36,000 m$^3$/d. A year of stress testing was undertaken to demonstrate that the existing plant could meet the new effluent limits, including nitrification, at the PCP’s current rated capacity, without down-rating. The yearlong stress testing addressed spring runoff and cold winter wastewater temperatures. Enhanced operational control, including a comprehensive sludge retention time (SRT) control strategy, which incorporated an online tool to assist operators with wasting control decisions, ensured optimal plant performance. Results indicated that a minimum SRT of 10 days was required during the cold temperature period to ensure complete nitrification (Newbigging et al., 1999).

The aeration system was key to maintaining the capacity of Plant No. 1 with sufficient oxygen to meet the effluent limits and maintain the elevated MLSS concentration. Plant No. 1 was retrofitted with fine bubble ceramic diffusers, which replaced the mechanical aerators. A similar aeration system is provided in Plant No. 2. Maintaining capacity and reducing aeration energy led to a review of the diffuser cleaning frequency.

A dynamic model was used to evaluate the impact of various parameters on the optimal cleaning frequency of the fine pore diffuser aeration system. Onsite oxygenation tests using the off-gas method were used as a basis for the model – both fouled and cleaned conditions. The layout consisted of two activated sludge processes, each representing different operating conditions. For the control process (Scenario 1), the diffusers began at a clean condition and the efficiency degraded over time. For Scenario 2 the diffusers are cleaned at a selected interval. The main parameters for controlling the simulation were cleaning frequency, cost of diffuser cleaning and the fouling rate.

The model was used to optimize the cleaning frequency to reduce energy usage and ensure adequate capacity. In addition to the energy savings demonstrated by the model of yearly cleaning of the diffusers, the impact on future oxygen demands was modelled. Future loadings at the plant indicated that the annual cleaning will be required to ensure that adequate aeration capacity is available for future
loadings. Figure 4 shows the impact of diffuser cleaning on the available air for the expected loadings. Without cleaning, the aeration demand will exceed the available capacity from the existing blowers.

**St. Thomas WPCP – Energy Savings**

The St. Thomas WPCP is a conventional activated sludge facility with an average daily rated capacity of 27,300 m³/d. Capacity is handled in three activated sludge plants (i.e., Plant Nos. 2, 3 and 4). The aeration for each plant is provided by diffused aeration systems with centrifugal blowers. The blower systems were historically separate for Plant Nos. 2 and 3 and Plant No. 4.

An energy audit of the facility was carried out to investigate energy saving options (Newbigging et al., 1996). The majority of the energy used at the plant is for aeration; hence optimization was focused on this process. The energy audit recommended:

- combining the two aeration systems;
- reducing the number of diffusers in Plant No. 4; and
- replacing the medium bubble diffusers in Plant Nos. 2 and 3 with fine bubble diffusers.

Historically, Plant No. 4 operated at elevated dissolved oxygen (DO) concentrations, often greater than 8 mg/L, even with one blower in service. Combining the two blower systems with a common header, although complex to control, allowed for excess air to be diverted to Plant Nos. 2 and 3. By combining the two aeration systems, one blower could be turned off for the majority of the year. The result was a power reduction of 2,640 KWh/d, which allowed for a payback period of less than two years on the investment of modifying the aeration system.

Even with the combined aeration systems, DO concentrations were generally still above the minimum requirement of 2 mg/L to maintain adequate treatment. Based on maintaining adequate mixing, a number of the diffusers could be removed to reduce the airflow to Plant No. 4 and reduce energy usage without impacting treatment or mixing.

Plant Nos. 2 and 3 utilize medium bubble diffusers which are not as efficient as fine bubble. Retrofitting the diffusers with fine bubble will further reduce energy usage at the plant. Unfortunately, the aeration tanks in Plant Nos. 2 and 3 are not as deep as Plant No. 4 and therefore the energy savings are not as great as they could be.

Because of this, further energy reduction options, beyond the aeration header retrofit, are available to reduce energy costs for aeration at the facility even more.

**Summary**

Plant optimization has come a long way from its inception in the 1980s. With current tools and testing techniques, a wastewater plant’s performance, chemical and energy usage, and capacity can be readily evaluated and documented. This allows upgrades to be focused on capacity and/or performance limiting areas, rather than an overall plant-wide upgrade/expansion. Optimization is an ongoing process that can lead to substantial benefits at a wastewater treatment plant. Care must be taken to ensure that optimization or capacity gains do not reduce conservatism in plant designs without enhancements to operating procedures, monitoring and control. Engagement of plant operations staff also ensures that gains made from the optimization process can be realized into the future.

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**Footnote**

1 Adapted from National Guide to Sustainable Municipal Infrastructure, 2003

**References**


Have you ever wondered why when sizing mixers you get such different recommendations back from mixer suppliers? The answer resides in the basics of mixing.

Mixers are low-head pumps. To evaluate the performance of a given mixer, it is necessary to first understand how to interpret mixer pumping and power draw. Dr. James Oldshue was the technical resource for Mixing Equipment Co. In Oldshue’s book, mixer pumping rate is defined as (Oldshue, 1983):

\[ Q = Nq \times \text{RPM} \times (\text{Dia})^3 \]

Equation 1

Where:
- \( Q \) = pumping rate at m³/min
- \( \text{RPM} \) = revolutions per minute
- \( \text{Dia} \) = Impeller Diameter in meters, m
- \( Nq \) = Empirical impeller pumping characteristic which varies with type of impeller

Equation 1 shows that the impeller pumping rate is linear with rotational speed but a cubic function of impeller diameter. So, if the mixer speed is doubled, the impeller pumping rate is doubled for the same diameter impeller. If the impeller diameter is doubled, the impeller pumping rate is increased by a factor of eight for the same speed.

The second important equation relates to power consumption (Oldshue, 1983):

\[ P = \text{SPGR} \times Np \times (\text{RPM})^3 \times (\text{Dia})^5 \times C \]

Equation 2

Where:
- \( P \) = power draw, kW
- \( \text{SPGR} \) = Specific Gravity of water = 1 in most cases
- \( \text{RPM} \) = revolutions per minute
- \( \text{Dia} \) = Diameter of impeller in millimeters, mm
- \( Np \) = Empirical impeller power draw characteristic which varies with type of impeller
- \( C \) = Unit conversion factor = 2.15926×10²⁰ (metric equivalent of \( C \) from Oldshue, 1983)

By substituting a reduced rotation speed into Equation 2, it is shown that for a fixed diameter impeller, reducing the impeller speed by 50% results in an 87% reduction in power use. A 20% reduction in speed is a 50% reduction in power draw. If the speed is kept constant, reducing the impeller diameter by 20% results in a 73% reduction in power use. So the power input to a given tank can be varied by controlling either the impeller speed or by reducing impeller diameter.

There are many impeller types as shown in Figure 1. Each impeller has a specific \( Nq \) and \( Np \) characteristic value. For some manufacturers these are closely guarded secrets; others are more open. Obtaining manufacturer mixer sizing and getting the details for power draw, impeller speed, pumping rate, impeller type and impeller diameter one can back-calculate the \( Nq \) and \( Np \) characteristics.

Based upon Equation 1, one could assume that mixers with the same pumping rate have the same impact upon mixing in a basin. Some manufacturers have probably mentioned that their mixers perform more efficiently because of ‘induced flow.’ Is induced flow a gimmick or is it real?

Eductor mixers (Figure 2) have no moving parts. As pressurized flow is directed into the throat of the venturi, bulk liquid is pulled into the mixer. This is ‘induced’ flow. These types of mixers, used in applications such as liquid-liquid mixing, can efficiently achieve high mixing rates.
mixers are known to discharge three to four times the motive flow. So how does the bulk fluid get pulled into the mixing chamber? Water flowing in a jet at a higher velocity than the rest of the liquid in the tank does not slide across the slower moving liquid - it drags it along. A high velocity jet of water flowing past lower velocity moving water, or static non-moving water, induces the slower moving water into motion through friction. Friction is resistance and that resistance results in energy transfer, setting the static fluid in motion or making the slower moving fluid move faster. Given enough time the high velocity jet will ‘induce’ all of the fluid in the tank into motion. The amount of motion is dictated by the

volume of the high velocity jet and the velocity of the jet.

Induced flow is real. The induced flow is created by the energy in the moving fluid being transferred to the slower moving water, which is different than what could be simply described as directly pumped flow. Momentum is defined as the energy contained in moving fluid. That energy in a pumped stream can be transferred to other liquid in a tank causing all of the fluid in a tank to eventually be in motion.

The submersible mixer manufacturers for years have contended that the correct way to compare submersible mixers is through thrust. That is now the ISO standard. Thrust is defined as the energy pushing against the submersible mixer mast and represents the energy generated by the submersible mixer in pumping liquid. This is a perfect example of Newton’s second law that for every reaction there is an equal and opposite reaction, making thrust equal to momentum.

Momentum is mathematically defined as Equation 3.

\[ M = \text{Mass Flow} \times \text{Velocity} \]

Equation 3

Where:

\[ M = \text{momentum} = \text{kg m/sec}^2 \ (\text{Newtons}) \]
\[ \text{Mass Flow} = \text{kg/sec} = \text{Flow rate (m}^3/\text{sec}) \]
\[ \times \text{Density (kg/m}^3\) \]
\[ \text{Velocity} = \text{m/sec} \]

Once the mixer direct pumping rate is known, that volumetric pumping rate must be converted to a mass flow rate. The pumping rate also needs to be converted into a discharge velocity. So, for axial flow impellers, the discharge area is the area inscribed by the mixer impeller or (diameter/2)^2 = PI. The mass flow rate of the pumped fluid times the area that the flow is pumped through is the momentum energy produced by the impeller pumping water.

An example mixing problem was developed, and input was requested from four manufacturers. They represent four different types of mixers:

- Vertical top entering mixers
- Submersible high speed mixers
- Floating surface down pumping mixers
- Submersible slower speed mixers

In some instances the manufacturers offered up more than one size of mixer. Table 1 presents a summary of the technical data.

Several points become obvious after examination of the data in Table 1. The power input needed for mixing a fixed volume varies considerably from one mixer type to another. The mixer direct pumping rate varies drastically between types of mixers. Generally, the higher the impeller speed, the higher the power draw to provide the mixing. The higher speed mixers generate a higher pumping velocity with a lower liquid pumping rate but the produced thrust is essentially the same across the type of mixers. While the mixing energy (thrust) is essentially the same, the electrical power input per unit volume is significantly different per type of mixer.

Why is mixing so important? The first issue is simply energy consumption. Understanding the difference between types of mixers allows a more energy efficient mixing system to be specified or installed. All mixers are not equal based on motor size and power draw.

The second issue pertains to mixing applications. Activated sludge denitrification and biological phosphorus removal systems are becoming common processes. These processes rely on the creation of anoxic and anaerobic environments. Over-mixing these treatment zones can induce aeration into a zone that is

---

**Table 1**

Summary of mixer sizing for a common mixer problem (552 m^3 volume)

<table>
<thead>
<tr>
<th>Units</th>
<th>Top Entering</th>
<th>Flygt</th>
<th>Aqua Aerobics, DDM</th>
<th>Wilo/ EMU</th>
</tr>
</thead>
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<tr>
<td>Impeller Diameter, m</td>
<td>2.53</td>
<td>0.58</td>
<td>0.29</td>
<td>0.60</td>
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<td>Revolutions/ minute</td>
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<td>580</td>
<td>1,200</td>
<td>366</td>
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<tr>
<td>kW</td>
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<td>4.85</td>
<td>3.56</td>
<td>3.9</td>
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<tr>
<td>Direct pumped flow, m^3/minute</td>
<td>154.35</td>
<td>35.12</td>
<td>17.11</td>
<td>35.43</td>
</tr>
<tr>
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<td>285.2</td>
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supposed to be devoid of oxygen. The surface turbulence caused by over- mixing will result in oxygen transfer and enough oxygen can be transferred to poison anywhere from 10-50% of an anoxic or anaerobic zone, rendering that zone inefficient for its intended purpose. Over-aeration through mixing can mean the difference between meeting your effluent nitrate or phosphorus removal goals/permit limits or exceeding them. Therefore, careful selection of mixing equipment and ensuring the different mixer types are properly sized and evaluated will produce a more energy and process efficient design.

If the intent is to competitively bid different mixer types, it is necessary to set the basis of the specification on mixer thrust not motor size. This could make the motor starters and wiring sizing somewhat more complicated, but the potential for energy savings is significant.

Ideally, a variable speed drive for the mixer offers many benefits. Simply slowing the mixer speed by 20% can save 50% on the annual electrical bill for mixing. Many times the final selection of mixing equipment will be based upon the experience of the WWTP maintenance staff. Submersible mixers are the low cost, higher energy use choice, but many maintenance staff do not like servicing submerged motors/equipment as compared to mixers that have motors above the liquid surface level. So, owner preference will play a big role in mixer selection.

How much mixing is enough? The mixer manufacturers have mixing recommendations for their equipment. This question can be addressed from field data collected during a mixer performance test. Specifically, an optical total suspended solids (TSS) meter was used to profile the suspended solids concentration in a basin equipped with a top-entering mixer. The top-entering mixer was operated at 80%, 50% and 30% design speeds and a total suspended solids profile was collected under each operating condition. The mixers were installed in anoxic and anaerobic zones and the test results for solids suspension/ dispersion were similar.

Figure 3 shows the mixer that was tested. Figure 4 shows the profiles from
one of the series of tests. The basin was tested for the TSS concentration at each corner of the tank and around the mixer in the centre of the tank for a total of six locations starting at roughly 0.9, 1.8, 2.7 and 3.6 meters of depth.

The tanks were 5.5 meters deep, however, the cord on the probe was only long enough to reach the 4-meter depth given the height of the walkway above the water surface level. The centre basin locations were only sampled to a 1.8-meter depth to avoid the mixer impeller.

At the three mixer speeds there was little to no surface turbulence. At the slowest speed there was some settling of the mixed liquor suspended solids (MLSS) at the liquid surface. As expected the TSS suspension deteriorated at the lower operating speeds of the mixer. However, a mere 5.5% variation in the MLSS readings is misleading. The 5.5% difference is calculated as the difference between the highest and lowest reading divided by the average of the TSS data. This means that the actual variability in the data is around +/- 2.75% around the average. This variation is technically within the accuracy of the TSS test. The impact on the floc was observed and the MLSS floc size remained large under all mixing intensities. At the lowest speed, about 2 to 5 cm of clear liquid were seen at the water surface, however the distribution of solids within the tank was quite good.

The use of Equations 1 and 2 and the calculation of momentum allow various types of mixers to be compared to define mixing equivalency. These procedures also allow a scientific, quantifiable approach to evaluating different types of mixers under competitive bidding. The evaluation also shows that for energy efficiency, variable speed drives should be installed to match power use with process needs for basins designed for future conditions.

About the Author:
Edmund A Kobylinski, PE, holds a BS and MS in Chemical Engineering from the University of Missouri – Rolla Campus, Rolla, Missouri, United States. He has 36 years of Environmental Experience, 28 years of which are at Black & Veatch as a Process Engineer.

References


Oldshue completed his BS, MA, and PhD at the Illinois Institute of Technology in Chicago although his education was interrupted by service on the Manhattan Project from 1944 to 1945 in World War II. From 1950 to 1992, Oldshue worked as Vice President and Director of Research at Lightnin’ Mixers Corporation of Rochester, New York and gave his time to both national and international engineering societies, winning numerous engineering awards and honorary degrees including service as President of the American Institute of Chemical Engineers in 1979 and election to the prestigious National Academy of Engineering in 1980.

Source: www.wikipedia.org
1.0 Introduction

The Bonnybrook wastewater treatment plant (WWTP) is the largest of three WWTPs in the City of Calgary and currently serves a population of approximately 900,000. First constructed in 1932, it has undergone four major expansions with the most recent completed in 1994. It is an advanced WWTP incorporating primary clarification, primary sludge fermentation, activated sludge secondary treatment configured for biological nitrogen and phosphorus removal, dissolved air flotation thickening of waste activated sludge, mesophilic anaerobic digestion, and ultraviolet disinfection of treated effluent prior to discharge in the Bow River. An aerial photo of the Bonnybrook WWTP is shown in Figure 1.

A consulting team, consisting of WPC Solutions, CH2M HILL, and EnviroSim Associates, was tasked by the City with:

1. determining the capacity of the liquid stream treatment train of the Bonnybrook WWTP to use for long term planning of the City’s wastewater treatment infrastructure (the focus of the capacity analysis was not only on the process tankage, but also on the capabilities of the existing process air blowers to deliver the required amount of air);
2. assessing the mechanical condition of the seven existing process air blowers; and
3. developing a plan for upgrading/-expanding the process air supply.

This article focuses on the capacity analysis aspects of the project.

2.0 Background on Capacity Analysis

The capacity of a wastewater treatment plant is primarily determined by four factors:

1. the facilities in place, including the process tankage and its configuration, and the conveyance infrastructure in the plant, including channels, pipes, pumps, etc.;
2. the effluent quality limits established by the regulatory authority;
3. the characteristics of the feedstock or raw sewage entering the plant in terms of volumetric flowrate, and the solids, organic and nutrient contaminant loadings, and the degree to which the maximum flowrate and loadings occur in unison; and
4. the manner in which operation of the facilities occurs to treat the feedstock and achieve the treated effluent quality limits.

It has been common practice to express wastewater treatment plant capacity in terms of the volumetric flowrate of the incoming wastewater stream to be treated. Units of megaliters per day (ML/D) or million gallons per day (mgd) have typically been used. In this regard, the capacity of the Bonnybrook WWTP, after completion of the last expansion in 1994, was assessed as 500 ML/d. When rating the capacity of a particular plant or comparing capacities of different plants solely on the basis of volume, the implicit assumption is that the influent contaminant concentrations are similar and therefore the influent loading is directly proportional to volumetric flow. However, recent trends in major Canadian cities clearly illustrate that the per capita flow rates are dropping significantly. Thus, statements of capacity, based solely on volumetric flow, are misleading.

The implementation of water conservation measures due to plumbing code changes and public education has resulted in lower volumes of wastewater generated per capita. In the Bonnybrook sewer catchment, the per capita wastewater generation rate has decreased from 750 L/cap/d to 410 L/cap/d over the past three decades, despite an increase in contributing population of over 80%. The result has been a net increase in wastewater flow to Bonnybrook of only 17% during the same period. However,
contaminant loadings in the wastewater generally increase in proportion to the contributing population, which has resulted in an increase in wastewater strength over the same interval. Hence it is useful to express WWTP capacity in terms of both volumetric and contaminant loadings. The former must be accommodated by the channels, pipes and processing tankage that is sensitive to hydraulic loading such as screens, grit removal systems, primary sedimentation systems, effluent filtration systems and effluent disinfection systems. The biological treatment system, the process air blowers and the entire solids processing train must accommodate the latter. For a given sewer catchment, the concept of equivalent population (EP) is sometimes used to express WWTP capacity. This necessarily requires knowledge of the per capita contributions to both the wastewater flow and the contaminant loadings.

3.0 Process Analysis and Modelling
A number of sub-tasks were completed to determine the Bonnybrook WWTP liquid stream treatment train capacity. These are discussed in the following sub-sections.

3.1 Process Data Analysis
An intensive analysis of daily Bonnybrook process data from 2007 to 2010 provided an in-depth understanding of the wastewater flow and contaminant loadings, the operating conditions, and the performance of the plant. This analysis revealed that the plant met the permitted treated effluent quality limits during the four-year period under study. The analysis also identified various minor operational changes that would contribute to positive gains in overall treatment capacity.

3.2 Wastewater Characterization / Nitrification Kinetics
A bench-scale testing program was conducted during the summer of 2010 on daily samples of Bonnybrook influent to measure the influent characteristics for the purposes of performing process modeling to estimate the capacity of the secondary treatment section of the plant. The approach followed the low F:M procedure presented in the Water Environment Research Foundation (WERF) Report No. 99-WWF-3 (Melcer et al., 2003). Figure 2 shows photographs of the bench-scale testing unit at the Bonnybrook WWTP. The objectives of the bench-scale testing program were two-fold:
- to estimate the nitrification kinetics of Bonnybrook’s wastewater (in wastewater treatment plants that must remove ammonia, nitrification kinetics are the single most important consideration that determines the capacity of the secondary treatment tankage and its optimal operation, once the wastewater flows and contaminant loads to be treated are quantified); and
- to estimate the wastewater characteristics of Bonnybrook’s wastewater in terms of the soluble/particulate split, the biodegradable/nonbiodegradable split, etc., and related parameters critical to a representative process modelling exercise.

A similar study was conducted in 2003 on the influents of both the Fish Creek WWTP and Bonnybrook WWTP. The intent of the 2003 study was to determine the nitrification kinetics and detailed wastewater characteristics of the wastewater to be directed to the greenfield Pine Creek WWTP, which was under design at that time, and to compare the results to similar data collected simultaneously at Bonnybrook. A comparison of the 2003 Bonnybrook results to the 2010 Bonnybrook results indicated:
- The wastewater strength in 2010 was significantly higher than in 2003.
- The fraction of biodegradable soluble matter in the 2010 wastewater was about 40% greater than in 2003.
- The fraction of biodegradable particulate matter in the 2010 wastewater was about 15% higher than in 2003.
- The fraction of nonbiodegradable particulate matter in the 2010 wastewater was about 60% less than in 2003.
- The nitrification kinetic parameters did not indicate the presence of any inhibitory substances in the Bonnybrook influent. The reaction rates determined were within typical ranges observed at other North American plants.

Information from the wastewater characterization program was used to calibrate the BioWin™ wastewater treatment process simulator, which in turn was used as a tool to estimate the capacity of the Bonnybrook WWTP.

3.3 Primary Treatment Capacity
An intensive sampling and analysis program was conducted around specific primary clarifiers and the fermenter systems to gather data to prepare mass balances for estimation of the performance of the primary treatment system. This testing was done for two hydraulic loading rates on the primary clarifiers. The results were used to calibrate the wastewater treatment process simulator employed in the capacity analysis. The data were also helpful in determining that two of the older primary clarifiers could be removed from liquid stream treatment service and dedicated to service as part of a side stream nutrient recovery process should the city decide to implement such a process in the future. If this modification were implemented, minimal adverse impact was predicted for the performance of the primary
3.4 Process Modelling

The BioWin™ wastewater treatment process simulator was employed to estimate the:

- capacity of the Bonnybrook liquid stream process tankage for current and possible future treated effluent limits imposed by Alberta Environment; and

- process air requirements for upgrading/expanding the blower and aeration systems to maximize the capacity of the liquid stream treatment tankage.

Each of the three secondary treatment plants at Bonnybrook (Secondary A, B and C) was configured individually and analyzed separately using BioWin™. For example, Figure 3 shows the Secondary Plant C flowsheet as portrayed in BioWin™. Steady state and dynamic simulations were run for summer and winter conditions using wastewater temperatures of 18.5°C and 11.5°C, respectively. In Calgary, March wastewater temperatures are the limiting case to determine the process tankage and the operating solids retention time (SRT) needed to achieve the degree of nitrification required to meet the regulated ammonia limit in the effluent. Conversely, summer wastewater temperatures, in combination with warm summer ambient temperatures, determine aeration and blower requirements.

Steady state simulations were used as ‘ranging runs’ to determine appropriate ranges for operating conditions at the Bonnybrook plant for various wastewater flows, contaminant loadings, and treated effluent limits. Dynamic simulations predicted process response to hypothetical future flow and load conditions. For nitrification and total nitrogen removal, particular attention was paid to the predictions of treated effluent ammonia and total nitrogen concentrations at various operating SRTs as well as the predicted solids loading rates (SLRs) on the secondary clarifiers for the estimation of plant capacity during winter conditions. Figure 4 shows a dynamic State Point Analysis chart generated in BioWin™ (the cluster of points represents changing clarifier state points with time as the clarifier SLR varies with influent flow and load). To determine the aeration and blower requirements, BioWin™-predicted oxygen uptake rates in the various zones in a bioreactor under ‘wedding cake’ hypothetical loading conditions (i.e., maximum day in a maximum week in a maximum month) were exported for each bioreactor to estimate the corresponding aeration and blower requirements for current and projected future conditions up to 20% beyond the present loading.

4.0 Capacity Determination

The tasks outlined in Section 3 were collectively used to determine a firm capacity estimate for the Bonnybrook WWTP. A summary of liquid stream and blower capacity status is provided in the following section.

4.1 Liquid Stream Treatment Train

The process simulation work in the ‘ranging runs’ determined that operating the Bonnybrook secondary treatment sections at a total SRT of 12.5 days (with an aerobic SRT of ~8 days) should be adequate to maintain nitrification and satisfy the winter ammonia nitrogen permit limit, while maintaining biological phosphorus removal. Using dynamic simulations to examine predicted process performance under a range of loading conditions allowed an accurate estimate of total capacity for the Secondary Plant A, B and C trains.

The State Point Analysis conducted in the process modelling work revealed that replacing the existing return activated sludge (RAS) pumps with larger pumps could increase the capacity of each secondary treatment plant. For the example shown in Figure 4, increas-
ing the RAS pumping rate would result in a clockwise rotation of the brown underflow line about the state point, thus avoiding a thickening failure in the clarifier at peak loads.

4.2 Blowers

The summertime maximum month 24-hour running average total oxygen uptake rate (OUR) predicted by the BioWin™ process simulation runs was used in a custom-prepared aeration spreadsheet to estimate the projected air requirements for the estimated installed Bonnybrook secondary treatment tankage capacity. Comparing the projected airflow requirements for these conditions to installed total/firm blower capacity indicated that blower upgrades were needed. The selected strategy involved the staged installation of new single stage variable speed 14 Nm³/s blowers to augment the existing multi-stage centrifugal blowers. This strategy offers several benefits including energy savings and operational flexibility. Currently, a project is underway in which three 2000 hp blowers are being installed, two new and one to replace an existing 900 hp multi-stage blower. Further replacements are planned for the future.

5.0 Conclusions

A comprehensive approach was used by the team of WPC Solutions, CH2M HILL, and EnviroSim Associates to provide the City of Calgary with an estimate of the Bonnybrook WWTP’s treatment capacity. The extensive data collected by the City played an important role in the analysis, and targeted supplemental data was gathered as needed. One aspect of this project that set it apart from ‘standard’ capacity estimation exercises is the City of Calgary’s willingness to embrace state-of-the-art approaches for determining wastewater characteristics and nitrification kinetics which greatly increased the power and utility of the process modelling employed in this work.

6.0 References


Nitrification Rate Estimation Methods

WERF presents three methods to estimate the nitrification rate, which is based on the limiting step in the process: the growth rate of the nitrifiers (µ₄₅⁴). These methods are:

1. Low Food to Microorganism Ratio Method (Low F:M) in which there is little change to the nitrifier mass during the course of the test and a linear change in the measured parameter. The rate is calculated by linking the production of nitrate/nitrite to µ₄₅⁴. An accurate measure of the quantity of nitrifiers is vital to this method. This method also provides other important process data.

2. High Food to Microorganism Ratio Method (High F:M) in which there is exponential growth of the nitrifiers during the course of the test and consequently an exponential-type response in the measured parameter. This method does not estimate µ₄₅⁴ directly, but rather the difference in nitrifier growth rate and decay. The advantage is that the concentration of nitrifiers is not required to be known to complete the calculations. It is also the simplest method.

3. Washout Method in which an intermediate F:M condition is applied. This test is conducted with a flow-through reactor and operated at a low SRT. Similar to High F:M, µ₄₅⁴ is not estimated directly. In this method, the actual plant effluent is used.

The WERF study showed that with proper experimental control, all three methods will produce similar results.

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Rotating Biological Contactors: How to Optimize Process and Maximize Capacity?

By Harpreet Rai, PhD, P.Eng, BCEE, Process Engineer, RV Anderson Associates Limited

In 2012, RV Anderson Associates Limited (RVA) was retained by a private community of 450 residents in southwestern Ontario to optimize their communal wastewater treatment plant (WWTP). The average sewage flow from the community is estimated to be 165 m$^3$/d. The raw sewage from the community sewer system flows into a rotating biological contactor (RBC)-based wastewater treatment plant (WWTP) with a rated capacity of 218 m$^3$/d.

The WWTP consists of two RBC systems preceded by a common equalization tank called the surge tank. Figure 1 shows the process schematic of each of the RBC plants. The plant influent is pumped from the common surge tank upstream into each of the two RBC systems. The influent discharges into the primary clarifier chamber underneath the RBC units, where the solids are settled. The settled sewage enters Stage 1 of the RBC reactor from a groove at the bottom of the Stage 1 cell. From Stage 1, the sewage flows horizontally across the next three stages sequentially through holes in the casings of subsequent submerged cells. The discs in all four stages have 40% of their area submerged in liquid. The attached biomass on the discs gets aerated via contact with air as the discs rotate slowly through a common drive shaft. Supplemental air is provided via blowers that discharge air through a coarse bubble system along the bottom of the first two stages of the reactor.

The treated effluent from Stage 4 flows into the downstream final clarifier, where the sloughed solids are allowed to settle and the clarified supernatant overflows into the treated effluent chamber. The treated effluent from the chamber is finally pumped to the tile beds for final disposal.

The settled sludge in the secondary clarifiers is periodically pumped to the surge tank, mixed with raw sewage and transferred to the primary chamber beneath the RBC units, where it cosettles with the primary sludge. The combined sludge accumulates at the bottom of the primary tank, and is hauled away every two to three months to a local municipal sewage treatment plant.

Process Issues and Project Objectives
Historically, both RBC systems have run smoothly, consistently producing the required effluent quality without process-related issues since their commissioning more than 20 years ago. However, within the last two to three years, the following operational issues were frequently observed by the operating staff:

1. sludge flotation and formation of ‘crusts’ on the surface of primary and secondary clarifiers;
2. inconsistent performance in two trains, with one train producing poorer effluent quality than the other; and
3. concerns that poor effluent quality could potentially clog tile beds and reduce their effective life.

In addition the client wanted to be proactive in improving the effluent quality in a way that not only improves the life of the tile bed, but is also protective of ground water quality and enhances the RBC system treatment capacity.

Process Investigation
The above process issues were investigated in order to identify their causes and recommend remedial measures to address them.

Sludge Flotation
The sludge in the primary clarifiers floated to the surface and formed a surface layer or a ‘crust’ as described by the operators, which built up to a
the surface crust. The breakage of this crust by hydraulic forces led to chunks of biomass entering the RBC system and in turn frequently overloading the system with particulate five-day biochemical oxygen demand (BOD₅).

A large fraction of the particulate organic matter in the raw sewage, which is normally removed as primary sludge in the primary settling chamber, was being hydrolyzed and converted to soluble organic matter (sBOD₅), which resulted in organic overloads in the first stage of the RBC system due to a higher soluble BOD concentration than envisaged in the design.

**Process Overload and* Beggiatoa***

The impact of the above two factors on the treatment process is worsened by a long sludge residence time of approximately six months in the primary chamber. This makes the sludge available for biological decomposition for a longer period under active biological conditions induced by the GRP.

Furthermore, during this period of observation the supplementary aeration for Stages 1 and 4 had been switched off because the plant had been meeting compliance with effluent quality requirements. As a result, the dissolved oxygen (DO) was observed to be below 0.5 mg/L in stages 1 and 2 of both trains.

Soluble BOD, loading in the first stage was determined to be 18.7 kg/m²·d, which was about 30 to 50% higher than the recommended optimal loading of 12 to 15 kg/m²·d (Metcalf Eddy, 4th Edition). The organic overloading in the first stage is reported to cause a whitish biofilm comprising *Beggiatoa* (a filamentous bacterial species) which leads to reduced BOD₅ removal efficiency by heterotrophs as they compete for space with *Beggiatoa*. In addition, the thicker biofilm and H₂S production by *Beggiatoa* causes odours and biofilm sloughing issues. Development of *Beggiatoa* was quite evident from the appearance of the first and second stage biofilms of the RBC (Figure 2).

**Loss of Nitrification**

The other major impact of BOD₅ overload and low DO in the first two stages is the high sensitivity of the nitrifiers to loading fluctuations. For example, a 25% increase in loading to one train in February severely inhibited nitrification as the effluent total ammonia nitrogen (TAN) was observed to rise sharply from 2.5 mg/L in January to 23 mg/L in February. Further, nitrification could not be recovered in the next six months in spite of reduction of loading to a normal level in March to the affected train.

These observations indicated that when operating at high base loads, nitrification may be possible without supplemental air up to a certain load as there are potentially viable conditions for nitrification in the last two to three stages of the system. However, as the load increases beyond a critical point, the balance tips to the BOD₅, consumers and the nitrifiers are washed out of the system. Once disturbed by a shock load, revival of nitrification can take several months in spite of the influent loading reducing to normal levels. On the other hand, quick recovery of nitrification within two weeks after starting supplemental aeration indicated that a viable DO concentration (above 1.0 mg/L) is critical for reviving and/or maintaining nitrification in the system. Moreover, low DO concentration (below 0.5 mg/L) in the absense of supplemental air adds to the nitrification inhibition.

**Process Remediation Measures**

Based on the process investigation and identification of the process issues identified above, the following process remediation measures were executed as recommended by RVA.

- **Stoppage of GRP addition** - The addition of GRP that was previously used to emulsify FOG in the wastewater collection system was gradually reduced and then completely stopped in May 2013.
- **Frequent removal of primary sludge** - The frequency of sludge removal from the primary clarifier was increased from twice per year to four times per year.
- **Supplemental Air** - The aeration was switched on in both plants in August 2013.

**Process Performance and Analysis after Remedial Measures**

The observations below summarize the performance of the RBC systems after execution of the above remedial
Capacity Assessments, Plant Audits, Optimization Studies

measures. See Figures 3 to 5 for average removal profiles of BOD, and total Kjeldahl nitrogen (TKN) in various treatment stages for both trains.

1. Since stoppage of enzyme addition at the grease interceptors to the system in May 2013, the crust accumulation in the surface of the primary clarifiers has significantly reduced and is much softer and thinner than observed previously.

2. Average soluble TKN of 3.0 mg/L in Stage 4 of both systems indicated that the systems have achieved near complete nitrification.

3. More than 80% primary effluent BOD₅ is removed in Stage 1 of the RBC reactors, with only 9% removed in Stage 2 to 4, indicating that Stage 1 removes the majority of the BOD₅ load, while Stages 2 to 4 are used for nitrification.

4. Mass balance for nitrogen assimilation in biomass indicated that nitrification gets started in Stage 1 under aerated conditions with DO above 1.0 mg/L, and is completed within Stages 2 to 4.

5. Final effluent TKN higher than that in Stage 4 TKN indicates digestion of accumulated sludge in the secondary clarifier, leading to release of soluble TKN in the final effluent.

Conclusions

- Long retention of the combined process sludge in the primary clarifier of an RBC can lead to sludge hydrolysis and eventually to increased soluble BOD₅, loading and loss of biological treatment efficiency of the RBC system. This condition can be improved by increasing the sludge removal frequency from the primary clarifier.

- The above condition can be further worsened by addition of biochemical grease removal agents in the collection system, as these products enhance biological activity in the settled sludge in primary clarifiers, leading to release of additional soluble and particulate organic loads, which overload and have a negative impact on the biological system efficiency.

- Such products, if used, should be applied judiciously and implications of these products on the treatment system should be considered carefully prior to their use.

- Provision of supplemental air and maintaining DO above 1 mg/L in Stage 1 not only helps to improve and/or maintain nitrification, it also helps mitigate Beggiatoa in the first two stages. This in turn enhances biological treatment efficiency of the attached biomass which translates into enhanced treatment capacity of the biological system.

Further Improvements

In addition to the above, the following process and/or operational modifications can lead to further improvement in treatment efficiency and enhance treatment capacity.

Frequent Removal of Secondary Sludge

Prolonged retention of sludge in the secondary clarifier leads to hydrolysis of the settled biomass leading to significant release of ammonia nitrogen in the effluent, thereby leading to noticeably higher effluent ammonia than what is achieved by the biological process up to Stage 4. Provisions should be made for frequent (weekly or bi-weekly) removal of the secondary sludge in order to minimize the digestion potential and release of bound ammonia to the effluent.

Step Feed System

When operating with supplemental air, with nitrification starting in Stage 1, it is likely that full nitrification is achieved by the end of Stage 2 or 3. This means that while the first stage of the system is slightly overloaded with soluble BOD₅ (17 g-sBOD₅/m²-d as opposed to the recommended limit of 12-15 g-sBOD/m²-d of media), the treatment capacity of at least one or more of the last stages is not being fully utilized under the current loads.

This condition can be improved by converting the current system to a step-feed system, which can be achieved by making a provision to distribute the primary effluent to the first two stages. This will improve both the process efficiency and the capacity through lower sBOD₅ load to Stage 1 and more optimal utilization of the latter stages of the reactor system.
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The Benefits of Using Enhanced Process Block Diagrams During a Process Assessment

By Patrick Coleman, P.Eng., Black & Veatch

A process assessment determines the capacity of what is already built. A process design establishes the capacity of what will be built. One would therefore expect that the tools used to develop a process would be similar to those used to assess a process (British Standard, 1988). One such process development/assessment tool is the process block diagram (PBD).

This paper (1) reviews the use of process development diagrams and (2) describes how an enhanced PBD (ePBD) can form the basis for a process assessment.

Design and Assessment Process

There are two stages to process design: development and implementation. Errors and inefficiencies slip into a design when implementation starts before development is finished. This risk increases when the development of the piping and instrumentation diagrams (P&IDs) starts during the development stage and is completed during the implementation stage.

Process assessment also proceeds in two stages: discovery and analysis. If the analysis stage starts before the discovery stage is complete, the analysis stage outcome will be flawed because it was based on an incomplete understanding of the process. The discovery stage requires the engineer to examine what is built and to understand how it works. The engineer must then document the process using the same process development diagrams and datasheets that would be used during the design development stage. Although a process assessment may recommend that the P&IDs be updated to reflect what exists on site, there is no need to update the P&IDs to assess a process.

Both the development stage of a process design and the discovery stage of a process assessment lead to an implementation stage. The implementation stage occurs when the other disciplines become involved in the detailed design process. To avoid errors or cost overruns, the development and analysis stages must be completed before the implementation stage starts.

Process Diagrams and Datasheets

A number of diagrams and drawings are used to develop a design, including process block diagrams, mass flow diagrams, flow diagrams, and data sheets (British Standard, 1988).

The process block diagram (Figure 1) is a simple diagram that shows essential process units as boxes, and their conveyance between process units as simple lines. Mass flow and mass balance diagrams track the flow of all matter through the process, while the flow diagrams identify the various flows that pass from one process to another. Data sheets contain all essential process data required for detailed design (i.e., process design implementation). These diagrams and data sheets build on the process block diagram nomenclature. The P&IDs are developed in the implementation stage.

These diagrams and data sheets also form the basis for piping isometrics, hydraulic profiles, and P&IDs. The P&IDs are best used to document, rather than to develop, a design, and are therefore not considered a design development diagram.

To save time, many firms in North America develop the process flow diagram (PFD) as the bottom part of a P&ID. Once the PFD is stable, they develop the top portion, which consists of connections to local control panels, programmable logic controllers (PLC), and a supervisory control and data acquisition (SCADA) system to meet the International Society of Automation (ISA) S5.1, S5.3, S5.4, and S5.5 standards. In this case, the P&ID starts during design development and is completed in design implementation (WEF, 2011). This is not an issue unless they use this approach to avoid developing the other design development diagrams mentioned above.

Many argue that this form of P&ID is just an unnecessary ‘holdover’ from the pre-computer control age that is expensive to produce and maintain. That is why some firms use process block and flow diagrams during design development, and rely on a document (e.g., system specification or user requirement specification) to describe the control system.

The process block, flow, and mass transfer diagrams and process datasheets can be produced economically using a spreadsheet (e.g., Excel™) and a graphics program (e.g., Visio™) rather than relying on computer-aided drawings (CAD). This approach links the...
diagrams to their calculations, making it easier to make changes and reducing the risk of a transcription error.

Process Flow Diagrams
Process industries define a flow diagram as a diagram that (McAvinew & Mulley, 2004) “… depicts all essential parts of a process or item of equipment which enables the analysis and calculation of physical characteristics to be undertaken. They are so arranged to show the operation as clearly as possible without regard to physical layout of items, their parts or their connections.”

Typically, flows enter on the left and exit on the right of a flow diagram. Low pressure starts at the bottom with high pressure at the top of the page.

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The first stage of a process assessment
Process Assessment

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The first stage of a process assessment
is to establish how the process design will be implemented. In a perfect world, this should be a simple desktop exercise. In the real world, it is more complex, for a number of reasons, including:
- What was built is not what is on the drawings.
- Operations staff made modifications to what was built.
- Subsequent packages inadvertently changed the plant’s capacity.
This is why the assessment process starts with reconciliation of the PBD with what is built and operating.

### The Role of the Process Block Diagram
A simple Block diagram is shown in Figure 1. The essential process units are shown as boxes, and the conveyance between process units are lines. Figure 4 shows an ePBD for the same process.

### What do ePBDs describe?
An ePBD describes:
- type, number, and order of all process units and process operations connecting flow streams, bypasses, and alternate routes, including preferred routes where appropriate;
- position of pumps, blowers, compressors, and in-line mixers;
- sample points; and
- chemicals – the points of application and control.

An ePBD does not describe:
- physical arrangements;
- numerical values of process conditions;
- items integral to the process unit;
- certain minor flow streams; and
- overflows, drains or roof leaders unless part of the process design.

The level of detail depends on the diagram’s purpose. The level of detail for the process assessment of a medium-size plant results in about 10 to 20 tabloid-size drawings.

### What do ePBDs document that PBDs do not?
The first difference between a simple PBD and an ePBD is the type of information included within the blocks. The block is given a unique number which is used in subsequent diagrams; it also indicates how many units there are. In the case of PU-1 Fine Screens, it is clear that there are two screens – one duty and one standby (i.e., 1+1). This is not the case for PU-4 Washer Compactor (i.e., 2) – there is one dedicated washer/compactor per screen which means if a compactor fails, the screen must be shut down. These types of nuances are important to identify during a Process Assessment.

<table>
<thead>
<tr>
<th>Flow Number</th>
<th>F05-01</th>
<th>F05-02</th>
<th>F05-03</th>
<th>F05-04</th>
</tr>
</thead>
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<tr>
<td>Flow Units</td>
<td>L/s</td>
<td>L/s</td>
<td>L/s</td>
<td>L/s</td>
</tr>
<tr>
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<td>54.8</td>
<td>82.2</td>
</tr>
<tr>
<td>Maximum</td>
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<td>219.1</td>
<td>219.1</td>
<td>328.7</td>
</tr>
<tr>
<td>Form</td>
<td>e.g. Liq</td>
<td>Liq</td>
<td>Liq</td>
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</tr>
<tr>
<td>Pumped</td>
<td>Y/N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Solids</td>
<td>%</td>
<td>-0.03</td>
<td>-0.03 to 0.05</td>
<td>-0.03 to 0.05</td>
</tr>
<tr>
<td>Operate</td>
<td>h/d</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>d/wk</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Grit</td>
<td>Y/N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Debris</td>
<td>Y/N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Note</td>
<td>Y/N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
The second difference is the numbering of the conveyance lines, which is important when building mass balance, mass transfer, and hydraulic diagrams. When there is a flow meter in the line (e.g., F1), the F-number is surrounded by two circles that identify the flow meter position, which is important when interpreting flow data received from the plant’s operations staff (Figure 5).

Important sample point locations are identified as a triangle (e.g., S1). This makes it clear what flows are represented in a sample. For example, ‘raw sewage’ samples often contain return flows from the solids processing. In one case where this nuance was missed, the return solids to the primary clarifier were counted twice in the design of the primary sludge pumps.

The PBD identifies two bypass lines: one around the fine screens (PU-1) through a manual bar screen (PU-3), and a second one around the vortex grit separator (PU-2).

The first bypass is passive in that the flow bypasses when the level rises upstream of the fine screens and overflows the weir. This is designated by a weir symbol (Figure 6). As part of the capacity assessment, it should be established when this weir operates and whether staff are notified.

The second bypass only occurs when the Operator intervenes (e.g., closes or opens a valve). This junction is signified by a triangle with an “A” (Figure 7). The arrow identifies the preferred or normal route. The Process Assessment should establish if both routes are still in use. It is not uncommon to find plants operating in a manner that is more determined by gate failures than by process performance. In fact, gate failure is one of the most common issues raised during Process Assessments because they have not been exercised and may fail when used.

The ePBD identifies movers (e.g., pumps) that have an impact on the process such as the grit pumps or screenings conveyers. Similarly, the PBD would identify air blowers, inline mixers, eductors and flow distribution, routing, or collection chambers.

The ePBD also identifies what and where consumables (e.g., chemicals) are added (Figure 8). For example, C1 Ferrous is added for phosphorus removal (Figure 4). The addition can be automatically controlled off the influent flow meter (F1) or manually by taking a sample downstream (S2).

### Mass Balance and Process Flow

A mass balance represents a single condition at a point in time. Therefore, an assessment would require a number of mass balances which report the mass flow at points in the process flow for each condition. At each key F-number (mass balance node), the liquid and mass flow is provided (Figure 9).

A Flow diagram represents a range of flows at any point in the process (Figure 3). Ideally, the flow table can be appended to the bottom of the ePBD.

### What can be learned when building an ePBD?

- Reconciling conflicts between drawings and what was built on site: A common task in an assessment is to reconcile conflicts between drawings and what was built on site. As a plant site develops, new sets of drawings are developed for each expansion, but the old drawings remain unchanged. When trying to reconstruct the process design, the assessor often has to go back to when the oldest asset was built and then reconstruct...
how the plant changed overtime. Unless a facility continues to update the P&IDs to keep them current, there is no plant-wide process roadmap. Once agreed upon with operations staff, the ePBD provides the roadmap allowing the process assessment to proceed.

- **Locating single points of failure:** Once the ePBDs are drawn, it is easy to identify single points of failure. To improve the reliability of the plant or improve site safety, it may be necessary to eliminate these single points of failure. The nature of the single points of failure becomes more obvious when the process assessment is subject to an operation and maintenance (OPMAN) review.

- **Confirming which flow lines are no longer in use:** It is not uncommon to have a connection between processes on-site that is no longer in use. It may be left over from a previous expansion or, in one recent case, necessary for the plant to reach rated capacity. In the latter case, the connection was poorly designed and never worked. The reason the connection was put there in the first place was forgotten and only became evident during a recent process assessment.

- **Identifying when the condition of an appurtenance (e.g., valve or gate) prevents a flow line from being used:** There is a practice where engineers install gates or valves that are only used infrequently (e.g., once a year or only during planned maintenance). If these gates or valves are not regularly exercised, there is a risk they will seize up. At one large plant in the US, the assessor discovered that approximately 70% of the key gates were no longer operable. This meant that the plant was operated not so much to optimize the effluent quality but to avoid having to operate a gate or valve that was at risk of failing.

- **Corroborating areas where the process intent was not realized due to design flaws or changes:** It is not uncommon for the premise upon which a design is based to change during the lifetime of a plant. For example, an industry may close or open, development may occur where it was not anticipated, or effluent targets may tighten. This means that the process assessment may need to alter the plant’s facility plan to match the current situation. A recent example is a case where a wastewater plant was designed to treat waste from a large brewery. The design used the brewery waste as a carbon source for biological phosphorus removal. Six years after the plant was built, the brewery was shut down and the site sold off. The wastewater plant now relies on chemical phosphorus removal and imports wastes because it has biological treatment excess capacity now that it longer treats the brewery waste.

**Why use an ePBD?**

ePBDs describe the wastewater process in a format that is simpler than a P&ID. The ePBD is the ‘process dictionary’ for the mass balance, mass flow, and flow diagrams. ePBD designations follow through these documents providing structure and consistency to an assessment project.

**Footnote**

1 A constituent or property of the water that is determined, or estimated (Drinking-water Standards for New Zealand 2005).

**Works Cited**


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In the past year, several Northern Ontario Communities have taken advantage of the Ontario Power Authority (OPA) Save on Energy Program in the interest of reducing their energy usage. The City of Greater Sudbury, Town of Espanola and Town of Cochrane have completed reviews of the aeration systems at their wastewater treatment plants (WWTPs). The studies received funding under the OPA Save on Energy Program’s ‘Process and Systems’ category. Subsidized energy studies are available towards facilities connected to a participating local electric utility where there is potential to reduce energy consumption by more than 100 MWh annually. The program has funding up to $50,000 available for preliminary (PES) or detailed engineering studies (DES).

These Northern Ontario WWTPs employ extended aeration systems with activated sludge treatment. Sudbury, Espanola and Cochrane each have centrifugal blowers to provide air to the biological treatment processes. Since aeration is typically the largest source of energy use in an activated sludge wastewater treatment plant, studies were undertaken to review the aeration systems and determine potential energy savings.

The engineering studies utilize detailed calculations and/or temporary power monitoring to determine baseline energy consumption for the existing blower systems. The data is compared to plant process parameters and Environment Canada weather data. Analysis is completed in accordance with the OPA Detailed Engineering Study Requirements Guidelines and The International Performance Measurement and Verification Protocol.

As per OPA guidelines, measures are then developed to reduce energy usage at the WWTPs. As such, a cursory review of blower technology (high speed centrifugal blowers, turbo blowers, and positive displacement blowers) was completed to determine effective measures for reducing energy usage. It was determined that turbo blowers provide the greatest advantage for these municipalities over the existing centrifugal blowers. The advantages include:

- reduced power consumption;
- lower noise and vibration;
- no lubrication required;
- reduced maintenance requirements;
- compatibility with variable frequency drives;
- able to be operated in conjunction with dissolved oxygen (DO) control; and
- increased operational flexibility.

To ensure the new turbo blowers meet the process requirements of the WWTPs, future population growth, potential changes in plant capacity, process changes, and weather data must be considered.

The installation of turbo blower aeration equipment provides considerable savings and typically has a simple payback of five to eight years. This can be further reduced to three to six years with capital incentives from the OPA. Capital incentives from the OPA are the lesser of the following:

- up to 70% of project costs; or
- $200 per MWh of annual electricity savings.

These types of studies are not exclusive to turbo blowers. Additional measures can be developed and reviewed, provided they meet the minimum requirement of 100 MWh per year of energy reduction. Additional measures at WWTPs may include:

- DO control;
- fine bubble aeration equipment;
- positive displacement blowers;
- improvements in pumping efficiency; and
- other process upgrades that remove or reduce the size of equipment.

These types of studies and funding programs are a great opportunity for Ontario communities to evaluate and improve processes at their WWTP. In addition, the capital incentives provide an opportunity to make these types of projects financially viable.
In an age where my daughter’s iPhone – which is surgically attached to her hand – provides 1000 times more technology than my first computer out of university, why are we still producing archaic tables from our plant condition assessments and asset management plans (AMPs)? Why are we continuing to produce tabular spreadsheets just like we did when computers first became accessible to most businesses in the early 90s? We might as well try staying connected with our friends and updating our Facebook profile via pager.

We live in a society loaded with information and technology. If I need directions to a hockey rink for my son’s game, I don’t refer to a map - I ask my phone how to get there. It assesses multiple routes for me that consider traffic and toll routes and allows me to make an informed decision based on my priorities at that very moment in time. Yet, year after year, we continue to spend money on facility condition assessments that do not give us all the information we need to make the decisions we want to make.

I recently completed a number of facility condition assessments for the Region of Waterloo. At the beginning of the project, the Region’s project manager, Richard Pinder, said to me “I do not want a binder at the end of this that will sit on my shelf. I want to know what I need to do to maintain these sites, not just now, but from now on.” Where asset management projects typically fail, is that they only provide an inventory of what you have, what condition it was in when it was reviewed, the age of the asset, and its total expected service life. So, what do I recommend to avoid this failure?

1. Build and Maintain a Solid Foundation
Whether you are spending project dollars to build an inventory from scratch or update an existing inventory, put it somewhere where staff can access it, update it, and be comfortable using it. Look at what software your organization uses and if there is a logical location for data (such as a maintenance management system or MMS) and put it in there. Not only are you going to update and improve what you had in there before, but the information will also be somewhere where staff can use it to make decisions. Depending on your organization, a geographic information system (GIS) is often a logical central location for inventories.

If none of these options are available, enter the information into a database where you can control the quality of the data and give others access to the inventory. Having the inventory in a database format, in an MMS, GIS or custom system, will provide benefits in the future, as you will be able to generate reports and dashboards, something that is not possible if the information is in a binder. Figure 1 illustrates an MS Access form with basic asset inventory information. It is easy to filter through one or multiple facilities to find asset information and update it.

2. This Is Not a Snapshot, It Is a Life Story
Next, I would suggest you collect more than just the immediate condition, immediate repairs and immediate code violations when you are in the field. Typically, condition assessments are carried out by technical experts in conjunction with the operators of the facility. There is no better time to identify and capture the anticipated major rehabilitation needed to maintain and possibly extend the life of the asset. What I have started doing is asking the field team to identify lifecycle strategies for all significant assets that do not follow a run-to-failure model or ‘do nothing until you replace it’ strategy.

Figure 2 provides a simple lifecycle strategy that illustrates the initial installation cost and additional rehabilitation activities and costs at three points in the asset’s life (the green bar stacks). Following this
strategy, this asset should see an expected service life of 30 years (the blue curve). On the flip side, if planned rehabilitation is not performed, the asset would see a reduced service life following the red curve (‘do nothing’) of approximately 20 years.

If you have been maintaining your inventory in a database structure, it is easy to apply this generic lifecycle strategy curve to all similar assets in the facility or portfolio. Add a pump, connect it to the proper lifecycle curve, and you have a clear picture of what you need to do, when you need to do it and what you need to spend to maintain that pump. Apply this philosophy across all your assets, all your facilities and all your portfolios. Now, instead of a shelf full of binders, you are maintaining a living up-to-date system and associated asset data that allows you to prioritize and plan rehabilitation activities, asset replacement and long-term funds to maintain your infrastructure.

3. Convert Information into Knowledge
Create custom and timely reports and dashboards that help you make decisions. Utilize the structure of the data, keep it up to date and create knowledge that helps you make decisions. Build reports that help you decide where best to spend your money and justify these decisions with council and the public. Figure 3 illustrates a simple, but very effective representation of information about a wastewater pumping station. Each pie chart shows the average condition of the all the assets in the facility based on replacement value. Green is new or good condition, yellow is fair, and orange and red are poor and failing, respectively. The top row shows the facility’s average condition based on not spending any money to replace or rehabilitate assets. From left to right, it illustrates now, in five years and in 10 years. Similarly, the row below shows the condition of the facility if 10% of its overall replacement value is invested in the facility each year. This example shows us a few things: Firstly, the overall condition of the facility will be unacceptable in 10 years if money is not spent on it, as evidenced by the amount of red and orange in the top right pie chart. It also shows that 10% reinvestment in the facility may be borderline acceptable for the first four or five years; however, in 10 years the facility will be in pretty bad shape and may require a higher level of investment before you reach that point. This type of report provides a powerful argument when negotiating your 10-year capital plan.

This does not have to be a complicated system; in fact, it may be better if it is not complicated. The key to success is to build and maintain the right data. Whether it is a set of condition assessments or information you have collected in your AMP, think about how it can support better decision-making. Collect and structure the data so that you can support the decisions you are making.

In summary, think about how this approach can be applied in your condition assessments, plant audits and AMP projects. A simple shift in thinking can add tremendous value to your investments. With this approach, you can achieve a practicable, sustainable and continuous asset management approach, which you can use to support decisions.
Starting from the Bottom – Rethinking Wastewater Servicing in Halton Region


The Problem
The Regional Municipality of Halton owns, operates and maintains over 90 wastewater pumping stations in seven wastewater treatment plant drainage areas. A total of 59 of those pumping stations are located in the southern portion of Oakville and Burlington, in close proximity to Lake Ontario, where the ground elevations are too low for the wastewater collection system to flow via gravity to the region’s wastewater treatment plants.

Many of these pumping stations are facing a double dose of problems: 1) they are reaching the end of their useful life, requiring renewal of the pumping station and associated force main and 2) intensification is increasing the wastewater flows which are required to be conveyed by the stations. Before launching into preparing plans for the required upgrades, the Region decided to take a step back.

These Pumping Stations are a Pain – How Did We Get Here?!
Most pumping stations in the south end of the Region were installed as new developments were constructed, particularly smaller estate developments directly on the shore of Lake Ontario, where the land was too low to be serviced by the existing trunk sewer. With some short term gain (additional development charge money and more rate payers in the community) came the long-term pain of having only one sewage pumping station per 5,000 people in the Region. These facilities burden a municipality with a lifetime of customer complaints related to odours and noise, risk of overflows and force main failures, and costs of operating and maintaining the facilities in perpetuity.

Rethinking Wastewater Servicing
Halton was (and still is) facing large capital projects in the short-to-medium term to renew/expand the existing stock of pumping stations. Before going too far down the road of no return, the region decided to rethink their wastewater servicing strategy to make it more sustainable over the long term. They asked some simple, yet often overlooked questions: Are all these pumping stations really needed? What would it take to eliminate some of the pumping stations? Is there a more sustainable strategy for providing wastewater servicing that:

- lowers the long term life cycle cost of the wastewater collection system;
- reduces the risk of wastewater spills into the natural environment;
- reduces the social impact of the pumping stations; and
- eliminates the operational complexity of the collection system.

The Approach – Starting from the Bottom
To address these questions, the region started from the invert elevation of the inlet sewer for the 59 sewage pumping stations. Reconstructing the gravity portion of the collection system that services the catchment area of each sewage pumping station would be impractical. However, it is feasible to eliminate some of the pumping stations by constructing a trunk sewer deep enough to enable a gravity connection from the inlet sewer invert.

One of the options investigated involved constructing one continuous deep trunk sewer in each WWTP drainage area, combined with small sections of local gravity sewers to connect each pumping station inlet to the deep trunk sewer. This approach would eliminate almost all of the 59 pumping stations except for a handful that would function essentially as lift stations at the downstream end of each deep trunk sewer, conveying wastewater to the three treatment facilities. However, this option was not feasible due to the high cost of constructing the trunk sewers in locations where only a few small pumping stations would be eliminated. As well, there technical issues associated with the lack of available land parcels required for the construction of the large pumping stations needed at the downstream ends of the trunk sewers.

The next potential option involved constructing several smaller sections of deep trunk sewer in strategic locations to eliminate some of the pumping stations. More than 100 different technically feasible permutations of various locations and lengths of deep trunk sewer were reviewed, each resulting in a unique combination of pumping stations that could be eliminated. The permutations were analyzed on a life cycle cost basis by comparing the cost of the deep trunk sewer to the cost of operating, maintaining and continuing to repair the pumping stations that would be eliminated.

The analysis resulted in the selection of an optimal combination that would allow the elimination of 31 pumping stations by:

- constructing small sections of deep trunk sewer;
- constructing local sewers to connect existing inlet sewers to the new deep trunk sewer; and
- completing the upgrades to the sewage pumping stations/force mains where each section of deep trunk sewer would terminate.

The total life cycle cost of the optimal combination was demonstrated to be lower than the life cycle cost of maintaining the status quo of 59 pumping stations. The life cycle cost savings calculated varied in each drainage area, depending on the specific combination of pumping stations eliminated and new infrastructure required. In addition to the life cycle cost savings, reducing the number of pumping stations also resulted in improved environmental and social outcomes and reduced risk exposure for the region. For example, eliminating pumping stations results in fewer locations with potential for noise and odour pollution to the surrounding community, reduced negative impact on the region’s aquatic ecosystems thanks to fewer
overflows into regulated areas, and fewer assets with a high consequence of failure managed by the Region (i.e., by developing response plans to provide bypass pumping).

**Innovative Construction Technologies – the Key to Success**

Much of the work required to construct the deep trunk sewers and the local sewers connecting the inlet sewers to the trunk sewer is feasible thanks to innovative construction techniques. The application of microtunneling, axis-guided boring technology, and other advanced trenchless construction methods were key to making the plan viable. Put simply, open trench construction would not be a practical method for the installing many of the gravity sewers recommended in the optimal solution.

**Improved Capital Planning**

The Region now has a long-term plan for each of the 59 pumping stations. The plan allows staff to manage the 10-year capital program for pumping stations within each drainage area holistically, rather than on an individual needs basis. Most of the construction work will not happen in the short term because a number of the existing pumping stations are in good condition and have sufficient capacity to accommodate intensification pressures. The long-term plan provides a coordinated approach, allowing the Region to proceed with greater confidence to renew pumping stations preserved in the new plan, and, more importantly, to not spend money in renewing pumping stations that should be eliminated over the long term.

**A More Sustainable Wastewater Servicing Strategy**

The approach taken by the Region of Halton is a great example of how asset management practices can be applied to making more informed decisions. The plan results in a more sustainable wastewater servicing strategy by reducing the life cycle cost of the system, and decreasing the risk of negative social and environmental impacts associated with the 31 pumping stations that will be eliminated over the long term.
Micropollutants such as pharmaceuticals, endocrine disruptors, personal care products and household cleaners have been present for decades in the natural environment. Since these substances can now be measured with confidence, they are causing increasing public concern. Studies conducted at the Experimental Lakes in northwestern Ontario have demonstrated that continuous exposure to various concentrations of some of these compounds can disrupt the spawning patterns and reproductive functions of certain fish species, and further studies are ongoing to assess the potential effect on aquatic ecosystems.

Municipal wastewater treatment facilities that employ secondary or tertiary treatment will only remove some micropollutants as part of the treatment process. However, due to the extremely low concentration levels in comparison to other chemicals present in the natural environment and the state of research, micropollutants are not currently regulated, although they remain under study and public scrutiny. The potential implications are important for Lake Simcoe, which is the largest and one of the most intensively fished inland lakes in Ontario.

Lake Simcoe is the discharge point for 14 wastewater treatment plants whose effluents are a potential aggregate source of micropollutants resulting from the use by humans of pharmaceuticals, personal care products and cleaners. While initiatives have been ongoing to protect and maintain the long-term health of the lake under the Lake Simcoe Protection Act and the Lake Simcoe Protection Plan, additional work still needs to be done to specifically address potential impacts of these micropollutants on the lake. To this end, The Regional Municipality of York undertook a pilot project at the Keswick Water Pollution Control Plant, looking at a hybrid treatment approach that combines enhanced coagulation or activated carbon adsorption with advanced oxidation using UV and hydrogen peroxide ($\text{H}_2\text{O}_2$). The purpose was to proactively evaluate an approach for reducing the concentration of micropollutants in the environment, which could be considered by treatment plants that already fulfill all provincial requirements for wastewater treatment.

The initiative was funded through the Ontario Ministry of the Environment and Climate Change Showcasing Water Innovation (MOE SWI) program, and the project was undertaken in collaboration with the University of Toronto and Calgon Carbon Corporation. The objective of the project was to demonstrate a feasible and practical solution for removing micropollutants in secondary wastewater effluent, and an approach for integrating advanced oxidation processes (AOPs) into traditional wastewater treatment plants.

In the hybrid treatment approach, enhanced coagulation/activated carbon adsorption are used to reduce the concentration of dissolved organic matter (DOM) in the secondary effluent before applying advanced oxidation using UV and $\text{H}_2\text{O}_2$. While reducing DOM in the effluent will incur costs, it is thought that these costs would be offset by the resultant improved AOP efficiency for the removal of the micropollutants. Effluent collected from the secondary clarifier was subjected to enhanced coagulation or adsorption treatment. A Calgon Carbon Rayox® Advanced Oxidation Batch Pilot Reactor (see Figure 1) was used for UV/$\text{H}_2\text{O}_2$ treatment of the pre-treated secondary effluent. The effluent was spiked with caffeine, carbamazepine.
(CBZ), 17b-estradiol (E2), sulphamethoxazole (SMZ), clofibric acid (CFA), diclofenac, and naproxen. These compounds were selected based on their reported frequent occurrence in wastewater effluents. Degradation of the micropollutants was monitored under three conditions of UV alone, AOP, and pre-treatment (PT) + AOP.

Five of the compounds are easily removed with UV alone such that more than 90% removal was obtained (see Figure 2). For these compounds, this same level of removal was obtained with or without the hybrid treatment. Nevertheless, it should be noted that the UV doses applied in the pilot were approximately 20 times the typical doses applied for UV disinfection. For other compounds (caffeine and carbamazepine), UV alone is inadequate and additional treatment with AOP is necessary (see Figure 3). With UV alone, only 37% removal was achieved, but with the hybrid treatment, average removal was 64% for caffeine and more than 70% for carbamazepine.

Pre-treating the effluent to remove organic matter reduced the electrical energy required by AOP by 25% - 50% for carbamazepine and caffeine respectively. The electrical energy was determined based on electrical energy per order (EEO) values which is the amount of electrical energy (kWh/m³/order) that is required to achieve one order of magnitude (90%) removal of the target compound in 1 m³ of water. The reduction in the EEO values for caffeine and carbamazepine are shown in Figure 4.

The pilot study demonstrates that UV alone is quite effective for some compounds, but AOP is a necessity for others. Additionally, the hybrid approach that combines enhanced coagulation/activated carbon adsorption and UV/H₂O₂ advanced oxidation improves the removal of micropollutants that are resistant to treatment with UV alone, and can reduce the UV electrical costs required to treat these compounds. For the hybrid approach, the coagulants and the activated carbon performed similarly. Nevertheless, consideration should be given to the fact that some coagulants may be incompatible with some filters and/or can change sludge characteristics, which was not investigated in the scope of this pilot work.

Advanced oxidation, compared to other treatment technologies, is a relatively expensive treatment option for micropollutants considering there is currently no regulatory requirement for treating these compounds. However, this pilot work demonstrates an approach that could be used to reduce the associated costs for AOPs, such that it can be feasible to consider integrating AOP systems into wastewater treatment plants should it become necessary to enhance efforts to reduce the concentration of these micropollutants in the environment.

About the Author: Jacque-Ann Grant is a PhD Candidate in the Civil Engineering Department at the University of Toronto. Ron Hofmann is an Associate Professor also in the Civil Engineering Department at the University of Toronto. Laura Meteer is a Water Quality Analyst in Operations, Maintenance and Monitoring, Environmental Services at The Regional Municipality of York.
A one-day seminar was conducted on Emerging Contaminants in Wastewater Systems on May 29, 2014 in Vaughan, Ontario as a partnership between the Drinking Water Research Group (DWRG), The Regional Municipality of York and the Water Environment Association of Ontario (WEAO). The event was co-chaired by Ron Hofmann of the University of Toronto and Laura Meteer of the Regional Municipality of York. More than 50 attendees representing a broad cross-section of the wastewater industry gathered to learn about the latest research on emerging contaminants in wastewater. The Toscana Banquet and Conference Centre was a hospitable venue to supplement this engaging seminar experience.

The seminar was a knowledge transfer component of a Ministry of the Environment (MOE) Showcasing Water Innovation (SWI) project on treating emerging contaminants in wastewater. A variety of perspectives on emerging contaminant research and development in Ontario were delivered by distinguished academic and government experts. The range of topics included: environmental risk assessment approaches, fate and removal of emerging contaminants by various treatment systems, and a regulatory policy development update from MOE representatives. The MOE SWI project, which focused specifically on the advanced oxidation treatment of micropollutants in secondary wastewater effluents, was highlighted in a presentation by Jacque-Ann Grant, a PhD candidate at the University of Toronto and one of the seminar organizers. As such, the seminar provided a great learning opportunity for new as well as experienced professionals. The seminar concluded with an informative presentation by the Water Environment Research Foundation (WERF) Program Director, Lola Olabode, on the Leaders Innovation Forum for Technology (LIFT) program initiative to accelerate innovation into practice and an overview of WERF’s research focus areas on emerging contaminants.
The WEAO Water For People (WFP) Committee and Water For People-Canada would like to thank all those who took part in the many fundraising events this year. With your generous help and contributions, we raised over $11,200, which means that we raised more this year than any other year! The funds raised will directly support Water For People projects in developing countries, including Bolivia, Honduras, Guatemala, Malawi, and Vietnam. Water For People-Canada is a charitable non-profit organization with an independent board that includes our own dedicated member, Don Hoekstra. WFP–Canada and WEAO operate under an official memorandum of understanding whereby WEAO transfers funds raised through its events to Water For People-Canada.

Water For People-Canada then transfers the funds to Water For People-US. While Canadian-funded projects are managed by Water For People-US, they are selected under the Water For People-Canada’s mandate. Look out for examples of the great work that Canadians are doing abroad in INFLUENTS’ upcoming publications, and celebrate some of our recent fundraising successes.

The 2014 WEAO Conference and OPCEA Exhibition, held in London, Ontario on April 6 – 8, 2014, raised approximately $8,500 through the efforts of our volunteers hosting the following events:

- the OPCEA Beverage Reception, where participants donated any sum for unlimited beverages and a glass to keep, raised over $2,000;
- the Charity Draw Table raised roughly $1,650 with all 1,000 tickets selling out early;
- the Water For People Party Monday Night Dinner at the Fox and Fiddle brought in $2,550;
- Kenadian Contracting Ltd donated $500; and
- the WEAO sponsored Conference Speaker’s gifts raised $1,800.

Another successful fundraising event was the recent Annual OPCEA Golf Tournament on June 4, 2014 in Newmarket. The 50/50 draw game raised $1,250 and OPCEA donated a further $1,500 resulting in a total of $2,750 for the Water For People cause.

Special thanks also go to all the volunteers that contributed their time and enthusiasm in organizing and promoting these amazing events: Carla Fernandes, Carolyn Lee, Dale Jackson, Dmitry Zolotnitsky, Don Hoekstra, Ed Pikovnik, Erin Longworth, Michael Chan, Ryan Aberin, and Tiffany Chai assisted with the Charity Draw and OPCEA Beverage Reception during the WEAO conference. Erin Longworth, Tony Petrucci, Mike Pearce, David Ohashi, Ed Pikovnik, and Nancy Afonso assisted during the OPCEA Golf Tournament dinner ceremony with the 50/50 draw.

Stay tuned for our next fundraising event at the WEAO Golf Tournament on September 11, 2014. As always, we will have many prizes to be won, so we hope to see you there!

2014 WEAO Conference and OPCEA Exhibition cheque presentation. Photos by Ian Smith, Toronto Water.

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**INFLUENTS | Fall 2014 | 57**
Exemplary Biosolids Management Award recipient presentations and seven technical papers were presented at the Residuals and Biosolids Session of the WEAO Conference in London on April 8, 2014. The morning session was chaired by Shirley Anne Smyth (Environment Canada) and Dean Iamarino (Halton Region). Shelly Bonte-Gelok (Ontario Ministry of Environment) and Candra Whitesell (AECOM) chaired the afternoon session.

The morning session began with a presentation by Michael Payne of Black Lake Environmental, who provided an overview of biosolids management practices in the European Union in comparison with Ontario, Canada and the United States. Payne pointed out that sludge is recognized as having value, and its disposal is no longer the ‘best’ option. Sludge as a resource can be utilized to produce energy (from digestion), organic raw materials (biosolids for land application) and minerals (phosphorus extraction).

In a world of diminishing non-renewable resources and increasing soil degradation, sludge is recognized as a renewable resource. Realizing the importance of standards for sludge use and generation by international organizations resulted in the establishment of the International Standards Organization (ISO) Technical Committee (TC) 275: Sludge Recovery, Recycling, Treatment & Disposal, convened by the Association Française de Normalisation (AFNOR) in France. AFNOR is the French national organization for standardization and France’s ISO member body. Payne provided an overview of the role of the ISO TC 275, its scope of work, working groups and Canadian Mirror Committee.

Shelly Bonte-Gelok of the Ontario Ministry of Environment (MOE) gave a presentation outlining how some of the Canadian Water Network (CWN)-funded research is assisting with the implementation of the national policy promoting the beneficial use of municipal biosolids. CWN was approved by the Canadian Council of Ministers of the Environment (CCME) in 2012. To address public concerns regarding potential environmental and human health impacts from emerging substances of concern (ESOCs) in municipal biosolids (e.g., pharmaceuticals, flame retardants, metals), the CWN has funded three projects related to municipal sewage biosolids. These projects are being led by university researchers in collaboration with municipalities, industry and government:

1. developing analytical techniques for quantifying engineered nanoparticles (e.g., nano-silver) in municipal sewage biosolids, and assessing the uptake and toxicity of these nanoparticles in earthworms and crop plants (McGill University in Montreal);
2. impacts to agricultural ecosystems from emerging substances of concern (Dalhousie University in Halifax); and
3. assessing potential biological responses in biota from terrestrial and aquatic biomes exposed to soils amended with various biosolids (Ryerson University in Toronto).

José Bicudo of Associated Engineering gave a presentation on anaerobic digestion improvements through better mixing. After providing an introduction to anaerobic digestion, explaining the benefits of proper digester mixing, and introducing common digester mixing systems, Bicudo introduced three projects involving digester mixing system upgrades – at the Lions Gate Wastewater Treatment Plant (WWTP), Alberta Capital Region Wastewater Commission WWTP and Iona Island WWTP. These projects demonstrated that good mixing allows for high-rate stable digestion, higher quality digested solids, and greater biogas production, while minimizing grit/solids deposition and scum blanket formation. Advantages and disadvantages of various digester mixing systems need to be considered in order to achieve the desired performance.

The morning session concluded with Kevin Staton of Thermal Process Systems, who gave a presentation on a case
The afternoon session opened with two presentations by 2014 Exemplary Biosolids Management Award recipients.

Kevin Staton, Thermal Process Systems.

Kevin Bossy of Bishop Water Technologies presented the company’s successful use of the Geotube® dewatering technology at the Greenway Pollution Control Plant (City of London) for dewatering ash produced from the sludge incineration process. This project received the 2014 Exemplary Biosolids Management Award in the category of Technology Development. After pilot testing in 2010, the Geotube® dewatering technology was commissioned at full scale in June 2012, replacing a two-lagoon system. Bossy noted that, although using Geotube® dewatering technology had resulted in an increase in workload associated with the day-to-day operation of the facility, the additional costs were outweighed by the recovery associated with the disposal. Dewatered ash is taken away by an aggregate company and used in production of concrete. Filtrate produced by the dewatering process is transferred back to the aeration tanks. The land formerly taken up by the two-lagoon system will be available for other uses by the Greenway plant.

A paper on dewatering upgrades to improve incinerator performance at the City of London’s Greenway WWTP was presented by Tom Woodcock of R.V. Anderson Associates Limited. The upgrades included replacing the existing dewatering facility utilizing belt presses with the new three-centrifuge dewatering system, with each centrifuge capable of processing 48 dry tons (DT) per day. Woodcock reported that the centrifuge dewatering system produces cake with a solids concentration consistently above 26%, which is a significant improvement compared to the 20% - 22% solids concentration generated by the old belt press system. At higher solids concentrations, the cake becomes autogenous (self-burning) and the auxiliary fuel is no longer required. In addition, the incineration process becomes more stable, confirmed by flue gas oxygen concentration, one of the key indicators of incineration performance. As a result of the installation of the centrifuge dewatering system, the City was able to economically add capacity to the existing incinerator and dispose of its biosolids using a stable, easily maintained process.

The afternoon session ended with a presentation by Peter A. Bradley from AECOM Canada Ltd. on the development of the detailed construction sequence for the Biosolids and Concentrate Conveyance Remedial Upgrades Project at the Ashbridges Bay Treatment Plant. The project included replacement of the existing aging biosolids conveyance infrastructure between the dewatering centrifuges in the Dewatering Building and the biosolids storage silos in the old Incinerator Building. Existing equipment had to be sequentially decommissioned and removed so that the replacement equipment could be installed within the existing building envelope without interruption of process operation. Bradley noted that the technical aspects of the design were integrated into the existing building envelope, and the sludge dewatering facility continued to operate during major construction on all levels within the building with minimal disruption.

2014 RESIDUALS AND BIOSOLIDS SEMINAR

Mark December 2, 2014 on your calendars and plan to attend our next Residuals & Biosolids Seminar, to be held at the Canada Centre for Inland Waters (CCIW), Burlington. A survey, distributed during the Residuals & Biosolids Sessions at the 2014 Conference, showed that energy recovery, dewatering optimization and treatment technologies are among the topics on which you want to be more informed. The Committee will plan the seminar with those comments in mind. Watch the WEAO website and e-blasts for more information.
2014 EXEMPLARY BIOSOLIDS MANAGEMENT AWARD WINNERS
By Shane Dennison, Bishop Water Technologies and Geoff Boyd, Walker Environmental Group

Technology Development: Bishop Water’s London, Ontario Geotube® Installation

THE CHALLENGE
The City of London operates six wastewater treatment plants (WWTPs). Sludge generated at five of the City’s plants is trucked to the Greenway Pollution Control Plant where it is mixed with the Greenway sludge and then sent to the fluidized bed incinerator. For years, ash produced through the incineration process had been discharged to a two-lagoon system where it was stored and then periodically transported offsite. While lagoons are used by many municipalities for the management of various waste streams, they do present their own set of challenges. Maintenance and general upkeep can be labour intensive, and their contents must eventually be disposed of. With limited options for final disposal of the material, and the high cost associated with removing the ash and transporting it offsite, a solution was sought which would not only reduce the operational costs involved with managing the ash material, but also produce an end product suitable for easier disposal.

THE SOLUTION
Bishop Water Technologies began working with the City of London in the spring of 2010 to develop a solution using the Geotube® dewatering technology. After performing extensive onsite bench testing and trial dewatering to determine the optimum chemical for conditioning the material prior to dewatering with the Geotube® technology, the City of London requested a pilot project be conducted.

In late 2010, Bishop Water began the project using a Geotube® unit measuring 9.1 metres in circumference and 15.2 metres long to dewater the ash. The Geotube® unit was situated around the perimeter of the existing lagoon cells. The ash slurry was diverted from discharging into the lagoon cells directly into the Geotube unit. Existing infrastructure was used to chemically condition the material. Filtrate produced through the dewatering process was discharged by gravity to the existing lagoon cells.

Based on the success of the pilot project, the City of London determined that the Geotube® units would offer significant benefits when compared to managing the waste stream using the onsite lagoon cells. The City retained R.V. Anderson Associates Limited as the lead engineering group for the project. Throughout 2011 Bishop Water Technologies worked closely with both R.V. Anderson Associates Limited and the City of London to develop a methodology and design for the installation which would allow the Geotube® units to operate as effectively as possible.

THE CONSTRUCTION
Construction of a permanent Geotube® installation began in the fall of 2011. Dewatering cells were constructed of concrete in order to accommodate the required Geotube®

HOW GEOTUBE® DEWATERING TECHNOLOGY WORKS
Dewatering with Geotube® technology is a three-step process.

In the confinement stage, the Geotube® container is filled with dredged waste materials. The Geotube® container’s unique fabric confines the fine grains of the material.

In the dewatering phase, excess water simply drains from the Geotube® container. The decanted water is often of a quality that can be reused or returned for processing or native waterways without additional treatment.

In the final phase, consolidation, the solids continue to densify due to desiccation as residual water vapor escapes through the fabric. Volume reduction can be as high as 90%.

Geotube® unit dewatering ash slurry at the Greenway Pollution Control Plant in London, Ontario.
units. Jersey barriers were used to segregate the cells, with each of the cells sloping slightly to a filtrate collection basin. The dewatering cells were originally constructed to accommodate seven Geotube® units measuring 22.9 metres in circumference and 16.8 metres long. However, to allow for increased capacity, it is anticipated that Geotube units 24.4 metres in circumference and 16.8 metres long will eventually be used in place of the 22.9-metre circumference units currently deployed.

THE PERFORMANCE
The performance of the Geotube® units to date have not only met the expectations of the City of London, but exceeded them. The simplicity of the technology allows the operators at the Greenway Pollution Control Plant to monitor the installation and operate key components of the facility remotely, meaning no additional personnel are required to operate the installation and minimal person-hours are required by existing staff.

Filtrate produced through the dewatering process is transferred to a lift station and then pumped back into the treatment process at the Greenway Pollution Control Plant for further treatment prior to discharge.

The plant was designed to provide the city with maximum onsite storage capacity of dewatered ash. The City of London intends to reuse the dewatered material as an aggregate for concrete, keeping the material out of the City’s landfill site.

The City of London is not the only entity to consider this facility a major success. The Ash Management System was awarded the 2012 Technical Innovation Award by the Ontario Public Works Association (OPWA) and the American Public Works Association (APWA) Technical Innovation Award for 2013.

Operating Programs: Walker Environmental Group Biosolids Management Program

OVERVIEW
Walker Environmental Group Inc. (WEG) owns and operates a biosolids management facility in Thorold, Ontario. Niagara Biosolids LP (NBLP) is a full-scale biosolids processing facility that manages 50-60% of all biosolids generated in the Regional Municipality of Niagara, as well as biosolids from neighbouring municipalities. The facility, a joint venture with N-Viro Systems Canada LP, was built in response to Niagara’s desire to diversify its existing liquid land application program.

NBLP uses the patented N-Viro Advanced Alkaline Stabilization process to produce a beneficial soil amendment by blending municipal biosolids with an alkaline additive. The final product is called N-Rich®. It is used primarily for soil pH adjustment and is rich in organic matter and nutrients. The demand for the product has grown each year since 2007, and has now outpaced production.

THE PROCESS
Dewatered biosolids are received into one of two enclosed bins at the front of the plant. The incoming biosolids are already suitable for land application and meet the criteria set out in Ontario Regulation 267/03 under the Nutrient Management Act before treatment at the facility. Each receiving bin has a capacity of approximately forty tonnes. The receiving area is maintained under negative pressure to prevent the escape of odours during the receipt of incoming loads.

From the receiving bins, biosolids are conveyed to a pugmill-style mixer where they are blended with an alkaline
admixture. Currently, cement kiln dust or lime kiln dust is used for this purpose. Producers sample the dust on a bi-weekly basis for analysis and are subject to regulatory criteria. Guidelines are set by the Canadian Food Inspection Agency (CFIA) under Trade Memorandum T-4-93 of the Fertilizers Act. The admixture raises the temperature of the blended material to above 52°C through an exothermic reaction between the calcium oxide present in the additive and the moisture in the biosolids. The admixture also increases the pH of the material to > 12. Through these two stressors, the alkaline admixture effectively pasteurizes the biosolids. It also adds nutrients such as calcium, potassium, magnesium and sulphur to the product.

After mixing, the product is conveyed to a rotary kiln where it is further dried and granulated. The temperature and length of time spent in the dryer is dependent on the moisture content of the mixed biosolids. If no further drying is required, the burner can be turned off and the product allowed to tumble through the kiln without supplemental heat.

The dried product is then deposited into one of four heat pulse cells. The product cures in the cells for a minimum of 12 hours at a temperature > 52°C and a pH > 12. The curing stage is designed to meet the pathogen destruction standards set by the US Environmental Protection Agency in CFR 40 Part 503 Standards for the Use or Disposal of Sewage Sludge. These guidelines have also been adopted by the CFIA. After curing and confirmatory sampling, the product is moved to the product storage building to await sale to customers.

COMPLIANCE
The Environmental Performance Department (EPD) at Walker Industries, WEG’s parent company, performs an audit of all operations on an annual basis to ensure compliance with Environmental Compliance Approvals (ECAs), permits, applicable regulations and internal standards. This program not only assures a high standard of compliance, but also motivates employees to continuously improve operations and practices.

COMMUNITY
WEG communicates with their stakeholders directly through operating committees, community groups, open houses and tours, and industry associations in order to encourage their neighbours to accept their facilities as part of their community.

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PASSING THE PLUNGER
By Carrie Brunet, Niagara Region

The ‘Passing of the Plunger’ has become a fun tradition of the Operations Challenge Committee. The outgoing chair passes the symbol of authority to the incoming chair signifying a changing of the guard. And the plunger is just that—a symbol.

The chair may be the front person, but this group is a true team. Just like the teams that compete in the Challenge each year, everyone has a role and they can all be counted on to pitch in wherever and whenever needed. The past chairs remain within arm’s reach to share their expertise, not only as past chairs and coordinators, but also as competitors. I look forward to the coming year and the fun times ahead.

If you have any questions about the Operations Challenge, please contact me: Carrie Brunet, Water and Wastewater Training Coordinator, Niagara Region – carrie.brunet@niagararegion.ca or 905-685-4225 x3767.

Coming soon:
Wastewater Microbiology Workshop
October 23, 2014 - Mark your calendars now!
Understanding microorganisms and microbiological principles is the key for ensuring the presence of a proper environment in a biological wastewater treatment facility and providing effective control of the wastewater treatment process.

WEAO’s Wastewater Treatment and Technologies Committee (WWT&T) committee – through their past successful workshops on wastewater microbiology – have helped the members of the wastewater industry in Ontario to continue to enhance their understanding of these fundamental principles.

This successful hands-on workshop will be back again on October 23rd, 2014 at the G.E. Booth Wastewater Treatment Plant, 1300 Lakeshore Rd E, Mississauga, ON.

The workshop will be co-presented by Jianrong Liu of WSP and Dave Neely of OCWA.

Workshop registration open now!
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OPCEA NEWS

WASTEWATER TREATMENT PLANT PHOTO CONTEST

Your wastewater treatment plant photo could be featured on the cover of the 2015 OPCEA Membership Guide!

Due to the success of the 2014 Directory Cover Photo Contest, OPCEA will again be running a Wastewater Treatment Plant photograph contest for next year’s directory cover. The photo contest is designated exclusively to wastewater treatment plants located in Ontario. The winner of the contest will have his/her name, company, wastewater treatment plant name and location listed on the inside cover of the 2015 Membership Guide.

Contest photos can be sent to Dale Jackson of ACG/Envirocan: dale@acgtechnology.com.

Congratulations to Pat Logan of Greatario Engineered Storage Systems, for submitting the 2014 winning photo of Ingersoll WWTP.

Photo Details: Each photograph submission must be a portrait layout in order to suit the membership guide cover. Resolution should be 300 dpi at 10 cm wide.

CONTEST CLOSES: Friday, January 31, 2015

OPCEA 23RD ANNUAL GOLF TOURNAMENT REPORT

On June 4, 2014, at the Cardinal Golf Club in Newmarket, Ontario, 50 Ontario Pollution Control Equipment Association (OPCEA) member companies and their industry guests enjoyed an excellent day of golf. In total, a record 274 golfers participated in the event. The weather cooperated, the course was in great shape, and once again the staff at Cardinal did an excellent job of hosting our annual event.

The day began with a barbeque lunch, followed by 18 holes of golf. It ended with an exceptional steak dinner and the awarding of prizes.

Our congratulations go out to this year’s champions of the John Coomey Memorial Trophy: the team from Syntec Process Equipment Ltd., which included Bob Wright, Mark Seymour, Charles Rittner, and Joe Perrotta. Congratulations also go out to the team from C&M Environmental, including Joshua Hamilton, John Hamilton, and Chris Kamps, who tied for first, but came second due to retrogression.

Water For People Canada participated in the tournament by raising $2,500 through the sale of tickets for a 50/50 raffle, with the proceeds going towards their efforts to provide clean drinking water in developing nations.

Congratulations go out to Nathan Reicheld from The City of Hamilton, the winner of the raffle, who won the draw and was presented with $1,250.

John Carney, OPCEA Golf Tournament Convenor, was pleased to add to the totals, by presenting Water For People with a cheque in the amount of $1,500 on behalf of the OPCEA.

New Members
OPCEA is pleased to welcome a new member, Sudbury Lime Limited.

A Great Networking Opportunity – OPCEA Annual General Meeting

The OPCEA Annual General Meeting will take place on February 15, 2015 at the Mississauga Grand Banquet Hall, Convention & Conference Centre, 35 Brunel Road, Mississauga. More information will be sent to OPCEA member companies closer to the date. The meeting will take place from 3:00 – 6:00pm and will consist of a Meet and Greet, followed by the Annual General Meeting (AGM). This will be followed by cocktails and dinner.

The OPCEA AGM is a great networking opportunity. It provides members with an update on the tasks performed by the OPCEA board over the last year and will provide an opportunity to discuss new business.
OPCEA PROFILE

GRAHAM SIMPSON
LIVING THE GOOD LIFE

During his more than 20 years with SEW Eurodrive, Graham Simpson became involved in many aspects of the pollution control equipment industry, from sales and marketing, to trade shows, to international regulations governing the energy consumption of electrical motors. By the time he retired from the industry in 2010, he had served as the president of OPCEA and started a stint as a director on the WEAO board of directors.

Back when he graduated from community college with a diploma in marketing, Simpson had no idea that he would one day be selling original equipment manufacturer (OEM) drives and gear motors to a wide variety of industries, including wastewater treatment plants. In fact, his first job was in banking, and it was not a good fit. His next experience – running the order desk at a machine tool company – proved to be much better.

“That’s where I got my mechanical beginning,” recalls Simpson. From there, he was hired by an electrical/mechanical distributor called Vickers Warnick. Then in 1988, he joined SEW Eurodrive as general OEM sales representative. Soon, he assumed responsibility for the company’s trade show business and became a member of OPCEA.

Simpson was then asked to join the board. Following in the footsteps of SEW Eurodrive, Heinz Held and Greg Jackson, he rose through the ranks and became OPCEA president in 2004-2005. At one point he was also asked to organize the trade show for the WEAO annual conference in Toronto. He was then asked to join the WEAO board as a director at large, and eventually became involved in the Environmental Health, Safety and Security Committee.

“I was only there a couple of years before I decided that golfing was more my calling,” laughs Simpson, adding that he was turning 55 that year and had decided to retire. Nonetheless, he has very fond memories of his time with both associations. A self-described ‘people person,’ he appreciated the opportunity to meet colleagues from across the industry.

He was also happy to hone his leadership skills as well as what he calls his ‘following’ abilities. “It’s important to know not only how to lead but also how to follow,” notes Simpson. “There are a lot of products and services sold in that industry, that, being a manufacturer you don’t get to be aware of.”

Another association with which he became involved over the years was the Electro Federation Canada, a group dedicated to moving the Electric, Electronics and Telecommunications markets forward across the country. “At the time, Canada and the U.S. were coming out with new energy regulations for electric motors,” recalls Simpson. “We were asked to review the new rules and make recommendations.”

He also had the opportunity to learn about leading-edge developments in electrical motors as a member of the New Products Group for SEW Eurodrive. His work in product research even took him to Europe a couple of times a year. Simpson has always enjoyed traveling. So when he retired four years ago, he spent the first year visiting golf courses in Florida and Myrtle Beach as well as in Northern England and Scotland. His affinity for the UK is no coincidence. He was born in Glasgow and immigrated to Ontario in 1966 when he was 10.

Like any good Scotsman, he is also passionate about soccer or ‘football,’ as they call the beautiful game across the pond.
By the time he retired from the industry in 2010, he had served as the president of OPCEA and started a stint as a director on the WEAO board of directors.

the pond. He was an avid recreational soccer player for many years and a member of the North American Rangers Supporters Association, affiliated with Scotland’s Rangers Football Club.

Although he has retired from soccer, he has not entirely retired from working with the wastewater treatment industry. Three years ago, a friend approached him for help managing a small concrete repair and restoration company, which, among other things, provides epoxy-coated and polished concrete flooring to local plants.

“I act as the general manager, office secretary, inside sales, etc.,” says Simpson. “Basically everything I’ve learned over the years, I now do for this company. It keeps my hand in things.”

He only works three days a week, which gives him plenty of time to devote to golfing and to his two-year old grandson as well as to his other hobbies, which include antique cars and traveling. He recently purchased a 1974 Triumph TR6 and a 1984 Mustang, which he plans to refurbish. Next year, he and his wife are planning to purchase a camper and travel to Newfoundland. The year after, they will go west.

No matter where he goes, there is one thing for sure. After a fulfilling career and many rewarding professional opportunities, Simpson is continuing to live the good life and enjoying every minute!

The Ontario Pollution Control Equipment Association is comprised of over 175 firms engaged in the manufacture and/or distribution of environmental and related equipment in Ontario. OPCEA is a non-profit organization dedicated to assisting member companies in the promotion of their equipment and services to the pollution control market sector of Ontario. Originally founded in 1970 under the name Ontario Sanitation Equipment Association, the OPCEA has since grown to over 150 member companies whose fields encompass a broad spectrum of equipment and services for the air and water pollution control marketplace.

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WADE HUNT
EMBRACING EDUCATIONAL OPPORTUNITIES

Not long after being hired with the Region of Durham’s wastewater division, Wade Hunt had the opportunity to become involved with the Operations Challenge. “It helped my progress in obtaining my licenses in the wastewater field,” says Hunt, who now works as the Chief Maintenance Officer at the Harmony Creek Water Pollution Control Plant (WPCP). “It teaches you how to create a team environment as well. It’s fun, educational and challenging.”

He enjoyed the traveling as well. Every year, as part of its technical conference, the WEAO holds an operations challenge where teams from various municipalities compete in five water service events. The top two teams then go on to compete at the Water Environment Federation Technical Exhibition and Conference (WEFTEC). During his time as a member of the Durham Sludge Hammers, the team represented Ontario at WEFTEC several times, in places such as Texas, San Diego and Washington, depending on where the event was held that year.

Hunt also found attending the international conference to be an excellent opportunity for networking. “When you start talking to the suppliers you find out so much about what is going on in the world of water and wastewater,” he explains. “You talk to them and get all the information you need. It’s quite educational.”

This ability to take full advantage of educational opportunities has propelled Hunt along a career path that has been both enjoyable and fulfilling. When he first graduated from Sir Sanford Fleming College’s Environmental Management Program, he found few opportunities in his field. After working as an exterminator, he was hired as a machinist at a local manufacturing plant. But after 9/11, the firm lost many of its contracts to the US and was forced to lay off much of its workforce.

At that point, Hunt decided to try applying, once again, to the Region of Durham. This time he was hired, starting his career in wastewater treatment at Duffin Creek in the dewatering department. After five years, he was transferred to the maintenance section of dewatering, where he stayed for four years before being transferred to Corbett Creek as a Maintenance Operator.

Then, three years ago, Hunt applied for a job posting at Harmony Creek and was successfully hired as the Chief Maintenance Operator. Today, he oversees the operation of Harmony Creek WPCP, including budgeting, job assignments, scheduling, training and purchasing. “Organization is key to this position,” notes Hunt. “You have to be well-organized to run a successful plant. The Region of Durham provides us with plenty of support. I can’t say enough good things about the Region as an employer.”

He enjoys the atmosphere in which he works and the leadership he has to apply. “I like being a leader,” says the CMO. “I like to get the necessary information to employees so they can pursue their training.”

Hunt appreciates the importance of training and education. Along the way to his current position, he earned licenses as a Class IV Operator and a millwright. He has also acquired all the necessary hours for a machinist’s license and plans to write the exam in the near future.

“It’s been a long time since I studied trigonometry,” he laughs, adding that, nonetheless, he is looking forward to hitting the books. Studying has always been something he has enjoyed. In fact, during his days as a member of the Sludge Hammers, the process exam was his second favourite event, right after the Safety Event.

The learning aspect was always an important part of what drew him to the Operations Challenge – in fact he hopes to attend this year’s WEFTEC in New Orleans as a judge. But the other part of the WEFTEC experience that was meaningful was the realization that the work he does has such an important impact on public health and safety.

The importance of this work is what has driven the CMO to approach the Emergency Management team to propose that the Region put together a team of water and wastewater engineers, mechanics and millwrights/electricians to repair and restore water services in regions hit by natural disasters. “After such events as Hurricane Katrina and Superstorm Sandy, it was essential to get the water and wastewater systems up and running again,” notes Hunt. “When the infrastructure fails, it is necessary to respond quickly in order to keep the public safe.”

Because of his passion for the job – and for learning and advancing – he is ready to take on new challenges, including, a position as supervisor should the opportunity arise. But for now, Wade Hunt is more than happy in his current position as CMO, running the Harmony Creek WPCP and serving the public in the Region of Durham.
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The answer to this question depends, of course, on a combination of deciding factors including the criticality of the asset, its replacement value, and the cost to maintain it.

To fully understand this question, one first needs to understand the distinction between a non-repairable and a repairable asset or piece of equipment.

Non-repairable assets are those which cannot be restored to their operating condition after their failure occurs, either because it is impossible or because it is too expensive to do so. Hence, these assets are replaced once they fail.

Repairable assets are those that can be restored to operating condition after their failure occurs. In time (after multiple failures), they may become non-repairable.

The distinction between these two types of assets leads to three maintenance/replacement strategies: “Breakdown Maintenance,” “Preventive Maintenance,” and “Preventive Replacement.”

Breakdown Maintenance is another way of saying: “Run until failure, and then fix when it fails.” This strategy is applied when the cost of replacement is low, failure is not severe, and/or the cost of maintenance is very high. Breakdown maintenance is generally applied to non-repairable assets.

Preventive Maintenance involves inspection, cleaning, adjustment, alignment, and repair or replacement of minor components if needed. It usually requires that the asset be shut down temporarily – although this is not always necessary. This maintenance strategy is usually applied to repairable assets or non-repairable assets for which failure would be catastrophic. The premise of this approach is that through preventive maintenance, the failure rate of the asset is reduced.

Preventive Replacement is a variation of the above strategy which involves scheduled replacement of an asset regardless of its condition. This approach is justified when the cost of failure is high – higher than the cost to replace the asset.

For repairable assets, these replacement/maintenance strategies can be expressed quantitatively as follows:

**Breakdown maintenance**
Total Cost per Unit Time = Cost of Failure * Failure Rate

**Preventive maintenance**
Total Cost per Unit Time = Cost of Failure * Failure Rate + Cost of Preventive Maintenance * Maintenance Frequency

Preventive maintenance has the effect of reducing the failure rate. Thus, failure Rate_{PM} is lower than the Failure Rate in the breakdown maintenance scenario.

The above concepts lead to different asset maintenance and replacement scenarios:

- If failure costs result in significant lifecycle cost increases, it may be time to schedule replacement.
- If the cost to repair is similar to the cost of replacing the asset, breakdown replacement could be considered.
- If the asset is near the end of its expected service life and the cost of failure is severe, a preventive replacement approach could be adopted.
- If the asset is repairable, but its replacement cost is less than the net present value of its remaining lifecycle cost (i.e. total cost per unit time * remaining useful life), then preventive replacement of the asset should be considered. It should be noted that the maintenance costs and failure rate of an asset may change if reliability improvement initiatives are applied.

Other factors need to be considered when determining when an asset needs to be replaced. For example, sometimes replacement is triggered by increased capacity requirements or by performance or quality requirements.

The key thing to recognize here is that sometimes it is better, and more cost effective, to apply a breakdown maintenance strategy to a portion of the asset portfolio. However, the decision needs to be made in consideration of the cost, performance constraints and risk tolerance of the organization.
Recently in Ontario, times have been exciting. Paramount, of course, was the provincial election, its result and now the direction of the new Liberal government. Looking to the not-so-distant future, there is also some exciting OCSI news and events to share.

Provincial Election

During the election period, OCSI sent questions to each party regarding their positions on infrastructure funding, planning and asset management, and a review of the Development Charges Act. I am pleased to say that we received responses from each party and those responses, along with the questions posed by OCSI, are posted on the OCSI website. Some of the parties’ responses, to be frank, were more comprehensive and engaged than others, but by just posing these questions, OCSI furthered its mandate to promote ‘Safe and Sustainable Infrastructure.’

The new cabinet was sworn in on June 24 and there was some significant realignment of ministries. The Ministry of the Environment now also includes Climate Change as part of its mandate and Minister Glen Murray will be taking on this portfolio. Infrastructure will now be part of the Ministry of Economic Development, Employment and Infrastructure under Minister Brad Duguid. We have already written to Minister Duguid, introducing OCSI and offering to meet with him.

One of the first acts of Minister Duguid in his new role will be to reintroduce Bill 141, the Infrastructure for Jobs and Prosperity Act. When the provincial election was called, Bill 141 was one of the many bills that ‘died on the order paper.’ OCSI supported the principles contained within the original Bill 141 and we anticipate that the reintroduced act will continue to promote those principles.

OCSI’s Infrastructure Forum, September 4

On September 4, 2014, OCSI hosted an Infrastructure Forum in Toronto, a half-day ‘think tank’ on two essential pillars of the infrastructure challenge: sustainable funding and affordable levels of service. This special event brought together municipal decision makers and key stakeholders to engage in a dialogue about the delivery of infrastructure in the Province. The event kicked off with keynote speakers who served as provocateurs, followed by breakout sessions facilitated by Waterlution. The groups then came back together to share the results of the breakout sessions and finished the program with an outcome statement for the Infrastructure Forum. A networking reception with a special guest followed. There were some interesting and thought-provoking discussions that resulted from the courageous conversations. Check the OCSI website for a report of the Infrastructure Forum and a copy of the outcome statement.

Wastewater Infrastructure Needs Assessment (WINA) Project

In January, OCSI commenced an exciting project ‘Wastewater Infrastructure Needs Assessment’ (WINA), which will support municipalities in their asset management processes. The WINA project will focus specifically on municipal wastewater facilities within the Great Lakes Basin. As part of the project, we are reaching out to municipalities to establish peer-to-peer groups on sustainable infrastructure planning and will be coordinating workshops for feedback on the project.

So far, OCSI has evaluated and provided input to the development of a risk-based prioritization process for wastewater systems which could assist municipalities in identifying critical projects. Over the next few months, OCSI will develop and implement surveys, workshops and consultations with municipalities and other wastewater stakeholders. A Technical Advisory Team has been established to review and provide feedback throughout the project. Results of the project will be shared in a technology transfer workshop later in the year.
The Ministry of Environment (MOE) agreed to provide OCSI (through the Municipal Finance Officers’ Association, one of our member organizations) with funding for the WINA project. A collaborative project with the Province was one of OCSI’s key strategic initiatives for 2014 and I am pleased to report that the project is proceeding well with positive feedback from both the MOE and the municipal participants. The then-Environment Minister Jim Bradley recently said, “Congratulations to the Ontario Coalition for Sustainable Infrastructure for undertaking important work which will help municipalities reduce harmful pollutants that flow from their wastewater and stormwater systems into waterways. These efforts will help protect our environment, and particularly the Great Lakes.”

**CNAM, 2014, Toronto**

OCSI also supported and helped organize the Canadian Network of Asset Managers (CNAM) annual conference in Toronto in May. In recognition of that support, OCSI and constituent organization members were able to register for the conference at the CNAM member rate, which provided registrants with a one-year membership in CNAM (a savings of $2.50), and consequently access to CNAMpedia, their collection of asset management best practices. I was invited to be part of a panel discussing the ‘Future of Asset Management in Canada’ (crystal balls were a prerequisite!) while Darla Campbell co-moderated the panel and workshop on ‘Accountaneering’. Darla also contributed greatly to the success of the conference by being part of the conference planning committee.

Through articles such as this, I will be keeping you apprised of OCSI’s progress. If you wish to know more about OCSI, please view our website at www.on-csi.ca or contact Darla at ExecutiveDirector@on-csi.ca. If you feel there are issues that OCSI should examine, please let the executive director of your respective organization know so that he/she can bring them to our attention.

OCSI brings together the combined resources of six well-established organizations to work toward sustainable infrastructure in Ontario. The Coalition comprises:

- Municipal Engineers Association (MEA)
- Municipal Finance Officers’ Association (MFOA)
- Ontario Good Roads Association (OGRA)
- Ontario Public Works Association (OPWA)
- Ontario Water Works Association (OWWA)
- Water Environment Association of Ontario (WEAO).

The mission of the Coalition is the promotion of ‘Safe and Sustainable Infrastructure.’

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<td>888-501-6508</td>
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<td>905-821-4844</td>
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<td>888-426-8180</td>
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<td>705-797-8426</td>
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<td>866-353-6464</td>
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<td>WSP Canada, Inc.</td>
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<td>Xylem Inc.</td>
<td>56</td>
<td>914-641-2160</td>
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• Self-cleaning perforated plate screens
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• FlexRake® low flow
• Screenings washer/compactor
• Auger conveyors
• 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 perforations)
• Raptor screenings washer press

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• Two & three rotary lobe P/D blowers
• Centrifugal multistage blowers
• Floating diversion curtains (for aerated lagoons, activated sludge systems & clear wells)
• Subsurface jet aeration/mixing systems (for high rate & low rate treatment systems)
• Drop in jet aerators/mixers
• 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
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• Spiral blade clarifiers

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• GBT & RDT for sludge thickening
• Belt filter presses & screw presses
• Centrifuges for thickening & dewatering

ODOUR CONTROL
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• Bioscrubbers
• Carbon adsorbers
• Chemical wet scrubbers

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• Screw pumps (open & closed designs)

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• Insertion mag flow meters with wireless data transmission
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• PWI Series DAF low profile, from 20-800 GPM
• Pipe flocculators
• Industrial wastewater treatment systems
• Coalescing oil/water separators
• Inclined plate clarifiers

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• Package potable water treatment plants
• Package sanitary wastewater treatment plants
• Package industrial wastewater treatment plants
• Package industrial process wastewater treatment plants

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