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have always found the topic of microconstituents in wastewater to be fascinating. I think it shows a real concern on the part of environmental professionals that we are looking for and taking seriously the possible effect on the environment from minute quantities of what are, for the most part, everyday household items. People splash on perfumes, cover themselves in personal care products, and pop pills on a daily basis. The average consumer is not afraid of these things in full strength on, and in, their own bodies. But we, as water environment professionals, still care about these things once treated and diluted down to miniscule levels, and so we research them. Yet, I feel a sense of panic every time some of that research makes headlines in the newspaper.

Aside from the obvious and important discussion regarding whether a chemical is actually hazardous, and, if so, what effect it has in what concentration, for me, microconstituents raise all sorts of epistemological questions over how we know things and how we individually form opinions and answers to questions such as whether or not treated wastewater is safe. As water environment professionals, we work every day to ensure the answer to these questions, to the best of our ability and understanding, is yes. To make sure we have not missed anything, we support research and studies, trying to measure ever smaller quantities and looking for increasingly subtle effects.

Every time we manage to detect something new in our effluent, we see the inevitable media reports that our effluent contains some new ‘toxic’ compound, apparently leading many to believe we are destroying our rivers and lakes, and potentially the entire ecosystem. Generally, this leads to calls from at least some concerned citizens that we need to remove this chemical from wastewater immediately. Apparently, their personal answer to “is wastewater safe?” has gone from a “yes” (or maybe an “I don’t care enough to know”) to a resounding “no” in only a few minutes. Is it not odd that some people would readily accept that a chemical they have probably never heard of, which they have likely used on a regular basis for years, is suddenly destroying the world? This rapidly formed opinion seems to ignore lots of evidence to the contrary. The very treatment process we use to treat the wastewater is a complex living, breathing ecosystem that worked fine. The rivers and lakes downstream of our plants appear to be doing well, and, in many cases, doing better than they did historically. We may even do toxicity testing and find that the effluent is not inherently toxic. Even we human guinea pigs who work with (and sometimes in) raw wastewater on a daily basis do not show any effects. So, on the face of things, there does not appear to be a problem. Yet, a single news story can somewhat change people’s opinions.

Why, then, does the new knowledge of the presence of some minute constituent in the effluent generate such interest in the media, lead to such dire conclusions and appear to mean more than the huge amount of evidence generated by our daily experience of living and working with wastewater? Maybe it is because the environmental effects may be startling to most people. I think most people are alarmed when it is claimed that a chemical can cause fish to change sex, (probably because most people do not know fish can change sex naturally), or some other seemingly strange outcome that people fear might happen to them or their children. This hypothetical fear seems to overcome logic and experience, leading people to believe that the shampoo they use every day might somehow return via the sewer, the wastewater treatment plant, the lake, the water plant, and the tap, to turn them into something from a SciFi movie, even though it only cleaned their hair this morning.

Let me be clear, I am not saying that some microconstituent may not be having a real impact on the environment, or that we should not continue to study these compounds for potential environmental effects. Also, if and when we do find specific chemicals, which we cannot economically treat, causing unacceptable impacts, we should help encourage product reformulation to avoid the use of that chemical. What I am wondering is why human reaction to these scientific studies is so dramatic and why reactions tend to revolve around the most current isolated finding, rather than the larger collective body of evidence? Maybe it has to do with the average person not knowing enough about wastewater treatment or the environment to do the research on microconstituents. It provides information that furthers our understanding of the world, and we should keep doing it. Hopefully, someday, we will even know enough to really understand how and why the various constituents in effluent contribute to its safety. I just hope that people’s decision-making processes are not overwhelmed by sensational new stories about this research before we learn enough to begin making well informed decisions.
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REDUCING OUR ENVIRONMENTAL IMPACT

This issue of INFLUENTS is about ‘microconstituents’, the term chosen when discussing the multitude of chemicals that are found in air, water, wastewater effluents, biosolids, etc. This does not mean that these chemicals have suddenly appeared, but that analytical capabilities and awareness allow us to search for more substances and at levels far below what has previously been possible. Chances are these substances have been in wastewater and biosolids at some level since humans started using the products manufactured by personal care product and pharmaceutical industries.

As reasoning beings, we have to remember that humans demand products to make our lives easier, cleaner, and healthier. The constituents of these products are not always flushed down the drain or dumped in sewers as a means of getting rid of excess product, but come through normal excretion processes of the human body (pharmaceuticals and natural hormones), as well as daily habits related to personal hygiene, cleaning, car washing, etc.

Sewage treatment processes were not originally intended to remove these chemicals from domestic sewage. Depending on the chemical and the sewage treatment process, they may be removed, changed to another chemical form, or flow through to discharge.

This issue will provide the reader with considerable scientific and technical background on microconstituents. The message I would like to convey is that it is not just the industries manufacturing the products, nor the sewage treatment plants that have to try and remove the residues, but we, as consumers, have to demand simpler products. Obviously, we cannot stop the flow of natural hormone products, nor the presence of pharmaceuticals that have saved many lives, but we can reduce our demand for ‘easier’, ‘cleaner’ and ‘healthier’ fast-fix solutions. We are all responsible for the end product. Therefore, we must all work to reduce contributions of these microconstituents to the environment. Take a look around your home and office to see what part you and your neighbours play in contributing microconstituents to the wastewater treatment process. See what you can do to reduce the need and the environmental impact.
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Ten years ago, microbiologist Ed Topp decided to devote his research to the study of microconstituents in biosolids. At the time, it was still a relatively new field. In fact, until then, the research scientist with Agriculture and AgriFood Canada had been working with soil microbiology for 16 years, researching such issues as the persistence of pesticides.

Then came Walkerton. “When Walkerton happened, I found the situation extremely shocking,” recalls Topp. “That is when I started working on water and microbiology.”

At the same time, the scientist was becoming increasingly aware of the presence of emerging organic contaminants in rivers and streams. Meanwhile, his colleagues at Environment Canada were detecting unusual changes in aquatic life. “The hypothesis was put forward that agriculture might be at the source of whatever agents were problematic in fish,” recalls Topp.

But, the researcher’s interests went much further. What exposure, he wondered, might humans have to these trace organics? And what was the significance of agriculture as a source of these microconstituents? These are questions he has been investigating ever since.

The concern regarding trace organics is driven by two factors, says Topp. “In the environment, we are now widely detecting drugs and other chemicals released from detergents,” he explains, adding that surveys have found these microconstituents in surface and groundwater across the US, Canada and Asia. “The concern is that humans and wildlife are being exposed – maybe chronically – to low concentrations of these substances.”

Because some of these are chemical contaminants that people excrete, Topp and his team are focusing on biosolids as the primary route of exposure. Households also consume other chemicals that go down the drain in the sink, toilet or bathtub and make their way to the sewage treatment plant.

“We are trying to determine what chemicals are in the biosolids,” Topp explains. “What happens when they go on land? Do they break down? Do they move into the adjacent water? Do they move into crops?”

These are important questions for someone who firmly believes that biosolids are an important resource for agricultural land. After all, agriculture involves adding nutrients – nitrogen and phosphorus – on land where they will be absorbed by either crops or livestock. People then consume these sources of nutrients and excrete a fraction of these same nutrients into biosolids. “If you want to be as green as possible, you have to close that loop,” says Topp. “You want to return these nutrients back onto the land, if you can do it safely.”

Herein is the crux of Topp’s research. His current projects aim to answer the very questions which will help scientists assess the safety of biosolid application – both human and animal – on agricultural land.

These projects include understanding the fundamental processes that determine the on-farm fate of pathogens, organic contaminants and nutrients. So far, Topp and his team have found that some of the more stable chemicals do not get broken down at the sewage treatment plant. Some will go out with the effluent and others will be present in biosolids that are applied on agricultural land. In some cases, biosolids are loaded with high concentrations of chemicals – some stable, some not. To date, the primary focus of the research has involved documenting the movement of these chemicals from fields that receive biosolids. That movement often involves water.
“We have a heavy interest on how agricultural practice in Canada affects water quality,” explains Topp. As a result, the research scientist is periodically invited to speak at meetings of the WEAO. Over the years, he has worked closely with many influential people in the Association.

“We have found that microconstituents can indeed move off agricultural land,” says Topp, “but, at very low concentrations. So far, when we look at the toxicological information available, we have not found any evidence that these concentrations are problematic.”

Nevertheless, it is important to manage even this small of a risk. This is why the research team also works on the development of risk management strategies. Projects in this area include developing new treatments for organic wastes as well as new and improved handling and application practices and technologies to enhance nutrient use efficiency and reduce the environmental and health risks from organic residues. The team is also collaborating with other colleagues at Agriculture Canada who are doing work on controlling drainage to prevent water from moving off tile-drained fields.

Whenever a new practice or technology is applied, the team then performs a risk management validation to assess its efficacy. This validation can be fairly complex. For instance, one management strategy tested involved denying pasture animals access to water. “You would hope that this would improve water quality,” says Topp, “but, when you are in a mixed-use area, agriculture may not be the source of fecal pollution. Septic systems, water treatment plants, and wildlife habitat all come into play.”

In this particular case, cryptosporidium counts actually increased. However, the scientists were able to identify the source as the local muskrat population, whose habitat had increased now that livestock was kept away. Furthermore, the muskrat cryptosporidium was found to be harmless to humans.

It is this kind of methodical research in which Topp and his team are engaged. Lately, the researchers have focused their attention on antibiotic resistance. They have been comparing the levels of antibiotic resistant bacteria in fields that have been treated with biosolids and those that have not. The next step will involve identifying whether the resistant bacteria were already present in the biosolids or whether bacteria in the environment have become resistant due to antibiotic residues. Then the team hopes to launch into another area of risk assessment by determining if biological or chemical agents are taken up by the crops grown on land where biosolids have been applied.

The risk assessment, management, validation continuum is a process that is ongoing. It is also necessary.

Topp notes that this research generates the scientific information which decision-makers use to make policy. “The more we know without being biased one way or another, the more comfortable all the different stakeholders can be with decisions made around biosolids application,” he explains. Considering the complexities involved with capturing a complete picture of the state of microconstituents on biosolids-treated agricultural land, Topp and his colleagues should have their hands full for many years to come.

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n celebration of the holiday season and another year of growth, the New Professionals Committee, in collaboration with the Ontario Water Works Association (OWWA) Young Professionals Committee, held its annual Holiday Bash. This event always provides a great opportunity to catch-up with friends and colleagues we may not have seen enough of throughout the year.

This year’s Holiday Bash was held on Friday, December 4, at Watermark Irish Pub, a Toronto Waterfront lounge/bar with great atmosphere. The event recorded another well attended NP/YP event, with over 45 new professionals and students attending for some fun, food, and socializing.

Special thanks to George Lai from the Ministry of the Environment, who attended the event as the past-president of WEAO. George provided helpful advice and tips to students and NPs who are pursuing their careers in the water and wastewater industry. Also among the attendees was Vanessa Chau from CH2M HILL, a WEAO director.

Big thanks go to Ben Pressman of York Region and Tina Zhang of Genivar for organizing the successful social event for the WEAO NPs and OWWA YPs.

Congratulations to Winners of the 2009 WEAO Scholarships

Rafiq Qutub, AECOM and Jeremy Kraemer, CH2M HILL, 2009 WEAO Scholarship Program Managers

JACQUE-ANN GRANT

Jacque-Ann is a PhD student in the Drinking Water Research Group in the Department of Civil Engineering at the University of Toronto. Jacque-Ann’s work, under the supervision of Dr. Ron Hofmann, is focused on pharmaceutical
and personal care products microconstituents in the aquatic environment. She is investigating the optimization of current wastewater treatment mechanisms to improve the efficiency of advanced oxidation processes for the treatment of these pollutants. She plans to pursue post-doctoral research and contribute to the growing scientific work in this area.

Prior to commencing PhD studies, Jacque-Ann was an Environmental Programme Officer at the Environmental Management Authority in Trinidad and Tobago. She was responsible for conducting environmental assessments of proposed development projects. Throughout her employment tenure, Jacque-Ann was exposed to the impacts of developments on water resources. Her essay discussed the emergence of pharmaceuticals and personal care products in aquatic environments in Ontario, and the effectiveness of current treatment technologies.

His impressive academic performance placed him on the Dean’s honour list every term, and he stands out as one of the top undergraduate students in his program. His essay focused on the need to improve the public education system to integrate water stewardship concepts throughout elementary school curricula.

BARRY O’DOHERTY

Barry is an undergraduate student in the Environment and Business program at the University of Waterloo. As part of his co-op experience, Barry worked at the Public Education and Outreach Department in the Regional Municipality of Peel. He was involved with outreach activities for school age children, teaching them about water treatment and source protection, as well as organizing tours of wastewater treatment plants. Barry believes that a major public education campaign is required to promote water conservation in Ontario, and that the public education system needs to incorporate water stewardship throughout the elementary grades, and not be restricted to science classes. Barry’s references indicated that he is extremely motivated in the water and wastewater field, and he demonstrates the capacity to be a strong leader.

MARYAM REZA

Maryam is a Masters student in the Department of Chemical Engineering at Ryerson University, working under the supervision of Dr. Manuel Alvarez Cuenca. Maryam’s research is focused on the development of a biological nutrient removal (BNR) unit. Her references describe her as having the creativity, dedication and professionalism well beyond what is expected of a graduate student. She exhibits strong academic performance and involvement with extracurricular activities, especially WEAO’s Ryerson Student Chapter, where she is currently the chapter president. Maryam’s essay discussed the issue of nutrient loading in natural waters and the available control technologies. She discussed the limitations of current BNR systems, including excessive residence times and high operating costs. Maryam described her research designing an innovative BNR system that has a smaller footprint, shorter hydraulic residence time, lower capital cost and higher removal efficiencies than conventional BNR systems. Her design received a United States provisional patent and is currently being tested at Ryerson University laboratories.
The Student Chapter Program is moving into a new and exciting direction. In the fall of 2009, the Water Environment Association of Ontario (WEAO) and the Ontario Water Works Association (OWWA) agreed to venture forward in the formation of joint student chapters on a case by case basis.

The WEAO New Professionals (NPs) and the OWWA Young Professionals (YPs) have been discussing and working towards developing a joint student chapter program since 2008. Upon approval of a Memorandum of Understanding by the Boards of both associations, the NPs and YPs presented the joint student chapter concept to a receptive audience of over 25 undergraduate and graduate students as well as faculty at the University of Western Ontario (UWO) on November 10, 2009.

The event featured presentations by three WEAO and OWWA directors, Gary Burrows (City of London), John Braam (City of London), and Tom Moulton (EMCO Corporation), who provided an introduction to the associations, the industry, and Water For People, and also offered the students some career advice and tips.

A number of NPs and YPs, including Monique Waller (CH2M HILL), Mark Ortiz (City of Toronto), Charlie Chen (AECOM), Alex Sandowski (Ipex Inc.), and Kathleen Hum (CH2M HILL) discussed career options in the water and wastewater industry. To wrap things up, Alvin Plobello (AECOM, formerly of the McMaster University WEAO Student Chapter) and Kellie Superina (University of Waterloo OWWA Student Chapter) both shared their student chapter experiences. Laurie Belgrave-Sookhoo (Genivar) and Vaughn Ash (Thompson Rosemount Group), two UWO alumni whom have taken on the role of ‘buddies’ for the UWO Chapter, also attended the event to meet and chat with the students.

A handful of keen students showed interest in leading the start-up of a joint student chapter at the UWO. The constitution and bylaws have since been drafted and the students have already started planning for a speaker event and possible plant tour in early 2010. Once the UWO Student Chapter’s constitution and bylaws have been approved by both association Boards, it will become the WEAO and the OWWA’s first joint student chapter, and the proud accomplishment of a long-standing collaboration between the WEAO NPs and OWWA YPs.

Also published in OWWA Pipeline Magazine, Spring 2010 issue.
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Over the past two years, Ryerson University Student Chapter has grown quickly and become one of the most active student groups within both WEAO and Ryerson University. The Ryerson Chapter began with only seven members back in 2007 when it was initiated with the help of our faculty advisor, Dr. Cuenca, and the NP Committee past-chair, Edgardo Tovilla. We were able to organize a dedicated committee to promote our chapter and now have over 100 members. The composition of the Ryerson Chapter is very diverse and includes undergraduate and graduate students from chemical, civil, and environmental engineering as well as biology/chemistry programs. This diversity has given us the flexibility to plan a broader range of activities which highlight our aim in promoting WEF, WEAO and the water environment in general.

Our first event, held in November 2008, was a seminar on careers in the water/wastewater industry and was a great success with over 50 attendees. In the last year, the chapter has organized and hosted a technical session on Wastewater Treatment Technologies as well as Asset Management and Decentralized Treatment Plants that was organized in collaboration with the WEAO University of Toronto Chapter. In September 2009, we had our first seminar on Automation of Wastewater Treatment Facilities, followed by a plant tour in October and a technical session on Membrane Bioreactors in November. In January, there was a seminar on Biosolids Quality and Land Applications, with Mr. Michael Payne from Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) as our keynote speaker. The seminars that we have organized from the beginning of the chapter until now have been kindly supported by WEAO. We would like to thank Shelly Singh-Ahmed, Steve McMinn, Vanessa Chau, Terry Martins, George Crawford, Brian Hurding and Ann Ndegwa for their engaging presentations and invaluable support.

In October 2009, we toured the Ashbridges Bay WWTP, thanks to Mr. Ian Smith, plant manager, who graciously accepted our request for a tour. He guided us through various treatment stages and gave us an excellent talk about the plant’s history, current status, and future plans. This plant tour was a great opportunity for students to witness first-hand the processes involved in the treatment of wastewater collected from all over the City of Toronto.

In addition to our chapter’s internal activities, Ryerson members participate in many of the WEAO and, particularly, NP Committee events. These events provide our members with great networking opportunities and a better understanding of the relevance of WEAO. Ryerson Chapter formed its first student design competition (SDC) team in the fall of 2009. Ryerson’s team consists of four members who will compete at the WEAO annual conference in London, ON. The Ryerson SDC team is highly motivated and is working diligently on the project with the supervision of our faculty advisor.

We would like to extend our thanks to Dr. Manuel Alvarez Cuenca in the Department of Chemical Engineering for providing us with his continuous guidance. Serving as executive members of the Ryerson Chapter has been a rewarding experience and we look forward to a bright future for our chapter.

More information about the WEAO Ryerson Chapter is available on our website http://stw.ryerson.ca/~weao/.
As an organization, WEAO has done a lot over the last several years to build a strong profile and membership experience for students and New Professionals (NPs). This has included special activities for students and NPs at the Annual WEAO Technical Symposium & OPCEA Exhibition. This year’s conference, April 18-20 at the London Convention Centre in London, ON will have the following events of particular interest to students & NPs:

WHOLE CONFERENCE

Lunches are included for the first 40 students who are pre-registered by March 12 (early bird registration)
Networking Board: Your chance to view various employers and job postings and have your résumé posted. Email your résumé to Anthony.Abbruscato@ch2m.com by April 9

Sunday, April 18
12:00-4:00pm • 2nd Annual Student Design Competition (SDC)
1:00-4:00pm • Tour of Oxford PCP (note: # of available spots is limited; pre-registration is required and the fee is $20)
6:00-7:00pm • The Social Hour: Connecting New and Seasoned Professionals
7:00-10:00pm • Ice Breaker Reception

Monday, April 19
All day • Technical sessions, including New Professionals session
12:00-2:00pm • Awards Lunch, including announcement of winners of SDC
1:00-7:00pm • OPCEA equipment exhibition

4:15-5:15pm • Student Panel Discussion:
Career Paths in the Water Environment Industry
Evening • Students & NP social dinner (location yet to be determined)

Tuesday, April 20
All day • Technical sessions
All day • OPCEA equipment exhibition
9:00am-3:00pm • Operations Challenge
4:00-5:00pm • Totally Wasted Game Show
7:00-10:00pm • Conference Banquet, including announcement of the Best Student Presentation Award

For students and NPs, the annual conference is probably your best opportunity for meeting people in the water quality industry in Ontario and learning about what is going on. Best of all, it is free for WEF/WEAO student members ($75 for non-members, or become a WEF student member ahead of time for just $25 USD at www.wef.org) and discounted for NPs ($425 for early bird registration).

Read about the positive feedback on last year’s conference from the perspective of students, new professionals, and NP members on pages 12-19 of the summer 2009 Influents magazine (http://www.weao.org/archive/2009_02Summer/Influents_2009_2-Summer.pdf).

We also have a brochure available providing further information about the students’ conference experience. You can use this to advertise to your student chapter about the benefits of coming to the conference. To obtain a copy or for more information about student and NP conference items, contact Charlie.Chen@aecom.com (NP Committee Chair) or Anthony.Abbruscato@ch2m.com (NP Conference Coordinator).
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39th Annual WEAO Technical Symposium and OPCEA Exhibition

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Welcome from the Chair

On behalf of the Conference Committee, I am pleased to invite you to the 39th Annual WEAO Technical Symposium and OPCEA Exhibition, April 18-20, 2010. This year, we are returning to London Ontario where we will once again be graced by the combined services and hospitality provided by the London Convention Centre and Hilton London. Just a short trip along the 401, or by train, the City of London offers many amenities and accommodations. For your convenience, special conference pricing has been secured at both the Hilton London and the Delta Armouries. The conference theme ‘ONE World…. ONE Water Environment,’ launched in 2008, has become a staple in our organization as we continue to highlight our contribution to the environment and wastewater industry.

Our keynote speaker is Bob McDonald, host of CBC Radio’s Quirks and Quarks and a reporter for CBC Television’s The National. For over 30 years, Mr. McDonald has been communicating science through media and, as host of the 7 part series ‘Water Under Fire,’ Mr. McDonald is familiar with the emerging challenges in the water and wastewater industries.

The OPCEA Exhibition will once again bring the latest and greatest technologies and services right to our door with over 100 booths to discover.

With nearly 100 abstracts submitted this year, we have once again put together a superior technical program filled with topical issues and experiences.

Building upon the success of the Student Design Competition launched in 2009 by the New Professionals Committee, this year’s event will see more than double the contestants on Sunday afternoon. Be sure to attend and support the future of our wastewater industry!

We look forward to cheering on our teams of professional wastewater operators as they compete in the Operations Challenge for the title of representing Ontario at the WEF Conference in the fall. The PWO Tour will visit the Oxford PCP, currently the largest membrane plant in Canada, on Sunday afternoon. New this year, we are offering a special Professional Wastewater Operators (PWO) program. Recognizing operators as the imperative front line professionals, this admission package will provide a full day workshop for operators to further sharpen their skills and offer networking with peers.

Keeping with our ‘recession busting’ strategy from 2009, we are pleased to offer last year’s registration prices for the 2010 conference. For convenient online registration, please visit www.weao.org. On behalf of the Conference Committee, and all of the WEAO volunteers, I look forward to seeing everyone at the London Convention Centre in April!

Neil Awde, Conference Chair

President’s Message

The time to register for our annual conference is here again. I’d like to invite you to join us in London Ontario, April 18 to 20th for the 39th annual WEAO Technical Symposium and OPCEA exhibition. We have a great team of people putting together this year’s events and it promises to be a good time.

Join us to get reacquainted with old friends, make some new contacts and learn about the latest advance in the field of wastewater treatment and the water environment.

Mark Rupke, President

The Ontario Pollution Control Equipment Association Exhibition

OPCEA expects over 100 member companies to come together to exhibit their equipment and services for the Water & Wastewater industry. The OPCEA trade show will be attended by many consultants, operators and other industry professionals who will be looking for new ideas, technologies, and professional expertise from the OPCEA exhibitors. Take this excellent opportunity to bring yourself and others in your group up to date on what’s new in the equipment and services side of the industry. New for this year, the exhibit area will be open in the morning in addition to the regular show times during all coffee breaks and Tuesday lunch. As always, be sure to also join us for a relaxed get-together during our Monday evening reception.
Executive Director’s Welcome

Welcome to London and the London Convention Centre for the 39th Annual WEAO Technical Symposium and OPCEA Exhibition.

It has been my privilege to represent WEAO as Executive Director. In this time I have seen many changes in WEAO’s evolution. We have taken on new issues such as Asset Management and Climate Change; increased our profile with provincial ministries; and expanded associations with others such as the Canadian Association for Water Quality, and OASIS. Each of these items builds the WEAO image, as does this conference. Enjoy the conference, a valuable opportunity to make new friends, develop contacts, and share your passion for protecting Ontario’s water environment. For those of you new to the Conference you will see high quality presentations and an extremely well organized event. This is all due to the hard work of our many volunteers.

Sincerely,
Catherine Jefferson

WEF Representative

Ed McCormick is a member of the 2009-2010 Board of Trustees for the Water Environment Federation (WEF), an international organization of water quality professionals headquartered in Alexandria, Va.

He is currently Manager of Support Services at the East Bay Municipal Utility District (EBMUD) in Oakland, Calif., where he has worked for over 25 years following five years in the private sector. In this role, he is responsible for EBMUD’s wastewater and recycled water strategic planning, engineering, construction, information systems and public outreach. Ed spearheaded the creation of the California Association of Sanitation Agencies’ (CASA) Biosolids Program, California’s first statewide biosolids management advocacy program, and pioneered the first-ever large scale Food Waste-to-Energy Project at a U.S. wastewater treatment plant, winning U.S. EPA Region 9’s 2006 Environmental Achievement Award.

Ed was also Project Manager of the landmark West Coast Benchmarking Study of seven major wastewater agencies totaling over 10 million customers.

A member of WEF since 1997, Ed has served on the Federation’s House of Delegates and as the Chair and Vice-Chair of the WEF Utility Management Committee, as well as Vice Chair of the Long Range Planning Committee. In addition, Ed chaired WEF’s Peer Review Committee for the Assessment of Reconstruction Costs and Debt Management for Wastewater Utilities Affected by Hurricane Katrina report that was published in 2006 and presented to Congress.

Keynote Speaker: Bob McDonald

Monday April 19, 2010
8:30 a.m.

Bob McDonald has been communicating science internationally through television, radio, print and live presentations for more than 30 years. He is the host of CBC Radio’s Quirks and Quarks, the award-winning science program with a national audience of nearly 500,000 people. He is also a regular reporter for CBC Television’s The National as well as Gemini winning host and writer of the children’s series Head’s Up. Bob has also hosted Greatest Canadian Invention and the seven part series Water Under Fire.

As a print journalist, McDonald has authored three science books and contributed to numerous science textbooks, newspapers and magazines including The Globe and Mail, Owl Magazine and many others. His latest book is Measuring the Earth With a Stick. He wrote the introduction to The Quirks & Quarks Question book and the Guide to Space: 42 Questions (and Answers) About Life, the Universe, and Everything.

Beyond his work in media, Bob sits on several boards and is Chairman of Geospace, an exciting new environmental centre and planetarium for the Toronto Waterfront.

McDonald has been honoured for his outstanding contribution to the promotion of science in Canada as the recipient of the Michael Smith Award from the Natural Sciences and Engineering Research Council, the Sir Sanford Fleming Medal from the Royal Canadian Institute and the McNeil Medal from The Royal Society of Canada. McDonald was also the recipient of a 2008 Gemini Award for Best Host in a Pre-School, Children’s or Youth Program or Series.

Bob has received four honorary Doctorates, from the University of Guelph, Carleton University, Laurentian University and McMaster University. Bob will speak to the issues and challenges facing both our industry and the expansive topic of water in general.
Conference Events

Operations Challenge
Come see some of the best wastewater personnel in Ontario display their expertise during the 39th Annual WEAO Technical Symposium and OPCEA Exhibition. The event will mark the 20th consecutive year for the Operations Challenge Competition. Participants are required to compete in five events testing their skills and knowledge against competitors throughout the Province. The five events are: Collection System, Laboratory, Process Control, Pump Maintenance and Safety.

Each Operations Challenge Team must follow the Water Environment Federation (WEF) requirements that team members be drawn from Professional Wastewater Operators (PWO) members, currently employed or retired, from one or more facilities or municipalities and each team must be comprised of at least two operators in non-supervisory roles.

Interested in Participating?
Be a part of the Operations Challenge Competition by demonstrating your expertise and professionalism by entering a team or becoming a volunteer on the Committee. To register a team for the Operations Challenge, please contact John Rammler at 905-576-9844 or john.rammler@durham.ca

For more information on the Operations Challenge please visit: www.weao.org/committees/Operations_Challenge/Operations_Challenge.html

“Totally Wasted” Game Show
Test your knowledge of the wastewater industry. Participate or follow along and cheer as teams compete in the 11th annual Totally Wasted Game Show (TWGS) that will take place following the Operations Challenge Competition on the exhibition floor. Team winners will each receive a trophy to proudly display their vast knowledge of our industry.

Fashioned after a popular TV game show, the TWGS quizzes contestants with questions comparable to those found on Provincial Certification Exams as well as some questions designed to raise a smile. The TWGS is both educational and entertaining. Teams should be comprised of a consultant, OPCEA supplier and professional operator.

Don’t delay, the first four teams confirmed will be the contestants for the 2010 Totally Wasted Game Show. To register teams please contact John Rammler at 905-576-9844 or john.rammler@durham.ca

PWO Tour
The Oxford Pollution Control Plant in London will host the 2010 PWO tour on Sunday April 18. Oxford PCP is one of the largest membrane filtration plants in Canada and certified to pump a daily flow of 17.25 ML. Attendees will get a close-up look at the plant, including its recent expansion and various treatment buildings. Representatives will be on hand to demonstrate and discuss Plant Operations and Design, Rotary Drum Screens, Membrane Filtration Systems and Ultraviolet Disinfection.

A bus will leave from the London Convention Centre at 1:00 p.m. and return by 4:00 p.m. Pre-registration for the tour as part of your conference registration is required. Space is limited and will be on a first come first served basis. The tour will not be cancelled due to weather, so dress appropriately - safety shoes/boots are required.

For more information, please contact Carrie Brunet, Niagara Region at 905-685-4225 x3767 or e-mail carrie.brunet@niagararegion.ca regarding the Professional Wastewater Operator (PWO) Technical Session and Tour.

Operator Certification Exam
WEAO will once again be hosting an Operator Certification examination session at the Annual Conference. It will take place on Tuesday, April 20th at the London Convention Centre, London commencing at 9:00 a.m. Please report to the Registration Desk in the Upper Foyer before 8:45 a.m.

The Ontario Water Wastewater Certification Office (OWWCO) will provide registration services for all levels of Wastewater Treatment, Wastewater Collection, and Water Treatment, including Operator-in-Training (OIT) examinations, but space is limited so sign up soon! Participants wishing to register for an exam must submit their application form and fees directly to the OWWCO no later than March 22, 2010. Applications, instructions and fee structures can be found at http://www.owwco.ca/certificationexams.htm

All persons registered for the Operator Certification examination session at the conference will be offered a complimentary pass to the exhibition show floor for Tuesday afternoon, April 20, 2010.

New this year! WEAO is offering a one-day Professional Wastewater Operators (PWO) program on Monday, April 19th entitled “Wastewater Certification Challenge” that may be beneficial to those writing their exam on Tuesday, April 20th. This PWO program will deal with exam writing strategies and focus on challenging exam topics. It also includes an invitation to the Operator’s Challenge Meet n’ Greet from 4:00 p.m. - 5:00 p.m. and an invitation to the OPCEA reception on the show floor from 5:00 p.m. – 7:00 p.m. If you are intending to register for an examination with the OWWCO as well as attend the WEAO Conference please check the box on the WEAO Conference Registration form indicating you are registered to write an exam.

Please note: that checking the box on the Conference Registration form will not register you for the examination, you must register for all examinations directly with the OWWCO.
New Professionals Program
Those new to the industry should be sure to take advantage of the New Professionals (NP) program. This includes discounted conference fees, a special Social Hour to meet seasoned professionals, and a “New Professionals” technical session on Monday where NPs will present their current projects. To qualify as an NP, you must have less than 10 years employment experience in the wastewater industry or be under 35 years of age.

Student Program
Students who are WEF/WEAO student members get free conference registration which includes all the icebreakers, technical sessions, equipment exhibition and in addition, the first 40 student registrants will receive free lunches. There will also be a Networking Board, the 3rd annual award for Best Student Presentation, and the 2nd annual Student Design Competition (SDC) presentations.

Networking Board
Are you looking to hire new employees? Or are you looking for employment in the water environment industry? If so, then be sure to use the conference’s Networking Board. Resumes, company information, and job opportunities can be posted on this year’s Networking Board by sending a PDF version to Anthony Abbruscato at Anthony.Abbruscato@ch2m.com. Employers can request an electronic copy of the resumes ahead of time in order to set up interviews at the conference.

Guest Program 2010
The Guest Program will begin with the group meeting for breakfast on Monday morning. After breakfast we will be off to a day of crafting. We will learn a variety of stamping techniques and show our artistic side by creating cards. When the day is done we will return to the hotel with our cards and supplies to continue being creative at home. Tuesday we will meet once again for breakfast and then off to do some shopping.

Water For People Canada Charity Draw Donations
As has become tradition at the conference WEAO and OPCEA will be holding fund raising events for the charity OPCEA hosts a reception on Monday evening and the proceeds from beverage sales go directly to WFPC. The Charity Draw is another great fundraiser that has become one of the many highlights of the conference, with the final drawings taking place at the banquet on Tuesday evening. Great fun is had by all as the draw takes place and the winners’ names emerge. WFPC changes the lives of many people across the face of the earth every day. Help us to help them continue this important work. Many of last year’s conference sponsors and OPCEA’s exhibitors generously contributed items for the charity draw. If you wish to donate an item this year please contact the WFPC coordinator for this draw, Dave Kirkland at 905-670-2660 or dkirkland@kenaidan.com

Hotel Information
MAKE YOUR RESERVATIONS EARLY TO GET THE GROUP RATE!

Hilton London - 519/439-1661 or 1-800-HILTONS by March 27/10, or
Delta Armouries - 519/679-6111 or 1-800-268-1133 by March 17/10.

Credit card or advanced deposit required, cancellation policy: 48 hours prior to arrival.

2010 Conference Technical Program Overview

MONDAY APRIL 19, 2010

**Session 1**

**Utility Management**

The Utility Management Session will have presentations on the challenges that we face in the management of our wastewater infrastructure capital assets and resources. Topics include lessons learned in asset management and master planning, preparing for labour shortage and new energy opportunities.

**Session 2**

**New Professionals – A**

The morning session will start with an overview of a biosolids Master Plan for the City of Greater Sudbury and how it will handle the disposal of sludge produced by wastewater treatment plants. This will then be followed by a study of the potential impacts of receiving septage at the Bancroft WWTP on both the liquid and solids treatment processes and how the Town intends to develop strategies to minimize the operational risks often associated with septage treatment. Then we will look at the City of Toronto’s plan to install upgraded chlorination and dechlorination equipment at the North Toronto Treatment Plant with the goal of achieving effluent residual chlorine not to exceed a concentration greater than 0.02 mg/L. Finally, the morning will conclude with a presentation on the various options of achieving low chlorine residual after the disinfection process with a look at dechlorination, UV and the application of peracetic acid (PAA), and whether PAA can be used at a full scale to supplement UV at a WWTP.

**Session 3**

**Advanced Treatment-A**

The first part of the Advanced Treatment Session will present papers on topics such as the use of Computational Fluid Dynamic Modelling, reactive filtration for advanced removals and the results of toxicity testing at City of London treatment plants.

**Session 4**

**Collection Systems Management-A**

The first part of the Collection System Management Session will discuss challenges of inflow and infiltration in new subdivisions, provide an evaluation of wet weather treatment alternatives, review modelling, design and operational issues surrounding air relief valves and identify pumping optimization using Computational Fluid Dynamic Modelling.

**Session 5**

**Water For People**

This Session will provide delegates with an opportunity to learn about the program work undertaken by Water For People in South America, India, and Africa, through the personal experiences of World Water Corps volunteers, who are professionals currently active in the water and wastewater industry in North America. In-country volunteer opportunities include Program Evaluation and Monitoring, Resource Mapping, Baseline Assessments and Hydrology. The speakers will engage the audience with bold technical details and personal anecdotes related to their particular World Water Corps experience.

**Session 6**

**Asset Management**

Asset Management is the process and way of business in order to optimize the performance of an asset through its life-cycle while maintaining the intended level of service in the most cost effective way for present and future needs. The papers in this session will touch upon aspects of asset management including: level of service, condition assessment, capital replacement programs and utilizing information management.

**Session 7**

**New Professionals-B**

The afternoon session will start with a presentation of the Thornsdale WWTP Class EA project with the recommended solution to construct a wastewater collection system for the entire community and treat the wastewater in a new WWTP to ultimately discharge to the Thames River. Then we will look at how sustainable development concepts can be incorporated into future municipal infrastructure projects with a focus mainly on the Courtice Trunk Sanitary Sewer Class EA. Next, we will find out why the Stevensville Sewage Pumping Station was pumping approximately 30% less then its rated capacity with an overview of the history and performance of the station and force main, as well as the methodology used to identify the sources of the capacity reduction. The afternoon will conclude with an overview of recent developments in ethanol plant wastewater processes around anaerobic digestion and nutrient removal, and investigate the effect these new technologies have on reducing the overall carbon footprint of corn ethanol process.

**Session 8**

**Advanced Treatment-B**

The second part of the Advanced Treatment Session will present papers on topics such as assessing filtration systems, hydrodynamic particle breaking for improved disinfection, peracetic acid as a disinfectant alternative, and nitrification rate testing for practical design.

**Session 9**

**Collection Systems Management-B**

The second part of the Collection System Management Session will discuss odor control issues, information sharing regarding various strategies for tackling private property issues, and combined sewer overflow challenges.

**Session 10**

**Non-Conventional Contaminants**

Microconstituents are natural and man-made substances detected in water which are being monitored to determine their fate and potential impacts on the environment. Substances include pharmaceuticals, personal care products, pesticides, nanomaterials, and industrial chemicals. Papers in this session will discuss work undertaken at the Provincial and Federal levels to address the microconstituents source, fate, treatment and regulatory issues.

TUESDAY APRIL 20, 2010

**Session 11**

**Biosolids Management-A**

This session will start with an overview of the recently released non-agricultural source materials land application regulations under the Nutrient Management Act. It will be followed by a case study of an Ontario municipality’s efforts to adjust their sewage biosolids land application program to meet the changing requirements of the regulation. In particular: what are the new requirements of their staff, their land application contractor, and their farm clientele? Add to that the costs of implementing these changes. In the end what is the bottom line? Eileen Smith from the MOE will discuss proposed changes to Ontario’s compost guidelines and expected time lines. The morning will conclude with a presentation from the winner(s) of the WEAO Exemplary Biosolids Management Award.

**Session 12**

**New Technologies and Research-A**

This session will open with a presentation on WERF optimization research, involving carbon, heat and energy analysis as plant evaluation tools. Primary and Waste Activated Sludge Controls, Best Practices, the study of a combined MBR-MR for industrial wastewater treatment process, and real-time remote monitoring of decentralized wastewater treatment plants will also be discussed.

**Session 13**

**Preliminary and Primary Treatment**

The session will discuss some of the fundamentals of preliminary and primary treatments. Presentations in this session will include designing a grit removal system, optimizing hydraulic throughput, identifying performance improvements through Computational Fluid Dynamics and the analysis of chemical phosphorous removal.

**Session 14**

**Biological Treatment**

Removal of ammonia from deoxygenating liquor by extraction and recovery, phosphorous removal facility at the G.E. Booth WWTP, aeration tank optimization for year round nitrification and upgrades for full secondary treatment (alternatives for in-pool), will be covered in this session on biological treatment.

**Session 15**

**Biosolids Management-B**

This session will focus on research. Ontario researchers are doing leading edge work in the area of biosolids management as it pertains to microconstituents, metals, pathogens and ecotoxicology. The presenters for this session are leaders in their fields and their research continues to expand our knowledge of biosolids land application management and sustainability. Each will provide a unique piece to the puzzle of furthering our understanding in a manner that is both practical and understandable. If you want to learn from the best, this is a must attend session.

**Session 16**

**New Technologies and Research-B**

The second part in this two part session will focus first on AnMBR for WAS digestion using hollow fibre membranes, and presentations on the first year of full-scale operation of anaerobic bioreactor process in the treatment of salad dressing wastewater.

**Session 17**

**Stormwater and Watershed Issues**

Management of stormwater is one of many issues that needs to be addressed from a watershed perspective. Localized and downstream impacts need to be considered. This session will look at a number of projects that have addressed various aspects of stormwater management, including development of a risk assessment tool for on-site wastewater systems, an assimilative capacity study in Mid-Halton and an economic analysis of phosphorous control options in the Lake Simcoe watershed.

**Session 18**

**Membrane Bioreactor Treatment**

Various MBR-related topics will be discussed during this MBR Treatment Session. In the first session, among these topics will be process evaluation and selection for the Woodward Avenue WWTP Membrane Facility, procurement and design of large MBRs, causes and modelling of membrane fouling in MBR systems, and mechanisms of foaming in submerged MBRs.
Special Thanks to Our Sponsors

Platinum Level

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- ACG Technology Ltd.
- OPCEA

Pumpen Intelligenz.

Gold Level

- Stantec
- SEW Eurodrive
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Silver Level

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- SNF Canada
- Gameby and Morrison
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- ERAMOSA Engineering Inc.
- Troy-Ontor Inc.
- Veolia Water
- Ontario Clean Water Agency

When you need to be sure

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**2010 Conference Technical Program**

**Monday, April 19, 2010**

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<td>Coordinator: Carrie Brunet</td>
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<td>11:45-</td>
<td>New Energy Opportunities for Ontario’s Water and Sewage Treatment Sector. Bob Griebbach, Paul Marsh, Hutch Mott MacDonald</td>
<td>Application of Peracetic Acid (PAI) for Wastewater Treatment. Minh Tran, Onta Basu, Carleton University</td>
<td>Optimizing and Troubleshooting Water/Wastewater Treatment Processes Based on CFD Analysis &amp; Case Study. Jungping Zhang, AECOM</td>
<td>Pumping Optimization Through Computational Fluid Dynamic Modelling. C. George, S. Scott, R.V. Anderson Associates Ltd.; Brad Johns, City of Sudbury; B. MacFadden, ITT Water/Wastewater</td>
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<td>12:00-</td>
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**12:00-2:00 Awards Luncheon – Hilton Hotel Grand Ballroom**

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| 4:15- | Integrated Lecture Panel: The Future of Wastewater Technology | | | | | |
| 4:30- | Integrated Lecture Panel: The Future of Wastewater Technology | | | | | |

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<td>Patty Guackenbush</td>
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<td>9:00-9:30</td>
<td>And What's It Going to Cost Me? A Municipal Case Study. Phil Sidhera, American Water</td>
<td>Primary and Waste Activated Sludge Controls: Best Practices. Ken Kennedy; Olav Natvik, Stantec Consulting Ltd.</td>
<td>Primary Sludge Pumping Optimization at the City of London’s Wastewater Treatment Plants. Mark Spitzig, City of London; Ken Klemper, Tecumseh Group; Stefano Antonacci, Meto Automation Canada Ltd.</td>
<td>Phosphorous Removal Facility at G.E. Booth (Lakeview) Wastewater Treatment Plant. Brad Petran; William Fernandes; Nevin McKeeon; Troy Briggs, AECOM</td>
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<td>3:30-4:30 Refreshment Break -Exhibition Area-LCC Grand Ballroom</td>
<td>3:30-4:30 Refreshment Break -Exhibition Area-LCC Grand Ballroom</td>
<td>Check <a href="http://www.weao.org/annual-conferences/current/conference.html">http://www.weao.org/annual-conferences/current/conference.html</a> for updates to this program.</td>
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<td>Chair/MC</td>
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<td>Darla Campbell</td>
<td>Past Chair/Wiki Organizer/Proceedings</td>
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<td>Anthony Abbruscato</td>
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### Conference Registration

For all the Conference information at a glance, visit our website at www.weao.org. To register, please fill out and return the accompanying registration form. You can also register for the Conference on-line. When you visit the website for the annual conference information, be sure to check out the rest of the site. If you want to receive future information, register your e-mail address by following the instructions on the home page. We look forward to seeing you in London!

### WEAO

The Association is the authoritative information source for water and wastewater treatment issues and technology. WEAO’s 1,350 members come from governments, universities, industries, consulting firms, equipment suppliers, contractors, and wastewater collection/treatment personnel. For conference information, contact WEAO, P.O. Box 176, Milton, ON L9T 4N9, phone 416-410-6933 x1, or e-mail julie.vincent@weao.org or visit www.weao.org.

### OPCEA

The Ontario Pollution Control Equipment Association is a non-profit organization dedicated to assisting member companies in the promotion of their equipment and services. Originally founded in 1970 OPCEA has grown to more than 150 member companies whose specialized fields encompass a broad spectrum of equipment and services for the generalized air and water pollution prevention and control marketplace. For membership or exhibit information, call Kelly Madden 705-725-0917, Fax 705-725-1068, e-mail opcea@opcea.com.

### PWO

The Professional Waste-water Operators (PWO) is a membership segment acting as a committee of the WEAO. The primary goal of PWO is to enhance the recognition and professional development of the people whose work involves performing the hands-on management tasks needed to operate and maintain municipal and industrial wastewater collection and treatment facilities. For information on Operations Challenge team registration, contact John Rammler at (905)576-9844 or john.rammler@durham.ca. For information on the PWO please contact Rick Niesink at rick.niesink@niagararegion.ca.
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Talking substance about detection … or naming the substances we detect?

Emily Callaway, CH2M HILL  |  Linda Macpherson, CH2M HILL  |  Jenifer Simpson, Science communicator/author

There is a movement in the water and wastewater industry to find a name to use when discussing the large number of substances that are found in water at trace concentrations. Several terms have been proposed and used in technical and media communications, including the terms microconstituents, trace organics, and endocrine-disrupting compounds. However, these names are not well understood by either the public or the media, resulting in confusion regarding the implications for human health. A major challenge surrounding the topic is communicating the significance of trace concentrations, and how these compounds should be addressed from a regulatory standpoint. The water and wastewater industry needs to change its vocabulary and develop a clear method of communicating about these trace substances in a way that fosters public trust and understanding.

Many synthetic organic chemicals have found their way into the environment. They include pharmaceuticals, detergents, insecticides, pesticides, cosmetics, fragrances, plasticizers and many more – there is scarcely any part of our modern lives where we do not come into contact with them. Society chooses to use them for many good reasons including the fact that they can extend our lifespan and improve our quality of life. Synthetic organics have been the subject of many attention-grabbing press accounts due to the fact that they tend to bioaccumulate (show up in increasing quantities the higher up an animal is in the food chain) and because they may be linked to sexual abnormalities in fish.

People are understandably concerned when they read that these substances are detected in drinking water. Media has taken the descriptive scientific name of endocrine-disrupting compounds out of context while cartoons have humanized the sex-change effects observed in fish, leading some to believe similar reproductive problems are inevitable in humans. This fails to reflect the fact that humans do not spend 100% of their lifetimes immersed in water, as do fish. Of course it is important to understand the influences on aquatic life, but it confuses the real findings to draw inappropriate inferences for human health. The other critical thing that is often overlooked in media reports is the fact the concentrations being detected are exceedingly small. As Southern Nevada Water Authority (SNWA) researcher Dr. Shane Snyder recently noted, “The highest concentration of any pharmaceutical compound in US drinking water is approximately 5,000,000 times lower than the therapeutic dose.” Imagine drinking a glass of water that had one five-millionth of an ibuprofen tablet dissolved in it. Is it reasonable to think that this could have a measurable effect on your body? You would need to drink five million glasses of water in order to consume the equivalent of a single tablet (and that might not even be enough to take care of your headache).

Unfortunately, we are not given the tools in our education or media communication to differentiate between our considerable exposure to these substances during our everyday activities and our minimal exposure to them in water, nor to understand what effects, if any, they might really have. When the media runs an alarming headline calling these everyday substances contaminants, compounds of emerging concern or, worse, unknowable unknowns, those of us who are not scientifically trained to understand those terms grow fearful. Our gut reaction is to demand the complete removal of these trace substances.

Highly advanced wastewater treatment processes like reverse osmosis can reduce concentrations to below current detection limits, effectively meeting the...
common definition of removal. However, current detection limits may soon be obsolete, as detection technology grows more and more advanced, allowing detection of smaller and smaller concentrations. ‘Zero’ and ‘completely removed’ will always remain elusive, but we can expect the concentration of the compounds to be ‘reduced’ so they do not pose a threat to human health.

Although water treated by reverse osmosis meets the current definition of pure (non-detectable concentrations), this advanced wastewater treatment requires a large capital investment and a large amount of electricity to operate. The ecological impacts of this cannot be ignored in light of the current global realization of the negative effects of rampant energy consumption. Treatment technologies need to be thoughtfully considered and selected to provide the right level of treatment for the intended use. Regulation of these substances should only follow, not precede, a very thoughtful, thorough, and scientific examination of the risks and environmental and public health impacts of such choices.

The critical question is not whether we can find things in water or what one word we should call them, but, rather, do they exist in concentrations that cause harm? Continued research is needed to assist decision-making about future management of these substances. It is inappropriate to equate detection of such materials with unacceptable risk to humans or the aquatic environment.

The water and wastewater industry is actively engaged in the discussion about the threat of harm, potential regulation, and the best way to effectively communicate with the public in a way that builds trust and reduces fear. The industry has just begun to realize there is public and media confusion regarding substance detection, the impact of the small concentrations of synthetic organic compounds, and their implications for human health. This confusion underscores the need for the water industry professionals and scientists to communicate clearly with each other and with the public.

In summary, within the water industry, there has been an extraordinary focus on naming the substances we are detecting. The industry is looking for just the right word or phrase to group together a broad and disparate group of substances that are byproducts of everyday modern life so that we can talk about them neatly, succinctly, and, above all, scientifically. Unfortunately, such a grouping and generalized characterization of these substances tends to frustrate rather than advance public understanding, as it implies there is a scientifically valid commonality of risk from the materials at trace concentrations. This well-intentioned simplification suggests that a host of potentially harmful substances are being detected in our nation’s waters. What we need is an honest presentation of scientific findings about detection and risk in familiar terms, without confusing the issue with a catch-all umbrella phrase, especially one with ominous overtones that leads us to believe there is something new and evil lurking in our waters.

Scientists and water professionals have a responsibility to help people understand risks and to pay attention to the impact their words have on a community that has poor understanding of water science.

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Having a robust and trusted water infrastructure is critical for Ontario’s future. Water that has traveled hundreds of kilometres from any human habitation may still carry traces of antibiotics taken by hospital patients, musks in perfumes, cleaning solvents used to mop floors, flame retardants in upholstery, and growth hormones given to cows. These emerging contaminants are a burgeoning concern to Canadians, yet their risks are poorly understood. ‘Emerging contaminants’ (ECs) is a term encompassing thousands of compounds released into our water systems daily – from drug residues, to personal care products, to industrial chemicals, to antimicrobial resistant organisms and even exotic ‘new’ compounds such as nanomaterials. Some of these compounds pass virtually unchanged through wastewater treatment plants which were not designed to remove them, emerging in wells and municipal drinking water sources.

Emerging threats to water quality differ from previous contaminant issues (e.g., pesticides, PCBs) in that the compounds involved may affect growth, reproduction, or development, even at extremely low exposures to humans or ecosystems. There is good evidence that mixtures of pharmaceuticals and personal care products (PPCPs) have biological effects at concentrations currently observed in the environment. There is also an increasing frequency of infections by antimicrobial resistant bacteria in the general population. Regulatory tools that were primarily developed for industrial or agricultural chemicals are inadequate for dealing with emerging contaminants (ECs), and new approaches to governance, technology and risk management are urgently needed.

The Centre for the Control of Emerging Contaminants (CCEC) brings together an interdisciplinary group of many of the most respected water scientists in Canada (Table 1), as well as industry and government partners. The Centre focuses on control of ECs in water, wastewater, and residuals (i.e., biosolids). The objectives of the Centre are to:

- develop and test new technologies to better control ECs;
- improve existing technologies for removal of ECs;
- develop analytical technologies for measuring/monitoring ECs in complex streams;
- contribute, through research, to the development of sound, science-based policy to control ECs;
- evaluate the impact of ECs on surface and groundwater systems;
- improve our understanding of the effects of a wide range of ECs in water systems;
- act as a forum that brings together researchers, technology implementers and regulators; and
- act as a resource and information warehouse for research on ECs.

The CCEC currently comprises 15 faculty members from five universities and provides training of critically needed professionals for the growing environmental sector. The CCEC has focused research capacity in the following four interrelated theme areas:

**THEME 1:** Advanced Drinking Water Treatment for Emerging Contaminants

**THEME 2:** Risk Assessment of Emerging Contaminants in Aquatic Environments

**THEME 3:** Characterization and Control of Emerging Contaminant Discharges to Water

**THEME 4:** Fate and Control of Emerging Contaminants in Current and Next-Generation Wastewater Treatment Systems

As a fundamental principle, the CCEC endorses a collaborative approach for the development of policy to manage ECs. Basic scientific research is the cornerstone of informed policy, and the Centre will support the development of science-based policy through its research.
and by acting as a forum bringing together researchers, technology implementers and regulators. Information obtained through the CCEC research initiatives will be disseminated to the scientific community, and to government and industry partners for use in regulatory policy development. The Centre for the Control of Emerging Contaminants will perform necessary and coordinated investigations into the levels and risks of ECs in Ontario’s water, and will develop applicable technologies and methodologies for their potential control. The CCEC has the technological and research expertise to become an international leader in the field of EC research. By harnessing the power and expertise of industry, government and academic scientists, information can be shared, tested, disseminated and implemented in a coordinated and timely manner. The CCEC will fill critical gaps in our understanding of the risk and management of ECs. The CCEC provides the opportunity to appropriately and effectively manage the issue of ECs in a way which will provide long-term benefits to both our society and the environment.

### TABLE 1: CCEC Researchers

**UNIVERSITY OF WATERLOO**
- Prof. Wayne Parker, Civil and Environmental Engineering
- Prof. Peter Huck, Civil and Environmental Engineering
- Prof. Sigrid Peldzus, Civil and Environmental Engineering
- Prof. Ray Legge, Chemical Engineering
- Prof. Dave Rudolf, Earth Sciences
- Prof. Mark Servos, Biology
- Prof. Barry Warner, Geography

**WILFRID LAURIER**
- Prof. Robin Slawson, Biology

**TRENT UNIVERSITY**
- Prof. Chris Metcalfe

**UNIVERSITY OF GUELPH**
- Prof. Ed McBean, School of Engineering
- Prof. Hongde Zhou, School of Engineering

**UNIVERSITY OF TORONTO**
- Prof. Bob Andrews, Civil Engineering
- Prof. Ron Hoffman, Civil Engineering
- Prof. Susan Andrews, Civil Engineering

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CSA introduces two new Municipal Infrastructure training modules, geared towards municipal infrastructure practitioners with stormwater-related responsibilities

<table>
<thead>
<tr>
<th>Sustainable Stormwater Practices: Fundamentals</th>
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<tbody>
<tr>
<td>• provides broad knowledge of sustainable stormwater management techniques at property, neighbourhood, and watershed levels.</td>
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<tr>
<th>Sustainable Stormwater Practices: Designing road and parking lot infiltration systems</th>
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<tr>
<td>• provides the background necessary to design or oversee the design of new and retrofit sustainable stormwater techniques for roads and parking lots.</td>
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Additional training modules and publications are in development; visit our website for the latest product information and course schedules. On-site delivery of training programs also available.
This article provides an overview of selected research and monitoring activities underway in the area of microconstituents in municipal wastewater within the Urban Water Management Section of the Water Science and Technology Directorate of Environment Canada.

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS
Two groups of microconstituents, pharmaceuticals and personal care products (PPCPs), are considered an emerging issue in municipal wastewater treatment in both Europe and North America (Termes, 2004; Daughton, 2004). Pharmaceuticals are designed to have specific biological effects on humans and animals at certain doses; their main route to wastewater is through use in private households, followed by excretion or disposal. Personal care products are used to enhance personal and household appearance and odour; they are not intended to cause any biochemical effects. Personal care products enter wastewater after personal and household washing.

Once in wastewater, PPCPs may be degraded during the treatment process, remain unchanged in the effluent, or partition to the solids (sludge). Their principal route into the environment is through effluent discharges and the land application of biosolids (Eschke, 2004; Xia et al., 2005). Some PPCPs are ubiquitous and persistent in the environment, while others may be considered ‘pseudo-persistent’: they dissipate readily, but, since they are continually discharged, the receiving environment is continually exposed to them (Daughton and Termes, 1999). There is a growing body of literature examining the effects of various PPCPs on aquatic biota. Results to date indicate that some compounds may have detrimental effects on some organisms, such as endocrine disruption or inhibition of the organism’s ability to excrete xenobiotics (Luckenbach and Epel, 2005; Kidd et al., 2007).

The Urban Water Management Section of Environment Canada (EC) and the Ontario Ministry of Environment (MOE) have collaborated on a large-scale wastewater research study to generate information on the occurrence and fate of PPCPs during municipal wastewater treatment. A short summary of results is provided below.

THAMES RIVER SURVEY
The goals of this survey were to expand the Canadian database of municipal wastewater influent and effluent concentrations for selected PPCPs, and to determine if three treatment configurations (lagoons, conventional activated sludge (CAS), and CAS plus filtration) affected the concentrations of PPCPs during the wastewater treatment process. Selected PPCPs included 10 acidic pharmaceuticals, triclosan (an antimicrobial additive in many consumer products), and six polycyclic musks (fragrances present in many consumer products). Twelve wastewater treatment plants (WWTPs) discharging into the Thames River participated in this survey.

The most frequently detected acidic pharmaceuticals in the influents were ibuprofen, gemfibrozil, naproxen, and diclofenac, with median concentrations of 13 700 ng/L, 450 ng/L, 5600 ng/L, and 200 ng/L, respectively. Clofibric acid, fenoprofen, and fenofibrate were not detected in any influent samples. Reduction of ibuprofen and naproxen from influent to effluent was consistently high (89-99%), while reduction of ketoprofen, diclofenac, and indomethacin was lower and highly variable. Lagoon systems showed the best reduction performance. Triclosan was detected in all influent samples with a median concentration of 1900 ng/L. Reduction from influent to effluent ranged from 74-95%; lagoon effluents did not contain any detectable triclosan. The polycyclic musks Galaxolide and Tonalide were detected in all influents, with median concentrations of 5200 ng/L and 2000 ng/L, respectively. Reduction from influent to effluent ranged from 0-70% for CAS and CAS plus filtration WWTPs, while reduction in lagoons was consistently above 90%.

These data demonstrated that there are detectable levels of PPCPs entering Canadian receiving waters in WWTP effluents, and that only some of these compounds are reduced during the wastewater treatment process. Complete results are reported in Smyth et al., 2006.

INTERSTAGE STUDY
Synthetic musk fragrance compounds are present in many personal care and household cleaning products. Musks are persistent and bioaccumulative in the environment, and tend to partition to solids during wastewater treatment. The purpose of the interstage study was to investigate the occurrence and fate of synthetic musks through the stages of treatment in a CAS plant. Concentrations and removals of musks in raw influent, primary effluent, secondary effluent, primary sludge, and waste activated sludge (WAS) concentrations were correlated to seasonal process temperatures. Complete results are reported in Smyth et al., 2007d.

Influent musk concentrations were as high as 7030 ng/L (parts per trillion) and were not correlated with temperature. Secondary effluent musk concentrations were as high as 2000 ng/L. Temperature appeared to influence the degree of removal of musks from wastewater during primary treatment: a median musk removal of 40% was observed at warm temperatures, while a median removal of only 9% was observed at cold temperatures. This temperature influence extended to overall treatment: a median musk removal of 82% at warm temperatures and 74% at cold temperatures. The removal of musks during secondary treatment did not appear to be influenced by process temperature; median removal was 71% at warm temperatures and 70% at cold temperatures. These results indicate that WWTPs employing only primary treatment may be achieving minimal removal of musks at colder temperatures.
Musk concentrations were measured in primary sludge at concentrations up to 35,000 ng/g (parts per billion) dry weight (dw), and in waste activated sludge at concentrations up to 52,000 ng/g dw. Keeping in mind the augmentation of musk concentrations in WAS due to sludge recycling, the longer HRT and higher suspended solids in the aeration tank appeared to be correlated with a higher degree of partitioning of musks to sludge. The results of this study corroborate earlier work in Europe, which indicated that volatilization and biodegradation of musks is minimal in wastewater treatment; musks are removed from the liquid phase by partitioning to the solids phase of wastewater. Therefore, optimization of solids separation may be one strategy for minimizing discharges of musks to the environment in wastewater effluents.

**GRAND RIVER SURVEY**

The Grand River Survey investigated seasonal fluctuations in influent concentrations and loadings of six polycyclic and five nitro musks, seasonal variations in effectiveness of their removal from wastewater, and removal of musks by four different treatment types: lagoon (1 plant), oxidation ditch (OD, 1 plant), extended aeration (EA, 1 plant), and CAS (3 plants) (Smyth et al., 2008). WWTP conventional performance (removals of biochemical oxygen demand and total suspended solids, and degree of nitrification) was assessed to provide the context for observations of musk removals. Water temperatures ranged from 2°C in February to 22°C in July, with the lagoon and oxidation ditch showing the widest variations. The HRT of the WWTPs ranged from weeks for the lagoon, to days for the OD plant, to hours for the EA and CAS plants. Estimated SRTs for each plant ranged from weeks for the OD plant, 7 to 25 days for the EA plant, and 1 to 4 days for each of the CAS plants.

Influent musk concentrations were as high as 56,600 ng/L and were affected by seasonal flow fluctuations, while loadings were generally consistent across seasons. These observations corresponded with the expectation that usage of personal care products containing musks would be generally consistent across the seasons, while influent musk concentrations would fluctuate due to seasonal flow variations. Effluent musk concentrations were as high as 4640 ng/L. Lagoon treatment produced the highest percent removal and the lowest effluent concentrations of musks. The lagoon and oxidation ditch showed the most extreme ranges of process temperature, ranging from 2°C to 22°C, and musk removal was better at the higher temperatures. The extended aeration and CAS plants showed somewhat less of a temperature range (7°C to 20°C), and there was no correlation between musk removal and process temperature. HRT and SRT in mechanical treatment plants were not correlated with musk removal; results indicated that the nature of the plant inputs and operation may have a greater influence on musk removal than simple retention time. For example, CAS plant 3 consistently showed better removals than the extended aeration plant, and consistently achieved more complete nitrification than the extended aeration plant during all seasons. These results indicated that lagoon, OD, EA, and CAS plants are capable of high removals of musks from wastewater, and that...
process temperature is not necessarily a limitation to removal.

The sludge and biosolids aspect of the Grand River Survey investigated concentrations of 6 polycyclic and 5 nitro musks in raw sludge and digested biosolids, and compared musk removal during aerobic and anaerobic digestion processes at the five mechanical WWTPs. The OD and EA plants used aerobic digestion and the three CAS plants used anaerobic digestion. Musks were present in raw sludge at concentrations up to 47,000 ng/g dw. Higher raw sludge concentrations corresponded with higher removals of musks from the wastewater. Musks were present in digested biosolids at concentrations up to 68,000 ng/g dw. Concentrations of musks in aerobically digested biosolids decreased proportionally with destruction of volatile solids, indicating that musks are removed under aerobic conditions. Concentrations of polycyclic musks in anaerobically digested biosolids increased proportionally with destruction of volatile solids, indicating that polycyclic musks are not removed under anaerobic conditions. Concentrations of nitro musks decreased with the destruction of volatile solids however the correlation was not statistically significant; nitro musks may be removed during anaerobic digestion but more study is needed. This study showed that the fate of musks during sludge digestion is dependent on both the musk type and the digestion process.

**FATE OF MICROCONSTITUENTS DURING SLUDGE DIGESTION AND DEWATERING**

Collaborative research is underway between EC and the MOE to determine the occurrence and fate of microconstituents through the stages of solids treatment processes typically used in Ontario. Previous EC/MOE research has indicated that the method of sludge digestion may influence the concentrations of synthetic musk fragrances in biosolids (Smyth et al., 2007), and recent studies by Agriculture and Agri-Food Canada observed that dewatered biosolids exhibited different dissipation characteristics after land application compared to liquid biosolids (Lapen et al., 2008; Topp et al., 2008). Based on this information, a study was initiated to determine the fate of several groups of microconstituents through typical Ontario sludge digestion and dewatering processes. The compounds under investigation include selected brominated flame retardants, pharmaceuticals, musk fragrances, and antimicrobials. Removal of microconstituents under aerobic digestion conditions was compared at warm (23°C) and cold (4°C) temperatures, and compared to anaerobic digestion. Centrifuge and filter press sludge dewatering technologies for anaerobically digested sludge, and centrifuge dewatering of aerobically digested sludge, were also investigated. Analytical results from this study are being finalized and prepared for publication.

**MONITORING OF CHEMICAL SUBSTANCES IN CANADIAN MUNICIPAL WASTEWATER**

The Federal Chemicals Management Plan (CMP) is taking action regarding chemical substances that are harmful to human health or the environment, and includes the collection of information on the properties and uses of about 200 substances that were identified through a categorization process as high priorities for action. The wastewater sector has been identified as a possible release point to the environment for certain CMP substances, so a national wastewater monitoring program has been initiated. The first year of this program included 20 WWTPs across Canada that were selected to represent typical Canadian wastewater treatment processes: facultative and aerated lagoons, advanced primary treatment, conventional secondary treatment, and biological nutrient removal.

Samples of raw influent, primary effluent, final effluent, primary sludge, waste activated sludge, and treated biosolids are collected at these WWTPs during warm and cold process temperatures. Samples are analyzed for chemical substances that have been identified as priorities by the CMP: Bisphenol A, brominated flame retardants, volatile methyl siloxanes, perfluorinated compounds, and metals. Conventional wastewater parameters are also being measured to provide a context for the observations of occurrence and removal or partitioning of these chemical substances during wastewater treatment. The number of WWTPs and analytical parameters in this monitoring program will evolve with our increased understanding of the occurrence and fate of chemical substances during wastewater treatment and the availability of analytical methods to quantify high priority substances. The results of this wastewater monitoring program will be used to improve our understanding and prediction of the fate of chemical substances during wastewater and sludge treatment, and to determine if control measures are needed to prevent these substances from entering the municipal wastewater system.

NOTE:
The full paper, with references, is available on the WEAO website (www.weao.org/influents)
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Environmental fate of microconstituents and removal during wastewater treatment: What do we know, what do we still need to find out?

Sandeep Sathyamoorthy, P.Eng, AECOM Water | Andy Reid, P. E., B.C.E.E, AECOM Water

INTRODUCTION
In recent years, the occurrence of endocrine disrupting compounds (EDCs) and pharmaceutical and personal care products (PPCPs) in surface and ground water has received significant attention. Treated wastewater effluents from Wastewater Treatment Facilities (WWTFs) are an important route for these compounds to enter the environment. Although the concentration of EDCs and PPCPs are very low in wastewater effluents, these point sources have been extensively studied in recent years, since these compounds have been shown to have deleterious effects on aquatic life. The most frequently cited impact of EDCs and PPCPs is the feminization of fish and other biota due to the presence of estrogens (Danish Environmental Protection Agency, 2002 and other sources). Current effluent quality requirements (e.g., BOD₅, TSS, TN, TP) are not compound-specific and may be incapable of addressing emerging concerns over the fate and impact of these microconstituents. A few regulatory agencies have begun the process of monitoring for selected EDCs and PPCPs (California, 2007); however, there are currently no mandatory regulatory requirements to meet EDC or PPCP effluent standards.

The use of EDCs and PPCPs over the last 30 years has exploded. They are essential to modern society: they have helped eradicate and/or control several diseases, improved quality of life, and increased our life spans. Markets for new and current PPCPs continue to grow in both the developed and developing world (Robinson et al., 2007). One can say with a large degree of certainty that the use of PPCPs will only increase in the years to come. EDCs and PPCPs have been shown to negatively impact reproductive potential and behavioral responses of animals. While some of these effects are reversible, other anatomical, physiological, and genetic alterations are permanent (Larsen, 2009). Although to date no data have been published on adverse effects on humans, even extremely low concentrations of these compounds potentially affect surface waters and, in turn, our drinking water sources.

Engineered systems such as wastewater treatment plants provide a direct route for EDCs and PPCPs to enter the aquatic and subsurface environments that serve as sources for drinking water (Heberer, 2002). While there are clearly benefits associated with controlled use of PPCPs, an increasing body of evidence suggests that EDCs and PPCPs are not fully removed or fully transformed in conventional wastewater treatment processes (Heberer, 2002; Ternes et al., 2004; Stephenson and Oppenheimer, 2007). Therefore, it is essential to study and understand the fate of these chemicals as they move through the engineered systems and subsurface and aquatic environments.

It is equally important that environmental engineering practitioners are aware of the current state of knowledge and implications of the research into these compounds on design and operation of treatment facilities. This article provides an overview of the fate of EDCs and PPCPs during wastewater treatment. The focus of the article is not on the specific technologies or systems that have been studied and/or employed; rather, our aim is to highlight the state of knowledge on removal processes and mechanisms.

TABLE 1: PPCPs and EDCs commonly detected and studied in natural and engineered environmental systems

<table>
<thead>
<tr>
<th>Class</th>
<th>API</th>
<th>Product examples/trade names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-steroidal anti-inflammatory drugs (NSAIDs)</td>
<td>Diclofenac, Ibuprofen, Ketoprofen, Acetaminophen, Naproxen</td>
<td>Voltaren (diclofenac sodium), Cataflam (diclofenac potassium), Ibuprofen, Advil, Motrin, Excedrin, Orudis, Oruvail, TYLENOL (acetaminophen), ALEVE, NAPROSYN, NAPROXEN</td>
</tr>
<tr>
<td>Anticonvulsants/Antiepileptics</td>
<td>Carbamazepine</td>
<td>Tegretol, Biston</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>Fluoxetine</td>
<td>Prozac</td>
</tr>
<tr>
<td>Lipid regulators</td>
<td>Clofibrate, Fenofibrate, Bezafibrate</td>
<td>ATORIMID-S, TRICOR, BEZALIP, CEDUR</td>
</tr>
<tr>
<td>Muscle relaxants</td>
<td>Diazepam, Lorazepam</td>
<td>VALIUM, DIAZEPAM, ATIVAN</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>Atenolol, Metoprolol, Propranolol</td>
<td>TENORMIN, Atenolol, TOPROL-XL (metoprolol succinate), LOPRESSOR Inderal</td>
</tr>
<tr>
<td>Estrogens</td>
<td>17α-ethinylestradiol (EE2)</td>
<td>YAZ oral contraceptive</td>
</tr>
<tr>
<td>Fragrances</td>
<td>Galaxolide, Tonalide</td>
<td>Aveeno Gentle Skin Cleanser, Tide with bleach, Ariel, Snuggle</td>
</tr>
<tr>
<td>Disinfectants/Antiseptics</td>
<td>Triclosan, Tonalide</td>
<td>COLGATE Total toothpaste</td>
</tr>
</tbody>
</table>

SOURCES AND TRANSPORT OF MICROCONSTITUENTS IN THE ENVIRONMENT
The fate of microconstituents in the environment is an area of active research. In North America, the
number of studies and projects increased quite dramatically following a landmark USGS study that found the frequent occurrence of microconstituents in receiving streams (Kolpin et al., 2002). However, the detection of microconstituents in the environment is not new; they have been measured as early as the 1970s (Hignite and Azarnoff, 1977). What is not known are the potential interactive effects such as synergistic toxicity that may occur from complex mixtures of microconstituents in the environment.

EDCs and PPCPs have caught the general public’s attention as a potential man-made problem. These compounds, which are used for overall health or safety, are found in minute concentrations (parts per trillion or less) in the environment. Compounds which have typically been detected and researched are hormones, anti-inflammatory drugs, antibiotics, beta blockers (often used in the treatment of cardiovascular disease), anti-epileptic drugs, musk fragrances, and flame retardants. PPCPs and EDCs originate from a wide range of products regularly used by the public; see Table 1 for some examples of compounds that have been detected in environmental systems along with the products where they are used.

The typical route for EDCs and PPCPs into the natural environment is shown in Figure 1. PPCPs ingested by humans and/or animals may be excreted (typically in urine) as the parent compound or as a metabolite. Alternatively, unused PPCPs may be directly flushed down the toilet. PPCPs in the sewage collection systems enter WWTFs or may be discharged directly into the environment where no treatment is provided (e.g., untreated combined sewer overflows). While WWTFs are not currently designed to treat PPCPs, recent studies have documented attenuation and degradation of these compounds within the treatment processes (e.g., Metcalfe et al., 2003; Joss et al., 2004; Stephenson and Oppenheimer, 2007).

Particular interest in EDCs and PPCPs as environmental contaminants and their fate in WWTFs is relatively recent despite research in the 1970s indicating the presence of such compounds in the environment (Hignite and Azarnoff, 1977). This time lapse could be attributed to the global and historic compartmentalization of disciplines within the research framework, resulting in pharmaceuticals research conducted under the auspices of human health agencies (e.g., the U.S. Food and Drug Administration or FDA) rather than environmental agencies (Daughton and Ternes, 1999). It is illustrative that one of the early studies considering pharmaceutically active compounds (PhACs) as environmental contaminants was led by researchers from a Veteran Affairs hospital and a department of medicine (Hignite and Azarnoff, 1977).

A HISTORICAL PERSPECTIVE OF THE REGULATORY FRAMEWORK
A look at regulatory processes provides some background into the research compartmentalization of reviewing new PPCPs. The policies in select regions are outlined below.

United States
Prior to being released for public consumption in the United States, new drug products undergo an environmental assessment in accordance with the National Environmental Policy Act of 1969. As part of this process, the FDA requires an environmental assessment (final rule in 21 CFR Part 25, 1997) for new products entering the market. The trigger level for the environmental assessment is set at a concentration ≥1 μg/L in the effluents of sewage treatment facilities, expected annual use of ≥44,000 kg, or extraordinary circumstances. At levels below 1 μg/L, manufacturers can request an exemption from performing the environmental assessment (Meyerhoff and Perkins, 2007).

European Union (EU)
The European Union Council Directive 2001/83/EC require an environmental risk assessment for drugs meant for human consumption. The trigger is a concentration ≥0.01 μg/L in surface waters, expected individual use ≥2mg/day, or potential for reproductive effects at levels < 0.01 μg/L. In addition, specific EU member countries are developing water quality standards for specific constituents. For example, the German Environmental Protection Agency has proposed a limit of
0.03 ng/L maximum annual average concentration for 17 -Ethinylestradiol (Moltman et al., 2007).

Canada
The New Substances Notification Regulations of the Canadian Environmental Protection Act, 1999, requires environmental assessments. Product use amounts >50,000 kg trigger a requirement to provide environmental data under current New Substance Notification Guidelines.

In order to determine the risk in the environmental assessment, the producer must submit results from a model that predicts the concentration of the proposed PPCP in the WWTF effluent or in the receiving surface water (Cunningham, 2007). Other specific toxicity testing such as respirometry using active sludge, toxicity testing using Daphnia magna, or biota growth inhibition may be performed in addition to the models as part of the environmental assessment (Meyerhoff and Perkins, 2007).

While these models provide an indication of PPCP concentration in the environment and potential behavior under specific conditions, they do not account for conditions when there are mixtures of these PPCPs in the environment. The models also do not account for daughter products formed through the biodegradation of the parent PPCPs in the WWTF. A recent example of this would be ranitidine (Zantac), which is used to treat gastritis (Sacher et al., 2008). Ranitidine produces NDMA when chloraminated. NDMA is a nitrogen-containing disinfection byproduct which is estimated to be 10,000 times more toxic than current regulated chlorinated disinfection byproducts.

FATE OF EDCS AND PPCPS DURING WASTEWATER TREATMENT
Within the WWTFs, potential attenuation mechanisms for microconstituents, include sorption, biodegradation (partial or complete mineralization), chemical (abiotic) oxidation, photodegradation, volatilization, and physical filtration (i.e., size exclusion) (Ternes et al., 2004). Each of these mechanisms is not applicable or effective at the different stages of treatment. For example, size exclusion filtration is irrelevant in the preliminary or primary treatment processes of a WWTF.

A summary of the potential relevant processes at each stage of wastewater treatment is provided in Table 2.

It is well documented that most of the removal of EDCs and PPCPs in a WWTF occurs in the biological treatment process. Primary treatment offers minimal removal of these compounds; however, the efficacy of the primary treatment process impacts the downstream processes quite significantly. Removal of EDCs/PPCPs through primary and biological treatment processes is discussed here.

PPCP REMOVAL IN PRIMARY TREATMENT
A limited number of studies have evaluated the removal of EDCs and PPCPs in primary treatment wastewater pro-

cesses. The removal of PPCPs in both conventional and enhanced primary treatment is extremely variable, ranging from less than 1% total removal to greater than 90% (Carballa et al., 2005; Suarez et al., 2009; Zorita et al., 2009). Sorption is thought to be the dominant mechanism for PPCP attenuation in primary treatment processes (Carballa et al., 2005; Stackelberg et al., 2007). It is unclear from these studies whether photodegradation has been considered as a potential pathway for PPCP attenuation.

PPCPs that are more lipophilic (i.e., higher K\textsubscript{ow}) tend to be removed more efficiently in primary treatment processes, suggesting that hydrophobic interactions play an important role in the sorption of PPCPs to primary sludge (Figure 2). The addition of a coagulant in bench tests improves the removal of PPCPs (Carballa et al., 2005), likely due to improved removal of colloidal and particulate material and the EDC/PPCPs sorbed to them.

PPCP REMOVAL IN BIOLOGICAL TREATMENT
The extent of PPCP removal in biological treatment systems varies greatly depending on a number of factors, the most important being solids retention time (SRT) and PPCP properties (Ternes et al., 2004; Clara et al., 2005a; Stephenson and Oppenheimer, 2007). Biodegradation and sorption are the main attenuation mechanisms for PPCPs in biological wastewater treatment processes (Andersen et al., 2003; Ternes et al., 2004; Urase and Kikuta, 2005; Stephenson and Oppenheimer, 2007). Volatilization is not considered a significant pathway given the low Henry’s Law constants of PPCPs (Namkung and Rittmann, 1987).

Operation of activated sludge processes at long aerobic SRTs (> 8-10 days) results in higher PPCP removal (Ternes et al., 2004; Clara et al., 2005a; Stephenson and Oppenheimer, 2007). This increased removal may be related to a wider biodiversity of bacteria in the activated sludge systems (Gobet et al., 2007) or to the presence of slow growing bacteria critical to the removal of PPCPs (Reif et al., 2008). There is general concurrence with the working hypothesis that biodegradation of PPCPs is predominantly a

![Figure 2: Efficiency of PPCP removal in primary treatment processes](image-url)
result of co-metabolic activity rather than use of these microconstituents as a food or energy source, given the extremely low concentrations in the treatment process environment (ng/L or parts per trillion levels). However, evaluation of the specific biodegradation pathways for PPCP removal remains an active area of research. For example, it was initially thought that EDC biodegradation was due to co-metabolism during ammonia oxidation; however, recent research suggests that heterotrophic bacteria may have a more significant role than originally assumed (Gaulke et al., 2009).

A recent WERF study provides a useful means of visualizing the available data. EDCs and PPCPs were grouped by occurrence and removal through six full-scale WWTFs and two pilot-scale systems (Stephenson and Oppenheimer, 2007). They defined a critical SRT as the minimum calculated SRT which provided at least 80% observed removal. It was found that a critical SRT of five days was adequate for over 50% of 20 compounds included in the study. They also observed minimal differences in the efficacy of EDC/PPCP removal between conventional and membrane bioreactor (MBR) systems when operated at the same SRT, which corresponds to the findings of other studies (Clara et al., 2005b; Cirja et al., 2008).

Nonetheless, MBRs are attractive given their ability to operate at long SRTs with a relatively small footprint and to produce an effluent of extremely high quality. These advantages must, of course, be weighed against the higher energy consumption (resulting from the aeration requirements for membrane scouring and the pumping energy required to overcome the membrane head loss) and O&M costs associated with MBR systems.

While (cometabolic) biodegradation processes are critical for pharmaceutical attenuation in activated sludge they do not constitute a complete picture of the removal of pharmaceuticals in the system. Sorption to the mixed liquor is also an important pathway for the elimination of these compounds, particularly those with a high partitioning coefficient (Kd). Ternes and coworkers found that sorption to activated sludge is a relevant means of removal (accounting for ≥ 20% of total removal) of chemicals with a partitioning coefficient greater than 300-500 L/kg-suspended solids (Ternes et al., 2004).

**SO, WHERE DO WE GO FROM HERE?**

Significant strides have been made in research related to the fate, attenuation, and impacts of EDCs and PPCPs in engineered and natural environmental systems in recent years. It has become abundantly clear that this is a complex problem, and it is not likely that there exists a single ‘magic bullet’ that could reduce or eliminate the discharge of EDCs and PPCPs into the environment. Therefore, it is imperative that the various stakeholders work collaboratively on a number of fronts to achieve a potentially optimal solution.

The current compartmentalized regulatory approach has a tendency to not look comprehensively at the effects that EDCs and PPCPs could have in the environment. Health and pharmaceutical regulatory bodies remain focused on the important work of ensuring the safety of new compounds for patient (human and veterinary) consumption, but not long-term environmental impacts. The environmental protection agencies are taking steps towards evaluating the fate and potential ecotoxicological risks associated with these new compounds in the environment. However, there remains a salient gap in our understanding of the lifecycle of an EDC/PPCP between the point of ingestion and the point of discharge from a WWTF.

To address this compartmentalization problem, some have advocated for an approach much like the USEPA’s Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), where potential responsible parties are responsible for the cradle-to-grave life of the microconstituent. The benefit of such a program would be that the end users (in this case, the WWTF and, ultimately, that specific community’s tax base) are not stuck with the price tag for ‘remediating’ the raw water and reducing the risk of impact on the environment.

Coupled with the fate approach, the regulatory community should work more closely with the pharmaceutical and chemical industries and the local community on multi-pronged approaches. These may range from simple solutions such as community-level pharmaceutical take-back programs to more elaborate green-chemistry replacements for chemicals where possible. Doctors could write prescriptions with smaller supplies of medication, thus reducing the overall waste. Similar considerations should be taken with veterinary medicines, particularly considering the intensive use of such medicines at the numerous concentrated animal feeding operations (CAFOs) worldwide.

Evidence from numerous studies indicates that it is possible to reduce the discharge of EDCs/PPCPs for WWTFs using advanced treatment technologies such as advanced-oxidation processes and reverse osmosis. Indeed, today’s ‘gold standard’ for treatment is based on a multi-barrier approach utilizing some of these technologies. While the use of these technologies undoubtedly improves EDC and PPCP removal, it comes at a significant increase in energy use and great capital expense. The mass of EDCs/PPCPs being removed through these systems is on the order of 5 g/d or less. Undoubtedly, there is a need to address the environmental consequences of these discharges on biota in our receiving streams. Before jumping headlong into upgrading WWTFs with state of the art technologies to remove minute amounts of microconstituents, we should consider our complete environmental stewardship, socioeconomic and collective financial responsibilities.

It is also clear that we must also continue making advances in research on the fate and transport of EDCs/PPCPs in natural and engineered environmental systems. The available analytical tools allow evaluation of the formation and fate of parent and daughter compounds. Clearly, this work will be extremely beneficial, not only to better understand the attenuation and degradation processes within the treatment plant ‘fence line,’ but also as input to risk assessment models and ecotoxicology studies.

**NOTE:**
The full paper, with references, is available on the WEAO website (www.weao.org/influents)

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Where do they go? The fate of microconstituents in wastewater treatment

Roger V. Stephenson, Ph.D., P.E., BCEE, Vice President, MWH

INTRODUCTION
Pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs) are present at very low levels in wastewater treatment plant effluent and have become a concern for their potential impact to the aquatic environment.

The objective of the study described herein was to investigate the fate of 20 PPCPs at full-scale, activated-sludge, wastewater treatment facilities. The participating facilities (Table 1) represent solids retention times (SRTs) ranging from 0.5 to 30 days, with capacities ranging from 5 mgd (19,000 m³/d) to greater than 300 mgd (1.1 million m³/d). Two pilot membrane bioreactors (MBRs) being operated at two of the full-scale facilities were also investigated for their potential impact on PPCPs. All facilities were located in the southwestern United States and treated municipal wastewater without relatively large industrial components.

METHODS
Samples were collected from the majority of these facilities during three discrete sampling events as 24-hour time weighted composites during periods of typical facility operation. The sampling equipment and all associated sampling materials were subject to three rounds of chemical cleaning with acetone and hexane prior to initiating the sampling process. Duplicate and split samples were processed using solid phase extraction.

### TABLE 1: Description of participating treatment facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Wastewater type</th>
<th>Primary treatment</th>
<th>Secondary treatment</th>
<th>Secondary aeration</th>
<th>MLSS (mg/L)</th>
<th>SRT (days)</th>
<th>Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Municipal from major metropolitan area</td>
<td>Polymer Ferric</td>
<td>High purity O₂ Activated Sludge</td>
<td>Pure O₂</td>
<td>1,300 – 2,600</td>
<td>0.5 – 1.5</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Municipal with light industrial component</td>
<td>No chemicals</td>
<td>MLE¹ Nit./Denit.</td>
<td>Diffused Air</td>
<td>1,800 – 2,000</td>
<td>3 – 5²</td>
<td>Deep bed³</td>
</tr>
<tr>
<td>C</td>
<td>Municipal with light industrial component</td>
<td>No chemicals</td>
<td>Activated Sludge</td>
<td>Diffused Air</td>
<td>2,000 – 3,000</td>
<td>4 – 6</td>
<td>Deep bed³</td>
</tr>
<tr>
<td>D</td>
<td>Municipal with significant industrial component</td>
<td>No chemicals</td>
<td>Nit./Denit.</td>
<td>Diffused Air</td>
<td>2,500 – 3,000</td>
<td>7 – 20²</td>
<td>Granular MF/RO</td>
</tr>
<tr>
<td>E</td>
<td>Municipal with light industrial component</td>
<td>None</td>
<td>Nit./Denit.</td>
<td>Diffused Air</td>
<td>2,100</td>
<td>11 – 16²</td>
<td>None</td>
</tr>
<tr>
<td>F</td>
<td>Municipal with light industrial component</td>
<td>None</td>
<td>Ext. Aeration Nit./Denit.</td>
<td>Surface Air</td>
<td>4,000</td>
<td>20 – 30²</td>
<td>Deep bed³</td>
</tr>
<tr>
<td>MBR #01³⁷</td>
<td>Municipal with light industrial component</td>
<td>n/a</td>
<td>Nit./Denit.</td>
<td>n/a</td>
<td>14,000</td>
<td>14²</td>
<td>n/a</td>
</tr>
<tr>
<td>MBR #02⁵⁰</td>
<td>Municipal with light industrial component</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>11,500</td>
<td>15</td>
<td>n/a</td>
</tr>
</tbody>
</table>

¹MLE (Modified Ludzack Ettinger Process); ²Reported SRT correspond to total from combined aerobic/anoxic facilities (in plants with Nit./Denit.); ³Granular Media; ⁴Utilizes flat sheet membranes; ⁵Located at plant E; ⁶Utilizes free-end hollow fiber membranes; ⁷Located at a facility not listed above; ⁸Almost no nitrification = <15% ammonia removal; ⁹Almost no denitrification = <15% total inorganic nitrogen removal; ¹⁰Partial Nitrification = 15% to 90% ammonia removal; ¹¹Partial Denitrification = 15% to 90% total inorganic nitrogen removal; ¹²Full Nitrification = >90% total inorganic nitrogen removal.
followed by gas chromatograph–mass spectrometer analysis.

RESULTS
The PPCPs detected in the influents were sorted into one of three categories, or bins, according to how often they were detected in the secondary process influent: infrequent, variable, or frequent. Overall, 60% of the target compounds occurred frequently, 20% sporadically, and 20% infrequently.

The percentage removals ($P$) of each compound through secondary treatment were calculated. On the few occasions when the observed effluent concentration was greater than the influent concentration (because of desorption from reactor biosolids or analytical precision or accuracy), the percentage removal was considered to be zero. The data revealed that

<table>
<thead>
<tr>
<th>Disinfection</th>
<th>Nitrification/Denitrification performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Almost no nitrification, Partial Denitrification</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Partial Nitrification, Partial Denitrification</td>
</tr>
<tr>
<td>UV</td>
<td>Full Nitrification, Partial Denitrification</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Full Nitrification, Partial Denitrification</td>
</tr>
<tr>
<td>UV</td>
<td>Full Nitrification, Full Denitrification</td>
</tr>
<tr>
<td>n/a</td>
<td>Full Nitrification, Almost no denitrification</td>
</tr>
</tbody>
</table>

**Table 2: Distribution of target PPCP compounds into occurrence and treatment performance bins**

<table>
<thead>
<tr>
<th>Treatment Occurrence</th>
<th>Bin T1: Excellent removal (Median &gt;80%)</th>
<th>Bin T2: Moderate removal</th>
<th>Bin T3: Poor removal (Median &lt;50%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin O1: Infrequent (Detected &lt;25% of observations)</td>
<td>Methyl-3-phenylpropionate</td>
<td>Octylphenol</td>
<td>TCEP Triphenylphosphate</td>
</tr>
<tr>
<td>Bin O2: Variable</td>
<td>Ethyl-3-phenylpropionate</td>
<td>BHA DEET Musk Ketone</td>
<td></td>
</tr>
<tr>
<td>Bin O3: Frequent (Detected &gt;75% of observations)</td>
<td>Caffeine Ibuprofen Oxybenzone Chloroxylenol Methylparaben Benzyl Salicylate 3-Phenylpropionate Butylbenzyl Phthalate Octylmethoxycinnamate</td>
<td>Triclosan Benzophenone</td>
<td>Galaxolide</td>
</tr>
</tbody>
</table>

**First sampling:** Partial Nitrification Partial Denitrification

**Second sampling:** Almost no nitrification Almost no denitrification

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FIGURE 1: Percent removal in relation to SRT for selected Excellent Removal Bin Compounds

FIGURE 2: Percent removal in relation to SRT for selected Moderate Removal Bin Compounds

FIGURE 3: Percent removal in relation to SRT for selected Poor Removal Bin Compounds
secondary treatment removed 55% of the compounds well, 15% moderately well, and 30% poorly.

Table 2 groups the occurrence and removal of the PPCPs according to their respective bin classifications.

There was no consistent correlation between removal performance and a compound’s tendency to adsorb on the biosolids indicating that biodegradation was effective in reducing some compounds not amenable to adsorption, and that solids adsorption was not sufficient in completely removing some compounds with a higher tendency to do so.

CRITICAL SRT VALUES

Plots of the percentage removal of each target compound versus the SRT of the secondary treatment process were used to define a critical SRT\textsubscript{80} - the minimum SRT value needed to consistently observe compound removal greater than 80%. Figures 1, 2 and 3 present percentage removal plots for selected compounds. For the 11 compounds categorized under the ‘well-removed’ bin classification, the SRT\textsubscript{80} was less than five days, with the exception of benzophenone, which had an SRT\textsubscript{80} of 13 days. Only one of the three compounds categorized under the ‘moderate removal’ bin classification had sufficient data to enable determination of SRT\textsubscript{80} values. The compounds in the ‘poor removal’ bin classification showed the most pronounced dependence upon SRT. Musk ketone, galaxolide, tris(2-carboxyethyl)phosphine hydrochloride (TCEP), and N\textsubscript{2}N-diethly-3-methylbenzamide (DEET) had SRT\textsubscript{80} values in excess of 15 days.

MEMBRANE PROCESSES AND FILTRATION

MBR No. 2 was run in parallel with the Plant E activated sludge process using identical influent. Due to the moderate SRT values of the MBR and the plant (11 to 15 days), only the four compounds with demonstrated SRT\textsubscript{80} values in excess of 15 days would be expected to have sufficient levels remaining in the secondary effluent to allow a comparison of percentage removals. Of these compounds, only DEET and galaxolide were detected in the influent during one sampling event. Although the data are limited, the results demonstrate the comparability of performance, with 67% removal of galaxolide for Plant E and 68% removal for the MBR. DEET was reduced below the method detection limit by both Plant E and the MBR.

Whenever PPCP compounds were still detected after secondary treatment, further treatment with media filtration was rarely effective in providing additional removal. Only six out of 30 observations demonstrated positive removals greater than 2.5%. These occurred as single events for chloroxylenol (42%), methylparaben (>97%), DEET (26%), musk ketone (>55%), oxybenzone (>68%), and triclosan (67%). Half of these positive removals occurred during the second sampling event for Plant F, and the other half occurred for the first sampling event of Plant D.

The data indicate that MBR ultrafiltration membranes do not provide an additional benefit of removing PPCP compounds by sieving, as the PPCP molecules are more than 100 times smaller than the pore size of the membranes. Similarly, media filtration contributed little or no removal of these compounds. Reverse osmosis was effective in removing any remaining aqueous phase compounds.

CONCLUSIONS

The major conclusions of the study are:

- Half of the 20 PPCP target compounds that frequently occurred were well removed (>80%) at a critical SRT\textsubscript{80} of less than five days.
- Compounds that occurred frequently and required a critical SRT\textsubscript{80} value of at least 25 days were the fragrances musk ketone and galaxolide. Triclosan and benzophenone, while also frequently detected, exhibited a lower critical SRT\textsubscript{80} value, in the vicinity of 10 to 15 days. Insufficient data were available to characterize the critical SRT\textsubscript{80} for DEET and BHA, but it was in excess of five days.
- Better PPCP removals were not observed for a pilot MBRs and little additional removal was evident for media filters. Reverse osmosis was effective in reducing any remaining target compounds to below detection limits.

ACKNOWLEDGEMENT

The research was supported by the Water Environment Research Foundation (Alexandria, VA) under Contract No.03-CTS-22UR. Complete details of this work can be found in the Water Environment Research Foundation report: Fate of Pharmaceuticals and Personal Care Products Through Municipal Wastewater Treatment Processes. 03-CTS-22UR. 2007.
Microcontaminants in wastewater: methods for their control at the source

Monique Waller, CH2M HILL | Jeremy Kraemer, CH2M HILL | George Crawford, CH2M HILL

INTRODUCTION

Microcontaminants (MCs) are present in sewage as a result of various industrial, commercial, institutional, and domestic activities. The term ‘microcontaminants’ refers to a wide range of compounds that may include metals, industrial organic compounds, pesticides, pharmaceuticals, and personal care products, which are present at very low concentrations – typically in the nanogram to microgram per litre range.

Focus is often placed on their removal at sewage treatment plants (STPs), however, addressing MCs at their point of use is a more logical approach, since many MCs persist through conventional treatment. While some MCs end up in the treated effluent, others are concentrated in sewage sludge. Effluents containing MCs may indirectly become sources for drinking water, while sludge may be destined for further treatment and land application or some other form of beneficial use.

WHAT OPTIONS EXIST BESIDES CENTRALIZED TREATMENT?

Although centralized treatment of sewage remains an important component of addressing water quality, programs that aim to reduce the amount of MCs that enter the sewer can make a significant difference in the amount of these contaminants that eventually reach (and sometimes persist in) the environment via effluent or biosolids. Typically referred to as source control, the reduction in loading of MCs entering the sewer can take the form of several methods, which can generally be categorized into two approaches:

1. **Source control by sewer users**, which occurs at the location of discharge into the sewer by industrial, commercial, institutional, and residential sewer users. This approach can be implemented through restriction, substitution, reduction, separation, and treatment of products, materials, or wastes that contain MCs.

2. **Source control by suppliers or consumers** can be carried out by manufacturers, wholesalers, and importers of raw materials or products containing MCs, as well as the consumers of these materials or products. This type of source control can be implemented by affecting the consumer’s behaviour or activities through a provision of information and alternatives, or through legislation.

Where feasible, source control is generally preferred over centralized treatment for reducing the loading of MCs that enter the environment, since dilution usually increases during the compound’s usage cycle. Avoiding the use of MCs that are harmful to the environment is the ideal scenario. This is shown graphically in Figure 1.

**TYPE OF SOURCE CONTROL IMPLEMENTATION**

Source control programs can be implemented at various jurisdictional levels, and through regulated or voluntary means. Examples of source control methods at different implementation levels are shown in Table 1. Some programs can be implemented through either regulated or voluntary means at more than one jurisdictional level. For example, best management practices at industrial point sources can be undertaken voluntarily or through regulation at provincial or municipal levels, or within industrial sectors.

**SOURCE CONTROL OPTIONS FOR MUNICIPALITIES**

National or provincial source control programs that allow for the restriction, substitution, or reduction of the use of MCs can be very effective for reducing their environmental loading, but may require large-scale jurisdictional implementation and years before results are observed. Alternatives that can be implemented at smaller jurisdictional scales, such as at the municipal level, include:

- **Sewer use and other by-laws** that provide discharge limits for MCs of concern, requirements for pollution prevention planning and best management practices for industries. (Example: The City of Toronto’s sewer use by-law incorporates discharge limits for 11 heavy metals and 27 organics, and incorporates requirements for dental waste amalgam separators and, most notably, pollution prevention planning.

- **Collection and disposal programs** for products containing MCs, such as household hazardous waste and pharmaceuticals, to allow for their separa-

---

**FIGURE 1:** Logical steps for the control of micro-contaminants

1. Avoid use of compound
   - Restriction
   - Substitution
   - Reduction

2. Remove compound prior to entry into
   - Reduction
   - Separation
   - Treatment

3. Centralized treatment
   - Separation
   - Treatment

Increasing dilution
Increasing difficulty to remove
<table>
<thead>
<tr>
<th>National or international</th>
<th>Regulated</th>
<th>Voluntary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>European Union’s REACH Regulation</td>
<td>Canada-Ontario Agreement (COA) respecting the Great Lakes Basin Ecosystem</td>
</tr>
<tr>
<td></td>
<td>Places responsibility on manufacturers and importers to provide information about the chemical substances they produce and to manage the risks associated with these substances. The regulation calls for the eventual phasing-out of the most dangerous substances and their replacement by suitable alternatives.</td>
<td>A federal-provincial agreement that supports the restoration, protection, and conservation of the Great Lakes Basin Ecosystem. The federal and provincial governments agree to address legacy pollutants (Tier 1 substances) and ongoing sources of pollution (Tier 2 substances).</td>
</tr>
<tr>
<td></td>
<td>Ontario Regulation 196/03 – Amalgam Waste Disposal (specific for mercury)</td>
<td>Eco-labels</td>
</tr>
<tr>
<td></td>
<td>Requires dental offices to follow a prescribed best management practice for amalgam disposal and have a properly installed dental amalgam device that meets the ISO standard for dental amalgam separators (Standard 11143).</td>
<td>A market-driven, voluntary approach that can promote environmental stewardship and sustainable practices among consumers and manufacturers.</td>
</tr>
<tr>
<td>Municipal</td>
<td>Sewer use by-laws</td>
<td>Ontario Ministry of the Environment (MOE) Industrial Sewer Use Best Management Practices</td>
</tr>
<tr>
<td></td>
<td>Sewer use and other by-laws set by municipalities or regions can be used to control the introduction of MCs into the sewer system. Sewer use by-laws may include discharge limits for individual compounds, and requirements for pre-treatment and pollution prevention planning.</td>
<td>Best Management Practices guidance documents relating to pollution prevention and treatment of specific harmful pollutants for six industrial sectors.</td>
</tr>
<tr>
<td>Within industrial sectors</td>
<td>Collection and disposal programs</td>
<td>Responsible Care Initiative</td>
</tr>
<tr>
<td></td>
<td>Household hazardous waste and pharmaceutical collection and disposal programs provide a means for the separation of materials containing specific MCs. These programs are usually voluntary although some examples exist of such programs being regulated.</td>
<td>A global voluntary program for the chemical industry that promotes best management practices. Each participating national chemical association oversees the implementation of the initiative by its member chemical companies.</td>
</tr>
</tbody>
</table>

**TABLE 1: Examples of source control methods at different implementation levels**

- **Education programs** targeting different types of sewer users (industrial, commercial, institutional, and domestic). *Example:* The Water Environment Federation has created a bill stuffer and brochure called Drug-Free Drains that utilities can use to educate the public about disposing of pharmaceuticals in toilets or drains (see [www.wef.org/PublicInformation/page.aspx?id=689](http://www.wef.org/PublicInformation/page.aspx?id=689)).

**AN OUNCE OF PREVENTION IS WORTH A POUND OF CURE**

As the old adage suggests, it makes sense for municipalities and other jurisdictions to explore and evaluate source control options, since it is usually less expensive and more effective to prevent pollution instead of treating diluted concentrations of MCs once they reach centralized STPs.

At the municipal level, a comprehensive sewer use by-law (coupled with a strong monitoring and enforcement program) is an effective tool for reducing the loading of MCs reaching STPs. In 2009, the Canadian Council of Ministers of the Environment (CCME) released a model sewer use by-law, which provides examples of clauses that municipalities can adopt to improve source control, such as pollution prevention planning, as well as guidance on discharge limits for several MCs. The model by-law is available from the CCME’s website at the following URL: [www.ccme.ca/assets/pdf/ pn1421_model_sewer_use_bylaw_e.pdf](http://www.ccme.ca/assets/pdf/ pn1421_model_sewer_use_bylaw_e.pdf).

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Microcontaminants and sewage treatment in Ontario

Vince Pileggi, M.A.Sc., P. Eng, Standards Development Branch, Ministry of the Environment

There are over 470 Sewage Treatment Plants (STPs) in Ontario, with an overall treatment capacity of about 6000 ML/d (about 2.5% of what flows over the crest of Niagara Falls in a day). These STPs, which include mechanical plants and lagoons, treat a mixture of residential and institutional wastewaters along with smaller contributions of industrial/commercial wastewater, septage and landfill leachates. The STPs have been engineered to remove conventional contaminants (e.g., carbonaceous biochemical oxygen demand (CBOD), total suspended solids (TSS), total phosphorus (TP), total ammonia nitrogen (TAN), and total nitrogen (TN)) to concentration limits in the parts per million (ppm) or mg/L range. These STPs have not been specifically engineered to remove microcontaminants, typically found in parts per trillion (ppt or ng/L) to parts per billion (ppb or μg/L), and only do so, to some degree, fortuitously. Currently, the Ministry of the Environment (MOE) does not include microcontaminants in its municipal effluent quality requirements. In fact, apart from a few parameters such as mercury, lead, nonyl- and octyl-phenol, no regulatory authority, worldwide, specifies limits on microcontaminants in their municipal effluent compliance requirements [1].

It is well documented that sewage effluent contains many microcontaminants from a variety of sources [1, 4, 6, 9, 11]. The MOE recently completed chemical characterization studies of sewage influents, effluents, sludge and leachate from selected Ontario STPs and landfill sites that included microcontaminants. Because of these studies, we now have a useful chemical characterization dataset of our wastewater discharges and residuals [4, 6]. The microcontaminants investigated included legacy compounds (e.g., metals, polycyclic aromatic hydrocarbons (PAHs), total polychlorinated biphenyls (PCBs), chlorobenzenes, (dioxins and furans) as well as emerging microcontaminants (polybrominated diphenyl ethers (PBDEs) and PPCPs).

The table below provides typical concentration values found from these studies in treated sewage effluents.

<table>
<thead>
<tr>
<th>Sample parameters and compounds</th>
<th>Typical effluent concentration values [4, 6]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional</strong>s1</td>
<td></td>
</tr>
<tr>
<td>CBOD, TSS, TP</td>
<td>&lt;25, &lt;25, &lt;1 mg/L</td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
</tr>
<tr>
<td>Hg, Ag, Cr, Cu, Pb</td>
<td>0.05, 10, 20, 30, 50 μg/L</td>
</tr>
<tr>
<td><strong>Phenolics</strong></td>
<td></td>
</tr>
<tr>
<td>o-cresol, p-cresol, phenol</td>
<td>&lt;0.2, &lt;0.2, &lt;0.6 μg/L</td>
</tr>
<tr>
<td><strong>Chlorobenzenes</strong></td>
<td></td>
</tr>
<tr>
<td>1, 2-dichlorobenzene</td>
<td>&lt;0.2 ng/L</td>
</tr>
<tr>
<td><strong>PBDEs</strong></td>
<td></td>
</tr>
<tr>
<td>PBDE-47, 99, 100</td>
<td>20, 20, 4 ng/L</td>
</tr>
<tr>
<td><strong>Dioxins and Furans</strong></td>
<td></td>
</tr>
<tr>
<td>Octachlorodioxin</td>
<td>20 pg/L</td>
</tr>
<tr>
<td><strong>PPCPs</strong></td>
<td></td>
</tr>
<tr>
<td>Benzafibrate, Roxithromycin</td>
<td>30, &lt;7 ng/L</td>
</tr>
<tr>
<td>Gemfibrozil, Ibufrofen</td>
<td>40, 100 ng/L</td>
</tr>
<tr>
<td>Carbamazepine, Naproxen</td>
<td>290, 90 ng/L</td>
</tr>
<tr>
<td>Norethindrone</td>
<td>&lt;10 ng/L</td>
</tr>
<tr>
<td><strong>Plasticiser</strong></td>
<td></td>
</tr>
<tr>
<td>Bisphenol A</td>
<td>1000 ng/L</td>
</tr>
</tbody>
</table>

1 Conventional are not microcontaminants, but are included for comparison only.

VIABLE MONITORING

Typically, the concentration levels of microcontaminants are in the range of nanograms per litre (ng/L) to micrograms per litre (μg/L). Currently, it is expensive to quantify these microcontaminants accurately and to eliminate interference (i.e., false positives) during chemical or biochemical analyses. The cost is inversely proportional to the method detection limit (MDL). In some cases, the MDLs in sewage matrices are higher than known levels of environmental concern for the same contaminants. The MOE Laboratory Services Branch is one of the few laboratories, along with a few university and private labs in North America, that can analyze for many, but not all, microcontaminants in wastewater matrices at low enough concentrations of suspected environmental concern. Recently, the US Environmental Protection Agency (US EPA) published Methods 1694 [2] and 1698 [3] for the analysis of...
Focus on MICROCONSTITUENTS

pharmaceuticals and hormones. Many reported environmental results include concentrations that fall below the MDLs and are reported as <MDL.

An example of typical environmental data results are shown in the figure above. The figure provides the logarithmic distribution of p-cresol (MDL=0.2 μg/L) found in 19 secondary STP influents (n=219, 100% >MDL) and effluents (n= 231, 67%<MDL) [4]. The figure shows that, at the 90%-ile level, secondary STPs are over 99% effective at removing p-cresol (from 300 μg/L in the influents to about 0.4 μg/L in the effluents). The calculation of this overall removal rate necessitates the use of censored data analysis, for the effluent data, to eliminate known biases associated with substitution methods of analysis [5].

EFFECTS

With wastewater effluents, it is difficult to isolate and differentiate whether the effects that may be observed are associated with any one or more of the large number of microconstituents, or as a result of interaction (synergistic, additive) with conventional contaminants such as ammonia.

This difficulty of differentiating and isolating the probable cause is also true for the conventional contaminants alone and has traditionally been addressed by using whole effluent toxicity (WET) testing as a surrogate measure for indicating adequate treatment. Given that the focus to date has been on conventional contaminants, currently, only acute toxicity associated with ammonia and chlorine compounds are dealt with at municipal STPs in Ontario on a site-specific basis through the Certificate of Approval process under section 53 of the Ontario Water Resources Act.

However, the traditional effluent toxicity endpoints (i.e., acute lethality to Daphnia magna and rainbow trout) are not considered appropriate endpoints to address the subtle chronic effects related to certain microcontaminants suspected of endocrine disruption effects and other subtle life-cycle effects. New sensitive and selective biochemical methods for testing the effects of different whole effluent mixtures are needed. These new methods are becoming standardized, but are still not readily available at a production scale for regulatory purposes. They include immunoassays (e.g., enzyme-linked immunosorbent assay (ELISA)-based screening methods for various environmental analyte classes) and toxicity testing with cellular-level organism or sub-organism biomarker tests (e.g., tests with bacteria, yeast and animal or human cell lines to estimate toxicity) [9].

TREATMENT

The degree to which STPs can remove or reduce microcontaminants is specific to both the compound and the treatment process. The main microcontaminant removal mechanisms include sorption to sludge for hydrophobic compounds, along with biotic and abiotic transformation of the parent compounds for more polar, water soluble and degradable compounds. Complete destruction of microcontaminants has rarely been observed under typical solids retention times (SRTs) and hydraulic retention times (HRTs) in conventional treatment plants. Although SRT control is a key parameter for removal of microcontaminants, the literature to date does not provide sufficient evidence supporting higher SRT alone as a strategy for substantial and predictable removals for all or even most microcontaminants. Different technological combinations are required based on targeted compounds and cost considerations. Some of the recommended treatment options for the improved removal of microcontaminants with corresponding cost increases include: conventional activated sludge (CAS) operated at higher SRTs (> 10 days); addition of filtration by the use of membranes (micro- and ultrafiltration) in combination with advanced oxidation; ozone addition followed by biofiltration; and, at the higher end, use of granular activated carbon or reverse osmosis [1, 10].

CONCLUSIONS AND FUTURE WORK

The current state of the science and engineering present technical and economical challenges to regulators as well as owners and operators of STPs, when expanding our monitoring and treatment efforts to address the need to reduce/eliminate microcontaminants from sewage effluents. To overcome some of these challenges, a multi-faceted approach is warranted that includes not only end of pipe controls, but also source and use of controls. Source and use of controls are discussed further in the article by Waller et al., in this issue of INFLUENTS. The latest research suggests that optimization of STPs by operating at an SRT of about 10 days (or higher) may be a necessary first cost-effective step towards improved effluent quality with respect to microcontaminants [1, 9].

In terms of the effects of effluent containing microcontaminants on plant and animals and future compliance monitoring, a combination of chemical and biological effluent analyses appears
to be the most suitable approach. This approach should effectively assess the ecotoxicological burden while not inducing unwarranted economic hardships.

The MOE is currently collaborating with Environment Canada and the Centre for Control of Emerging Contaminants (CCEC) in a comparative study to investigate the effects of effluents from different treatments on more sensitive life forms. The treatments being examined include conventional activated sludge (CAS), CAS operated at high SRT to ensure nitrification (CAS-N), and CAS in biological nutrient removal mode for both nitrogen and phosphorous removal (CAS-BNR). The primary goal is to determine if CAS, CAS-N and CAS-BNR will produce effluents that show significant differences in the biological response on selected sensitive biological endpoints. It is planned to include, as part of the biological endpoints, a long-term study of fathead minnows exposed to the different effluents over a six-month period. This life-cycle study is being conducted by Joanne Parrott and coworkers of Environment Canada at the National Water Research Institute in Burlington, using a similar methodology as described in previously published work [7]. The additional goals of this study are to link the chemistry to the biological effects for selected microconstituents and, from this, to find possible economical surrogate measures related to more sensitive end points. It is expected that the study will be completed within three years.

ACKNOWLEDGEMENT

For their valuable technical and editorial comments, I wish to thank from MOE-SDB: Ramanathan (Mano) Manoharan, André Schnell, Sonya Kleywegt and Natalie Feisthauer; and from CH2M Hill: George Crawford, Jeremy Kraemer and Monique Waller.

END NOTE

CCEC is a consortium of universities, private and public organizations whose mission it is to promote and coordinate fundamental and applied research into water and wastewater treatment as related to the control of emerging contaminants.

REFERENCES


BIOSOLIDS USE IN NON-AGRICULTURAL APPLICATIONS:

Thinking outside the spreader

By Ashley Ahrens, Project Coordinator SYLVIS Environmental and John M. Lavery, Senior Environmental Scientist, SYLVIS Environmental

Biosolids are the semi-solid treated and stabilized residual resulting from the wastewater treatment process. Depending on the treatment process and wastewater treatment plant inputs, biosolids can have a variety of physical and chemical characteristics. Generally speaking, all biosolids contain high amounts of organic matter and reasonable levels of macro- and micronutrients which are essential to plant growth.

In Ontario, biosolids have been traditionally applied as a soil amendment and fertilizer on agricultural cropland. Canada-wide, the use of biosolids as a nutrient source and soil amendment for agricultural crop production is also the most common biosolids use. Extensive research has shown that biosolids fertilization of agricultural crops is protective of human health and the environment, however, there are considerations including public and stakeholder perception, biosolids production and application constraints, (related to biosolids storage and agricultural windows for application), diversification in biosolids management, as well as considerations related to the optimization of the value inherent in biosolids.

Biosolids have been, and continue to be, used in many non-agricultural initiatives including forest fertilization, disturbed land reclamation and the use in mitigating landfill gas production concurrent with landfill operations and closure. These opportunities capitalize on the characteristics of biosolids – providing significant gains in tree growth, conservation of productive land in the return of disturbed land into production and using biosolids to treat and reduce greenhouse gases. In non-agricultural biosolids management opportunities, think ‘outside the spreader’ and think synergies.

The purpose of this article is to provide select examples, by way of case studies, of non-agriculture biosolids management opportunities that are actively practiced across Canada. We will look at three successful non-agricultural opportunities:

- forest fertilization;
- aggregate mine reclamation; and,
- a landfill biofilter for greenhouse gas mitigation.

These management options and the supporting case studies are useful and timely reminders that biosolids have some impressive properties that allow us to capitalize on the benefits outside of traditional agricultural fertilization.

FOREST FertilIZATION:

Tried and tested, new and innovative Forest fertilization is a relatively well known opportunity for biosolids management in Canada and is often considered a superior option in forested areas with nutrient poor soils. Forest fertilization is the application of biosolids to a forest in order to help trees achieve their maximum natural growth potential. Most forest soils are naturally nutrient deficient in nitrogen. Most forest tree species respond positively to the addition of nitrogen with phosphorus, sulphur and boron. Biosolids have these macronutrients and important micronutrients. The growth response from biosolids is particularly evident on poor soils without significant organic matter for retaining soil moisture. The organic characteristics of biosolids assist in retaining moisture during the often dry growing season, allowing for increased growth.

Biosolids forest fertilization typically occurs several years following planting, where the trees are close to occupying the site and out-competing the under-story vegetation. An application to recently planted seedlings may fertilize the competing vegetation as much as the planted trees, resulting in the rapid establishment of vegetation. Biosolids are used intentionally for this effect in stabilizing soils on slopes immediately after a forest fire, or for visual quality objectives. Biosolids are also applied to maturing trees, where the trees add additional foliage and woody biomass prior to harvest.

In the past, fertilizing trees with biosolids was challenging as the biosolids used were predominantly as a liquid, which required spraying into the tree stands. Application technology to apply de-wated biosolids was developed that allows for the ‘flinging’ of biosolids over or through forest stands to a distance of 30 m. Typical application technology employs an ‘aero-spread’ (see figure 1), which is mounted on a log forwarder or a rock truck base. The unit can traverse roadways and skid trails, feeding biosolids into a high powered fan which ‘flings’ the biosolids up to 30 m into forest stands. Buffer distances to surface waters and areas of environmental or natural significance are easily established, minimizing potential impacts. During application, the biosolids break into discrete pieces falling through to the forest floor. Within one to two weeks, it is difficult to distinguish an application area as being fertilized by smell or sight.

New opportunities in forest fertilization are fast emerging, through the development of under-utilized land into agro forestry crops of hybrid poplar, willow, or aspen. These options take
advantage of agricultural techniques to grow woody biomass for pulp and paper or bioenergy initiatives. Straight, planted rows of coppiced1 trees allow for designs tailor made to seasonally apply biosolids, using standard farming machinery, to optimize the utilization of the nutrients and organic matter inherent in the residuals. In this use, biosolids approaches a use similar to that of agriculture, although the perennial woody nature of the ‘crop’ trees allows for applications throughout the growing season to fast growing high nutrient demand trees.

**CASE STUDY: Vancouver Island University woodlot, Nanaimo, BC**

Starting with research and demonstration plots in 1992 and moving to an operational program shortly thereafter, biosolids from several generators are used in the fertilization of an educational/for profit woodlot owned by Vancouver Island University near Nanaimo, BC. Biosolids from the Regional District of Nanaimo and the District of North Cowichan are currently being applied to Vancouver Island University’s woodlot under a Land Application Plan (LAP). The forest is a model for striking balance between potentially competing land uses as biosolids application is carefully mixed with commercial forestry, forest education through the university, biking, hiking, and equestrian trails, and hunting permits. Proactive stakeholder consultation and environmental monitoring supports the program objectives. The biosolids application services are managed by Vancouver Island University, which, using the proceeds of improved productivity, provides scholarships and funding for forestry education. Biosolids application at the Vancouver Island University woodlot significantly improved tree growth as compared to non-fertilized plots, or pre-fertilization measurements. Figure 2 shows the profile of a tree core demonstrating the significant responses in tree growth as evident by wider tree rings following a single application of biosolids.

1Coppicing is a woodland management practice in which young tree stems are repeatedly cut down to near ground level. In subsequent growth years, many new shoots will emerge, and, after a number of years, the coppiced tree is harvested.

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Land reclamation using biosolids is accomplished by using more aggressive land application techniques such as direct surface applications, deep row applications or fabricated biosolids growing medium applications to disturbed land, tailings, spoil, or areas with nutrient poor soils.

Direct surface applications are ideal for mines, gravel pits, landfills or marginal land. Biosolids are spread annually or as a one-time reclamation mix using either agricultural implements or heavy machinery, and then incorporated into the soil using agricultural discs. This provides organic matter and nutrients to the soil which facilitates vegetation establishment and succession. The intent of many reclamation projects is a single biosolids application to provide the nutrient and organic matter to start the soil forming process, cycling nutrients through the vegetation and soil. Biosolids application rates are typically determined based upon the requirements of the vegetation present. In many reclamation initiatives, there is no soil present, and often no vegetation. Biosolids applications occur at calculated rates to ensure no excess nutrient availability. This can be achieved through adding a high carbon substrate slowing nutrient availability or by applying biosolids in deep rows.

Deep row biosolids applications involve burying biosolids in excavated channels and covering the channels with 10-20 cm of cover material. Selected trees and shrubs are planted on top of the rows so that the roots may penetrate into the biosolids medium below. As the roots penetrate, the biosolids mineralization occurs, releasing the nitrogen to the plants. This feedback mechanism controls nutrient availability. The deep row system slows the nitrogen mineralization process, reducing the potential for adverse water quality impacts. The benefit of deep row applications is that a onetime fertilization at higher application rates is required and odors are eliminated through addition of cover material. This application method may be incorporated with traditional surface applications to establish tree corridors or windrows.

Biosolids can be used as a feedstock in the fabrication of a reclamation mix. These mixes are usually formulated with biosolids, a carbon source (usually wood-waste or primary pulp mill biosolids) and sand. Reclamation mixes are placed on steep slopes or on areas where there is limited ongoing access. Reclamation mixes can be prepared and tipped over longer slopes to provide a one-time application followed by seeding and planting.

CASE STUDY: Construction Aggregates Limited aggregate mine reclamation, Sechelt, BC

Construction Aggregates Limited (CAL) in Sechelt, BC operates the largest aggregate mine in North America. In 1997, a reclamation program was initiated that focuses on the beneficial use of organic and inorganic residuals, primarily municipal biosolids, to improve reclamation outcomes prior to return of mine land to the Sechelt Indian Band (SIB) and associated land stewards. Once an area has been mined, stockpiled soil removed from
an adjacent site or stockpile is placed on the area. This soil or overburden is very low in organic matter and fertility. Each year at CAL Sechelt, biosolids from three local generators are applied to designated reclamation areas within the mine. Direct surface applications of biosolids are followed by seeding with grass mix and planting hybrid poplars using SIB trainees and workers, providing a valuable education in plantation forestry for local First Nations partners. Figure 3 illustrates the effect of biosolids fertilization on poplar trees after just five years of the reclamation program. Trees are established in sedimentation pond fines, fertilized with biosolids and tree heights are in excess of 13 m. Reclamation mixes are also used at the mine, reclaiming slopes and more sensitive areas to wetland or natural wild areas through mix placement, while direct biosolids applications are best suited for more level topography.

This decade-long operational program provides cost-effective progressive mine reclamation through the use of locally-generated organic residuals as soil amendments. Synergies are achieved for both the mine, the biosolids generator, the environment and the SIB First Nations, increasing awareness and understanding of land reclamation and environmental stewardship in the community.

CAN’T PASS THAT GAS: Biosolids in greenhouse gas mitigation initiatives

Methane is a greenhouse gas generated in landfills through anaerobic organic decomposition. While landfill caps are designed to trap and harvest these emissions, quantities of ‘fugitive’ methane still manage to escape the harvesting system and diffuse through the landfill cap and cover soil. Biocovers that have been developed consist of the top layer of media which is placed on a closed landfill either as intermediate cover or upon final cover and closure. The biocover is an engineered, soil product with physicochemical properties that encourage the growth of methanotrophs (bacteria that consume methane), thus reducing the quantity of methane that escapes from the landfill. Biosolids are used as a principal component of the engineered biocover, providing necessary nutrients and organic matter to facilitate both methanotroph establishment and sustainable vegetative cover.

CASE STUDY: Biosolids biocover at the Cedar Landfill, Nanaimo, BC

The ongoing development of the Regional District of Nanaimo landfill recently required the interim closure of 2.1 hectares (5.2 acres) of the landfill. This project involved the application of an engineered biocover over the closure area, using an engineered biocover composed of chipped clean woodwaste stockpiled at the landfill, local biosolids and sand (see Figure 4). Biocover mixes are specifically designed to provide the ideal nutrient availability, water holding capacity and porosity for the aerobic methanotrophs to consume methane from the landfill. Tests before and after the biocover application demonstrated that a significant amount of fugitive methane is now effectively consumed and released as carbon dioxide – a significantly less potent greenhouse gas. There are opportunities throughout Canada to use biosolids in methane oxidation initiatives in passive cover systems or active biofilter designs. Synergies include the use of biosolids to mitigate environmental impacts of landfill activities.

THINKING OUT OF THE SPREADER

While agricultural applications have and will continue to be a mainstay of biosolids beneficial use, the opportunities for non-agricultural biosolids management initiatives can be equally compelling. Non-agricultural applications can bring diversity and contingency to biosolids management programs. There can be advantages in logistics of application. Forestland fertilization programs can increase the growth rate of the trees providing economic and educational returns. Integrating biosolids use with reclamation and restoration activities can return disturbed land to agricultural production – or the production of biomass for bioenergy. Biosolids and other residuals can be used to mitigate landfill greenhouse gas emissions.

While these options may be considered ‘new’ or ‘innovative’ in different regions of Canada, they are simple proven opportunities to capitalize on the value inherent in biosolids in fertilizing trees, developing productive soils and vegetative ecosystems and mitigating greenhouse gas emissions.

Diverse biosolids management options are key to satisfying stakeholder, community, and cultural requirements, and can be a valuable tool in increasing environmental awareness and education by promoting environmental stewardship.

City of Hamilton 2009 State of the Infrastructure Report

R.V. Anderson Associates Limited was retained by the City of Hamilton to prepare the 2009 “State of the Infrastructure report, which outlines the state of practice with respect to the sustainable management of the City’s Public Works assets.


These types of reports are invaluable strategic planning and communication tools. They provide information regarding the effectiveness and impact of a community’s infrastructure management practices, investments and policies on the current and anticipated future state of public works assets and ability to provide services on a sustainable basis.

R.V. Anderson Associates Limited

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WEAO's 2nd Government Forum

Catherine Jefferson, Chair Government Affairs Committee

EAO’s Government Affairs Committee hosted its second Government Forum on January 12, 2010 at Queen’s Park. Participation was extended to a variety of provincial and federal government ministries and departments as well as the WEAO Board, committee chairs and committee members. This year, OPCEA made a presentation on its organization and how it works with WEAO, as well as its interests related to government affairs. Topics of interest to WEAO’s membership and related to the association’s mandate included:

Research and Innovation in Wastewater Management – Chaired by Brian Gage

This section provided information on government research and innovation; how an association such as ours can become more involved; and how our members, as equipment suppliers, could be involved. The speaker was Craig Wardlaw from the federal government’s Industrial Research Assistance Program (IRAP).

Funding Programs for Infrastructure/ Municipal Wastewater Effluent Strategy – Chaired by Vanessa Chau

This was a presentation on Financially Sustainable Water and Wastewater Services as well as an overview of recent infrastructure funding programs and investments in water and wastewater infrastructure. The presenter was Michael Azulay from Ministry of Energy and Infrastructure (MEI).

Regulatory Related Issues (Phosphorus, Great Lakes, Toxics Reduction, Environmental Assessment and Approvals) – Chaired by Nancy Bonham

This section generated discussion on issues that are topical and that affect wastewater treatment facility operations including different approaches to managing substances such as phosphorus (site specific, one shoe does not fit all); toxic substance reductions; and environmental assessment processes. Speakers included Matt Uza – Ministry of the Environment (MOE), Tom Tseng – Environment Canada (EC) Ontario Region, Phil Brennan – MOE, and Doris Dumais – MOE.

Health, Safety, Security – Chaired by Cordell Samuels

This section covered areas related to health and safety with respect to plant/stormwater/distribution system operations; use of biosolids (employee and public exposure); emergency preparedness; and security of facilities (including stormwater) from outside attack or other events. Speakers were Tony Amalfa – Ministry of Health and Long-Term Care (MHLTC), Bruce Nelson – Emergency Management Ontario, Nathalie Osipenko – MOE.

Source Water Protection, Stormwater Management, Rural Runoff, Nutrient Management – Chaired by Harold Chard

This section provided information on how the Source Water Protection Committee may affect wastewater management in new or expanding operations; the status of stormwater management in Ontario and how the Ministry of Natural Resources (MNR) and the conservation authorities fit in; and nutrient management on the farm from biosolids application to the impacts on runoff. Speakers were Keith Willson – MOE, and Len Senyszyn – Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

The specific presentations are available through the WEAO website, as is the list of invitees. Overall, the session was very informative for all involved, including providing awareness of the association to various government departments, and providing WEAO’s expertise as a credible and preeminent industry organization that can contribute considerably to upcoming policy development and subsequent legislation.
Committed to creating sustainable wastewater and biosolids solutions

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VWS Canada/John Meunier Inc., the Canadian subsidiary of VWS, has proudly served Canadian municipalities for more than 60 years. We design, manufacture, and support drinking water, wastewater, and biosolids solutions locally for communities across Canada.

Visit our booth at OPCEA April 18-20, 2010
The CWWA fall Board meetings were held in Ottawa in conjunction with the Windows on Ottawa Conference and AGM December 3-4, 2009. The previous Board met before the Conference on December 2 to close out any outstanding 2009 issues, with any unfinished business carried over to the new Board. The Board of Directors voted in favour of appointing André Aubin, a former president of the association and now a retired member of the Ville de Montréal, as an Honorary Member for his considerable assistance in fulfilling CWWA’s responsibilities for supporting the International Water Association (IWA) Montréal 2010 Congress. This was officially announced at the AGM the following evening.

Another item that arose at this meeting involved the addition of two new Board seats. The purpose was to provide some additional flexibility in structuring the Board of Directors as it would be useful to the association to have the ability to appoint up to two Directors-at-Large for a defined period of time. Other Canadian associations have similar provisions within their bylaws which enables them to maintain corporate experience within the Board, to respond to changing needs of member representation, or to meet the needs of corporate affiliation. It also serves to meet exceptional, but perhaps time-limited needs for expertise or knowledge that the other Board members may not bring to the table. This was brought to a vote and passed at the AGM on December 3.

The new Board Executive was appointed at the AGM on December 3. The 2010 Board Executive is:
• Greg Chartier (City of Saskatoon) as President;
• Rosanna DiLabio (WEAO representative) as First Vice-President,
• Dan Limacher (City of Calgary and Western Canada Water representa-
tive) as Second Vice-President,
• Roland Richard (Greater Moncton Sewerage Commission) as Secretary-Treasurer, and,
• Thomas Schmidt (Region of Waterloo) as Past-President.

The Window on Ottawa Conference was well attended by over 130 delegates including representatives from member utilities, government agencies, consultants and others. Presentations were given on topics such as the Canadian Council of Ministers of the Environment (CCME) Long-Term Strategy for the Management of Municipal Wastewater Effluents, the Federal Fisheries Act, Climate Change and the CCME Biosolids Task Force Group. Information and updates were presented on various survey initiatives such as the Environment Canada Municipal Waste and Wastewater Survey, the Statistics Canada Water Accounts Survey and Infrastructure Canada’s initiative to determine the condition of the country’s core public infrastructure. Several presentations on the government’s efforts to monitor and regulate the shellfish industry were given as well as an update of the Canadian Food Inspection Agency’s research efforts to track viruses in shellfish. On December 4, Brian Jean, Parliamentary Secretary to the Minister of Transport, Infrastructure and Communities, addressed the delegates on the Conservative government’s initiatives to strengthen Canada’s infrastructure and stimulate the economy. This was well received by all in attendance.

The new Board met after the AGM to set the objectives for 2010. The Board will be meeting again this coming May in Kelowna, British Columbia to continue its work. This Board will also have the task of finding a new Executive Director, as Duncan Ellison has announced that he would like to retire by the end of this year. For myself, this will be my last CWWA Update, as I will be relinquishing my position as CWWA Liaison for WEAO to stand for vice-president of WEAO in April. It will not be my last involvement with CWWA, as 2009 was a busy year for CWWA with many operational and other successes, but also one of frustration given that one of the CWWA’s principal tasks is to monitor and comment on the activities of the federal government and national organizations. The continuance of a minority government and a desire on the part of the government to centralize decision-making in the Prime Minister’s Office led to a number of frustrations as draft legislation was slowed and then (as of December 31, 2009) died on the Order Paper when Parliament was prorogued until March 2010.

The legislative successes included creating an understanding by the proposing departments that the amendments to the Transportation of Dangerous Goods (TDG) Act and the new Human Pathogens and Toxins Act would have an impact on municipal services, unless the expected requirements for enhanced safety and security around treatment chemicals and human pathogens and toxins were modified. In the case of the former, the relaxations are expected in the regulations. In the case of the latter, modifications were introduced in the legislation. Comments were also
The success thought to have been achieved with the proposed new Consumer Products Safety Act was terminated when the Senate rejected the House of Commons version and sent it back for revision. This Bill could have allowed control over residential drinking water treatment units, but died on the Order Paper before the House of Commons was able to react. The Senate Clean Drinking Water Act, which was sent to the House of Commons, also died on the Order Paper, but CWWA would have submitted a brief on the Bill should it have gone to Committee.

On the regulatory front, CWWA submitted comments on a number of draft regulations and was actively involved in several consultation initiatives such as proposed Drinking Water Parameters, NPR1, the Fertilizers Regulations, the Statistics Canada survey of drinking water utilities, and the State of Municipal Infrastructure.

CWWA wrote to Minister Prentice (Environment) concerning the need for a national water conservation program and a national water efficiency labeling scheme (based on WaterSense); Minister Baird (Infrastructure) concerning the infrastructure program; the Parliamentary Committee on Natural Resources concerning the use of biosolids as a source of alternative energy; and to CCME on matters related to the Waste Water Effluents Strategy and the Biosolids activities – largely without much success as CCME seems to want to choose when and how it consults, not receive suggestions from national utility committees.

During the course of the year, CWWA issued 62 Communiqués to members alerting them to changes in federal regulations or programs or significant activities or events occurring in Canada and elsewhere, in addition to the regular 10 times a year Bulletin, and the two times a year Municipal News and Views.

CWWA was involved either directly through staff or by member volunteers in nine national standards technical committees (of CSA, BNQ, and UL) and internationally in the NSF International Standards water committees and the ISO TC 224 Performance Assessment activities.

As a partner with the Canadian Association for Water Quality in the International Water Association’s Canadian National Committee, CWWA was active in the planning for the Montréal 2010 World Water Congress.

Finally, CWWA hosted the 3rd National Wastewater Management Conference, the 3rd National Water Conservation Conference, the 2009 Window on Ottawa, and three workshops on Energy Efficiency, Wastewater Heat Recovery and Crisis Management and Planning.

The 2010 year looks to be equally challenging as the parliamentary situation is not expected to change. However, there are a number of significant federal regulations expected to be published for comment including the Fisheries Act regulation on deleterious substances – known as the National Performance (effluent) Standards, the TDG Act safety and security regulations, and the Human Pathogens and Toxins Act bio-safety and bio-security regulations. CWWA will also be encouraging wastewater utilities to commence their environmental risk assessments of effluents under the CCME Strategy.

Finally, CWWA will be organizing the 14th Canadian National Drinking Water Conference in Saskatoon, October 30-November 2 and participating in the Montréal 2010 World Water Congress, September 19-23. The 2010 Window on Ottawa event will likely take place November 30-December 2.

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**Water Industry Leadership – Executive Director**

**Canadian Water and Wastewater Association**

**THE OPPORTUNITY**

The Canadian Water and Wastewater Association is looking for a highly motivated Executive Director with excellent organizational and communication skills to provide leadership and a national voice for the water, wastewater, and stormwater industry. Representing the interests of Canada’s municipal and community water services to the Government of Canada, as well as national and international organizations, you will provide an effective voice in the formation of legislation, regulations and programs.

Reporting to the CWWA Board of Directors and operating under a policy governance framework, this position directs a team of seven professional staff and various national industry committees.

**THE QUALIFICATIONS**

You will have a professional qualification and/or university degree in science, engineering, political science or public administration. You will be conversant with the structure and issues of the water, wastewater and stormwater industry, and with the structure and processes of the Canadian federal government. You bring to the role excellent technical, administrative and communication skills to determine strategic issues and influences on the water sector and have an ability to prepare and present complex and technical reports verbally and in writing. As a national representative for the industry, you will be located in Ottawa and be fluent in English and French.

For more information and a detailed job description, please direct your enquiry to executivedirectorsearch@cwwa.ca. Applications, quoting competition # 10-02, will be accepted no later than March 31, 2010. Please send résumés to CWWA (Executive Director Search) Unit 11, 1010 Polytek Street, Ottawa, ON, K1J 9H9. FAX: (613) 747-0523. Email executivedirectorsearch@cwwa.ca
AUTOMATIC WATER SAMPLING
Lou Dinato, Can-Am Instruments Ltd.

Water sampling is probably not one of the main topics discussed at the dinner table each evening, but who would have thought that almost every object at the dinner table, including the table in most cases, was produced or supplied by manufacturers that have their process effluent sampled using water samplers. As simple as it sounds, collecting a water or wastewater sample may be trickier than you think.

Selecting a water sampler may be easy if you only had one option, but, in today’s market, we are given many choices. It is usually best to speak to a professional who can review your application, assist with installation and provide training.

What is water sampling?
Water sampling is collecting a representative water or wastewater sample from the location to be monitored, and having it analyzed for predetermined contaminants. STANDARD METHODS (20th Edition, Section 1060 § B, Collection and Sampling) states that “A sample can represent only the composition of its source at the time and place of collection.” Water/wastewater sampling is the first and most important step in determining the quality of an effluent and the effect on the target body of water. Laboratory analysis will determine the concentration and/or presence of specific substances in the water, such as TSS (total suspended solids), TP (total Phosphorus), BOD (biochemical oxygen demand), VOC’s (volatile organic compounds), etc. High quality results can only be achieved when the sample is representative of the site of interest. These results can be used to assess and determine specific loading and cross referenced to local, provincial and federal water quality limits. Typically, samples are collected from municipal and industrial sources along with creeks, rivers, streams and lakes in order to determine if a water quality issue exists. Samples are also collected at different stages of the treatment process within a water/wastewater treatment facility to ensure that the treatment system is running efficiently.

Why we need to collect water samples
Water samples are collected to ensure that we are not affecting and contaminating the environment and general population with pollutants discharged into our waterways. Water sampling can also be used to assess the loading at municipal treatment facilities to see if it is necessary to have pretreatment at pollutant sources. Sample collection and analysis has become a regulatory requirement in most areas and, in others, gives us a better understanding of the impact we have on our bodies of water. Some of the people collecting water samples may be consulting engineers; municipal, provincial and federal regulatory bodies; treatment plant operators; laboratories; facility operators; and sampling service providers. Wherever the water/wastewater sample is collected, local bylaws and regulations apply to make sure that allowable limits of specific parameters are not exceeded. Not monitoring and reporting your effluent quality may result in penalties from local, provincial or federal agencies.
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Types of samplers
Samplers come in many different shapes and sizes with add-on features allowing the end user to collect the exact sample needed. The most common water sampler is one which uses a peristaltic pump to deliver a water sample to an internal sample container. These samplers come in portable, refrigerated and all-weather models. One of my favorites is the Hach SD900 group of sampler because of its ease of use. Other technologies used for water sampling may have a mechanical gathering system known as the dipper sampler. The dipper sampler simply scoops a water sample from the sampling source and conveys it to a sample container. We also see vacuum systems that have no moving parts at the sample collection end of things, but simply use a container under a vacuum to obtain a sample. Most samplers can be configured with 1-24 internal sample containers. Samples can be collected on a time or flow proportional basis. The more options the better. You may also need to monitor flow or a specific water quality parameter, and samplers can have all these options along with alarm reporting and data download capabilities directly through the instrument’s internal modem or cellular device.

Selecting the appropriate materials like polyethylene, glass, stainless steel, teflon, etc. for the wetted parts of the sampler, such as the intake tubing, the sample delivery system, and the collection bottles, should be taken into consideration. Chemical resistance charts are a good reference. Under Municipal Industrial Strategy for Abatement (MISA) guidelines, the material in the sampling train is mandated for type and length of tubing/wetted parts.

Sampling techniques
Water/wastewater sampling is generally performed by one of two methods, grab sampling or composite sampling. Grab sampling is just what it sounds like; all of the test material is collected at one time. As such, a grab sample reflects performance only at the point in time that the sample was collected, and then, only if the sample was properly collected. Composite sampling consists of a collection of numerous individual discrete samples taken at regular intervals over a period of time, usually 24 hours. The material being sampled is collected in a common container over the sampling period. Therefore, the analysis of this material will represent the average performance during the collection period.

Composite samples of wastewater plant effluent collected, stored, analyzed, tabulated and averaged over an extended period of time provide the only verifiable indication of treatment plant performance. Collecting and analyzing these composite samples is often an expensive and time-consuming process. For these reasons, most regulatory organizations recognize independent third-party certifiers, who use composite sampling methods to conduct performance evaluation and accurately measure system performance in a standardized, reproducible setting. Attempting to evaluate a residential treatment system in the field by analyzing a grab sample taken from a sump or any other containment vessel provides a compound degree of error and can yield erroneous conclusions about system performance.

Other sampling methods could be employed: discrete sampling, where the sample is collected in 2, 4, 8 or 24 bottles over a period of time, usually 24 hours, at regular or irregular time intervals; flow-based or time-based sampling; setpoint sampling for individual parameters; or stormwater sampling.

How to select a sampling system
When selecting a water sampler, you must consider the liquid to be monitored along with any specific site, regulatory and reporting requirements. You may also want to consider your future needs and choose a sampler that allows for the addition of options without the need to purchase a new system. Most importantly, select a system from a supplier that can support you and address your needs quickly and effectively. You are best at knowing what your application is and how it works. Digital pictures work great and can be a useful tool to send to a sampler supplier. This can give the supplier a feel of the site and quickly narrow the selection process to what you need. It is also important to know the cost of ownership of the sampler. Typically, samplers come with warranties that cover major failures. You even have the option through most suppliers to test drive a unit before you purchase for a week or two.

Installing sampling equipment
It is very important to select the correct sampling location, as the sample collected will be representative of the site. I recommend installing the sampler as close as possible to the sampling source to avoid any strain and wear on the sampler’s pumping/suction system. The sampler should be accessible to users for programming and sample collection. The intake line should always be placed in an area of the sample source that is well mixed and representative of the location.

If you are not in the market to purchase a water sampler, you can rent a unit or even have your water sampling performed for you by a sampling provider. Depending on the length of your sampling program, the equipment will need to be maintained to ensure it is operating properly. This can easily be done when the sample is collected and prepped for analysis.

Water sampling has become an important tool in keeping our waterways healthy, and samplers are allowing us to capture more accurate representative samples for monitoring and compliance purposes.
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JOHN PLASKON P. ENG.:
BACK IN THE GAME

Since accepting a retirement package from Semco Systems Limited in April 2009, John Plaskon has decided to ‘get back to his customers.’ “I have always enjoyed helping customers solve their problems by sourcing process equipment solutions for them,” says the professional engineer.

For the majority of his career, that is exactly what he did. Plaskon was involved in process equipment sales for 33 years, the last few in a more administrative role as the president of Semco, a provider of chemical handling equipment, including environmental solutions for air, earth and water.

Over the years, he has made many contacts in the industry. During the holiday season, he decided to scan all the business cards he had accumulated into a contact management database. “I decided that the contacts I came across that I would never want to do business with again would wind up in the waste basket,” he notes. But, at the end of the exercise, he had only discarded a handful of cards. “That is when it dawned on me,” he says. “We are so privileged to work within a group of very professional and dedicated people.”

This positive experience started early in his career when he was working in Calgary, from 1977 to 1983, with an equipment supplier to Dome Petroleum. Because Dome had a drill fleet in the Arctic, Plaskon even had the chance to work aboard a drill ship on the Beaufort Sea, providing technical support for the horizontal drilling equipment the company was using to find shallow oil reserves.

In fact, Plaskon has had no shortage of exciting and diverse experiences during his career. His work has taken him to all four corners of the world, from Tuktoyaktuk to Europe, from Brazil to China.

Before joining Semco as sales engineer in 1988, he spent five years with Robbins and Myers Moyno working with industrial pump technology. It was during that time he became a member, and eventually president, of OPCEA.

“During my year as president, OPCEA suppliers were finding it pretty tough to sell in a struggling economy,” he recalls. “I remember that Larry Madden, Terry Fahlenbock and I thought that providing knee pads for the sales guys at the OPCEA table top exhibits would be a great idea so they could beg for orders. It created quite a laugh at the conference that year.”

Plaskon had the chance to reconnect with many of his former colleagues last April when he attended the OPCEA conference for the first time in many years. He plans to become more active with the association now that he is returning to a more interactive role in the industry.

“I see myself as more of a conduit between the consultants and the equipment suppliers,” he says. “Over the years, I have accumulated a lot of information on the source of supply that exists out there.” Through his new company, Process Equipment Solutions (.ca), he is looking forward to providing cost effective solutions by representing qualified and experienced process equipment manufacturers to customers throughout southern Ontario.

Packaged Auto-Start Sewage Pumping Stations
The Gorman-Rupp Base Mounted Auto-Start station incorporates the Gorman-Rupp Super T Self-Priming Pump with liquid level control which automatically converts to 12 volt DC and drives the pump with a standby engine - providing normal pumping service during power failures. When power resumes, AC motor operation is automatically restored. It meets all standby requirements and uses a variety of fuels.

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OPCEA ANNUAL GENERAL MEETING

Due to the print deadlines of this issue, the summary of the Annual General Meeting held on February 16, 2010 will be in the next issue of INFLUENTS.

OPCEA 2010 ANNUAL GOLF TOURNAMENT

This year’s OPCEA Annual Golf Tournament will be taking place on June 2, 2010. Please note the tournament is being held at a new location, the Cardinal Golf Club on Highway 9, just west of Newmarket. A BBQ lunch precedes the shotgun start at 1 pm, and there will be a steak dinner to follow. Book your teams early as this event has sold out very quickly in past years. More information is available on the OPCEA website at www.opcea.com.

OPCEA TRADESHOW

The OPCEA Tradeshow will be held in conjunction with the WEAO Conference at the London Convention Centre in London, ON, April 18-20, 2010. For more information on free passes to the OPCEA Tradeshow, please visit www.opcea.com.

Member companies, please watch for your exhibition registration package to arrive soon by regular mail. Information on exhibiting at the tradeshow is also available on our website.

OPCEA DIRECTORY

The OPCEA Directory questionnaire will be distributed by mail in the near future. Please take the time to review and carefully complete this questionnaire, as this information is what will be listed in the OPCEA Directory.

WEAO FORUM ON PROVINCIAL MINISTRIES AND WASTEWATER ISSUES

A Forum on Provincial Ministries and Wastewater Issues, organized by WEAO, was held on January 12, 2010 at Queen’s Park. At this forum, which is the second one organized by WEAO, OPCEA presented an overview of the association and some of its issues to senior officials of the Ministry of the Environment and other related ministries. The presentation was made by OPCEA Vice President, Frank Farkas. Follow-up questions were fielded by Frank and other OPCEA members in attendance.
BETH VAN ERP: PROTECTING MUSKOKA’S WATER

As the Chief Operator for Bala and Port Severn Water and Sewer in the District Municipality of Muskoka, Beth Van Erp wears eight hats. For each of these communities, she is responsible for water treatment as well as wastewater treatment, collection and distribution systems. Although juggling four responsibilities at two locations can be challenging, she truly enjoys the diversity every day brings.

“There is a feeling of pride that, in Muskoka, we are producing safe drinking water and helping to keep Muskoka’s main resource, our lakes, pollution free,” she says of her team, which also includes a crew of four operators.

Every morning, all five meet at the Bala Wastewater Treatment Plant, Van Erp’s base, then split in half to service the two towns: Port Severn, with its Sequencing Batch Reactor (SBR) and Class II WTP, and Bala, with its Extended Aeration Plant and Class IV WTP. Located about a half hour apart, the two towns have not only different systems, but also different profiles. Bala’s population of about 630 increases significantly during tourist season. Port Severn is also a very small community, but, in the summer, the population explodes. Van Erp explains that, although the town only has 83 connections, one of them is for a trailer park with upwards of 500 trailers during the summer months.

Regardless of the season and the demand, the team must ensure the wastewater treatment plants for each town consistently meet regulatory effluent objectives. At the same time, they are also responsible for ensuring they stay in compliance with the strict drinking water regulations. This means performing daily lab analyses and online analyzer calibrations, and making any necessary adjustments for process optimization. “We also do as much equipment maintenance as we can in-house,” notes Van Erp.

She adds that, because the Chief Operators responsible for each of Muskoka’s 17 treatment plants all wear many hats, the District emphasizes cross-training. In fact, Van Erp holds her Water Treatment III and Water Treatment IV licences, as well as Class II Distribution and Collection System licences.

Her first experience in the field involved sampling lakes for the cooperative education component of her Georgian College coursework. Later, her boss at a subsequent job asked her to consider a career as a water treatment operator. “I had never even heard of such a thing,” she laughs.

Nonetheless, she soon found herself writing her Operator-in-Training exam at the Bala WWTP and working as an Operator I. Later, she moved on to Port Carling, where she became an Operator II and a Treatment Operator, returning to Bala to assume her current position in 2004.

As of February 2010, she has completed all her pre-requisites as a Certified Technician (C. Tech.) with the Ontario Association of Certified Engineering Technicians and Technologists (OACETT). After completing two more courses and a technology report, she will have her full Certified Engineering Technologist (CET) designation. Van Erp sees her progress so far as being only the beginning of a long and fulfilling career. “I love what I am doing,” she says. “When you go to work and love your work, it doesn’t even feel like a job.”
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In many ways, Gerry Stevens is the missing link between operators and design engineers. Over time, the Process Design and Operations Specialist has transformed his experience in wastewater treatment plant (WWTP) operation into a thriving consulting business of guiding engineers through the design process.

“Many design engineers have little or no experience with WWTPs and need help understanding what operators need in terms of equipment,” Stevens explains.

Certified as a Wastewater Treatment Plant Operator IV in 1978, after 15 years as plant manager of two activated sludge wastewater plants for the City of Kelowna, he quickly learned what those needs were: “I learned not only how to manage a WWTP, but also about the daily tasks and responsibilities of plant operators, the technology required, and how to implement a design that works.”

During his time with the City, he was also involved in writing standard operating procedures on equipment maintenance and process optimization. “If you understand at an operating level how to get people to use equipment to manage a process, then you understand how to streamline that process,” he explains.

Under his guidance, Kelowna became one of the early leaders to computerize its entire WWTP and remote sewer/water sites. Says Stevens: “By the time I migrated to consultant work 20 years later, I had a clear understanding of operators’ needs in terms of real-time information, alarming and reporting events for their processes.”

The link between those needs and design became even more evident between 1979 and 1981 when, as Kelowna’s Project Manager, Stevens worked closely with the design and construction team building North America’s first full-scale biological nutrient removal (BNR) facility. Later, as Kelowna’s new Water and Wastewater Superintendent, he took an active role in optimizing the nutrient removal process.

After leaving the City of Kelowna, he continued working with BNR as a process design and operations expert with an engineering consulting company in western Canada that designed WWTPs around the globe. “I was dealing with a lot of masters and PhD-level engineers,” he recalls. “It became obvious that BNR was not something found in any engineering textbook.”

Since then, nitrogen and phosphorus removal have become the cornerstone of many WWTPs worldwide, and textbooks have begun to catch up. Yet, to this day, maximizing energy efficiency and meeting process requirements for bacteria are not well understood, says Stevens, now a consultant with AECOM.

“Operators are often being shut out by the engineering teams during the design and selection of processes,” he says. “At the same time, operators often do not understand many details about processes they are given to run. There is a knowledge gap that I try to bridge.”

Clients have not been the only ones to notice his role in bridging the gap between process design and operation optimization. In 2006, the Water Environment Federation awarded Stevens the Morgan Operational Solutions Medal in recognition of his valuable contribution to the industry.

What this tribute says about Stevens’ career is that it has been anything but typical. Thanks to a combination of skills, circumstances and drive, he has truly become the missing link.
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IS SUSTAINABLE FUNDING FOR WATER AND WASTEWATER SYSTEMS FINALLY COMING TO ONTARIO?
A private member’s bill would require municipalities to implement full cost recovery

Introduction
The latest move in Ontario’s long and protracted shift towards sustainable water and wastewater infrastructure funding is Bill 237, which would enact the Sustainable Water and Waste Water Systems Improvement and Maintenance Act, 2009 (SWIM). If enacted, it would establish the Ontario Water Board to oversee aspects of municipal water and wastewater treatment. Municipalities would be required to assess the full cost of providing water or wastewater services, describe how they intend to pay the full cost, and then submit this assessment as a Business Plan for review and approval to the proposed Water Board.

If enacted, this SWIM would supersede similar legislation that has been in the works for eight years. Its mere introduction should remind government of the need to tend to work left undone following the Walkerton Inquiry Report.

The challenge of sustainable infrastructure funding
When it comes to government spending, water and wastewater projects often take a back seat to flashier projects. May 2010 will mark one decade since the Walkerton tragedy. Evidence at the Walkerton Inquiry pointed to the challenge that many municipalities have in understanding the costs of running water and wastewater systems and sustaining infrastructure, together with the pressures to keep water rates low and to redirect resources from the water systems to other projects.

Justice O’Connor considered the need for a means to ensure that municipal water and wastewater systems are adequately financed so important from a safety perspective that he devoted an entire separate section of his report to financial issues. Justice O’Connor recognized that full cost accounting and full cost recovery were key components to ensuring the sustainability of water and wastewater systems, and that financial plans should be prepared based on these components. The provincial government’s role would be to set standards for full cost recovery and to determine the degree to which the government would review and approve these plans.

Since Walkerton, the province introduced a Drinking Water Licencing Program that includes the requirement to prepare Financial Plans. However, Financial Plans will not require full cost recovery until the Sustainable Water and Sewage Systems Act, 2002 is proclaimed into force.

The fix that never was: Sustainable Water and Sewage Systems Act
Justice Dennis O’Connor’s report of the Walkerton Commission Inquiry was submitted to the government in early 2002, at which point the province had already introduced the Sustainable Water and Sewage Systems Act (SWSSA). However, the SWSSA was never proclaimed into force, nor were the regulations necessary for the act to operate ever developed.

The SWSSA would have required municipalities to conduct an assessment of the full cost of providing the water and wastewater services and the revenue needed to provide them. These costs would have included source protection costs, operating costs, financing costs, renewal and replacement costs and improvement costs associated with extracting, treating or distributing water to the public, and “such other costs that may be specified by regulation”. This list of general components lacks the specificity to guide municipalities. For example, how are indirect costs, or costs that may also benefit other municipal activities treated?

Municipalities would be required to prepare and implement plans describing how they intend to pay the full cost of providing those services. This does not address the exceptional circumstances, as suggested by Justice O’Connor when provincial subsidies are appropriate.

Finally, the SWSSA would have required municipalities to establish and maintain a dedicated reserve account, segregated from its general revenues, for revenue allocated to pay the full cost of providing water services or wastewater services. Plans would be approved by the Minister of the Environment.

The stopgap: the Financial Plans Regulation
Part of the intent of the unfulfilled SWSSA has been revived in the Financial Plans Regulation developed under the Safe Drinking Water Act. The regulation came into force August 14, 2007. It requires municipalities to prepare financial plans when they apply for a municipal drinking water licence for a new system or apply for a renewal of a municipal drinking water licence. For new systems, the financial plans must indicate that the drinking water system is financially viable, include a statement that the financial impacts of the drinking water system have been considered, and include details of the proposed or projected financial operations of the drinking water system. Applications for amendments to licences require more detailed information.

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Eventually, all municipal drinking water systems will be required to create these financial plans, starting as early as July 2010.18

The Ministry of the Environment has developed a guideline to assist municipalities in meeting their obligations under the Financial Plans Regulation.19 The guideline covers topics such as long-term capital investment planning, asset management, and approaches to developing financial plans.

Although the Financial Plans Regulation fulfills one of the key requirements of the Walkerton Inquiry, it does not require full cost recovery as recommended. Instead, it merely requires that the system be “financially viable.” The Financial Plans Regulation was intended to be a stopgap measure until regulations under the SWSSA could be developed.20


Ontario Bill 237 is a private member’s bill, introduced by David Caplan (MPP, Don Valley East). So far, this has only received first reading on December 9, 2009.

If enacted, SWIM would establish the Ontario Water Board to oversee aspects of municipal water and wastewater treatment, and would require municipalities to prepare business plans for the provision of water services or wastewater services (which would be submitted to the Board for approval).

Plans under SWIM must contain, among other things, an assessment of the full cost of providing water or wastewater services to the public and a description of how the municipality intends to pay this full cost. The plan would also have to specify that full metering of customers will be used as a source of revenue, subject to any exceptions prescribed by the regulations.

However, none of SWSSA, SWIM nor the Financial Plans Regulation defines “full cost” as it applies to mandatory cost recovery. Without such standards to guide the approval of Business Plans, the objectives of any Water Board would be thwarted from the outset.

Mr. Caplan’s private member’s bill may prompt government to seriously consider the linkage between financial issues and safe water and to develop mandatory full cost recovery standards with municipalities. Then it will have played an important role in ensuring safe drinking water for Ontarians.

End notes
1 S.O. 2002, c. 29.
2 To be fair, the government has recently announced funding for many individual municipal infrastructure projects; see http://www.mei.gov.on.ca/en/infrastructure/sectors/?page=water for more information.
4 Ibid. p. 300
5 Ibid.
8 Ss. 3(5), 4(5).
9 Ss. 3(7), 4(7).
10 Ss. 9(1), 10(1), 14.
11 Part II Walkerton Report page 316 12 S. 22.
13 S. 7.
14 S.O. 2002, c. 32.
15 O. Reg. 453/07, ss. 1(1), (2). See also Safe Drinking Water Act, 2002, s. 32(5) para. 2(ii).
16 O. Reg. 453/07, s. 1(2) paras. 1, 2(i) and 4.
17 O. Reg. 453/07, s. 3(1).
18 O. Reg. 453/07, ss. 1(3) and 3(1).

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Raj is an Associate Lawyer with a degree in environmental engineering.

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in our sector, success has focused almost exclusively on counting beneficiaries – the number of people supported with improved water and sanitation facilities in a given year. Really, we need to start asking – do the beneficiaries actually have running water and sanitation years later? Do these beneficiaries, their children and their grandchildren have safe water and improved sanitation or are these successes short-lived?

Water For People has learned this lesson directly from its own experience, emerging from the first organizational strategic plan (2007-2011). Most goals were achieved two years early and were operational in 10 countries, allocating over 80% of our finances to programmatic work, achieving organizational excellence targets and shortly surpassing our goal of supporting 1,000 people/day with improved water or sanitation facilities.

Water For People has learned over the past four years that counting beneficiaries as its primary measure is an inaccurate indicator of success and impact. We rightly celebrate the exciting day when families get a new water point. But, this day is only the start of an important journey that we need to better track and understand. We have learned that the question is not how many people we help in Year X, but how many of these people still have services in the years that follow. How many people never have to turn to a non-governmental organization (NGO) again for support, once the expected lifespan ends of their new water facilities or latrine, supported originally by Water For People? How many communities actually have the ability to maintain and replace their systems so that they never have to go back to a dirty water point or seek a new charitable support?

Water For People is implementing a program called ‘3, 6, 10,’ which links the core sustainability indicators with the following crucial financial indicators, so that we can really hold ourselves accountable for our work:

- **3 years following project completion** – evidence that money is available for repairs, that repairs are happening and the account is well managed (accurate financial management, no fraud, etc.).
- **6 years following project completion** – enough money is available to replace the most expensive part of the system.
- **10 years following project completion** – enough money is available to replace the entire water system.
- **ultimately, what percentage of community water systems and sanitation facilities are actually replaced without the financial support of an external NGO?**

The final indicator identified above is the most important one. There is no time limit on this as different technologies have different operational life spans, but it will be critical to measure whether funds are available locally.

continued on page 78
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(between the community, local government and, increasingly, local private sources such as microfinance institutions and even private operators) to replace systems.

It is intentional that none of the indicators identified above focus on health outcomes. It is extremely difficult to demonstrate conclusively that a water intervention led to a clear health outcome without doing complex studies utilizing control groups that do not receive the same intervention. This is a questionable use of scarce sector resources and can be morally problematic. What is certain is that no positive health outcomes can be expected if the project fails. As such, if the sector can begin to demonstrate that water is flowing, toilets are used and managed hygienically, and hands are being washed at key times, then that would be an enormous step forward for the sector, without having to take that extra step to show that water and sanitation are functioning and health has improved.

Possible sustainability indicators for sanitation
- No open defecation.
- No feces or urine on floor/seat/walls of latrine.
- Latrine is being replaced when full or cleaned as needed so that family can always use a latrine.
- No family without a toilet in the community.

Possible sustainability indicators for water
- The quality of water meets host country government standards over time – with a focus on a handful of bacteriological parameters (E. coli and total coliforms) plus any other water quality challenges that are known in the area and that undermine household health (like arsenic in West Bengal, India).
- The quantity of water available to households meets host country government standards over time.
- That the water system is inoperable for no more than one day per month.
- The number of users per water point meets host country government standards.

Possible hand washing indicators
- People in communities know all times when hand washing needs to be practiced.
- People are demonstrating proper hand washing technique.
- Soap or other cleansing agent and water are available for hand washing at the latrine and in the kitchen.
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<td>HETEK Solutions Inc.</td>
<td>888-432-8422</td>
<td><a href="http://www.hetek.com">www.hetek.com</a></td>
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<td>Hy-Grade Precast Concrete</td>
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<td>ICR Water Technologies</td>
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<td>ITT Water &amp; Wastewater Canada</td>
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<td>877-553-6967</td>
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<td>John Brooks Company Limited</td>
<td>877-624-5757</td>
<td><a href="http://www.fluidhandlingsolutions.com">www.fluidhandlingsolutions.com</a></td>
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<td>John Meunier Inc.</td>
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<td>Kemira Water Solutions Canada Inc.</td>
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<td>Liberty Energy Centre</td>
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<td>Xerxes Corporation</td>
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