

Memorandum

TO: Members of Committee of the Whole
FROM: Erin Mahoney, Commissioner Environmental Services
DATE: February 16, 2018
RE: **Update on Water and Wastewater Research and Innovation**

This memo provides an update to Council on water and wastewater research activities and innovations undertaken in 2017.

Research programs bring about innovative solutions and are key to Environmental Services meeting and anticipating emerging challenges

To stay ahead of regulatory changes and in step with advances in treatment technology, Environmental Services has been engaged in a research and innovation program since 2008 spanning both water and wastewater disciplines. The program supports protection of public health and the environment by:

- understanding emerging challenges;
- leveraging and implementing the latest technologies;
- optimizing facility operations to reduce chemical consumption and improve treatment quality; and
- aligning with a complex and changing regulatory framework.

Through strategic partnerships with various universities, agencies, industry experts, and our services providers, York Region has made considerable progress in implementing innovative solutions to complex problems and challenges in the water and wastewater industry. These partnerships include:

- University of Toronto's Drinking Water Research Group (DWRG)
- Water Research Foundation (WRF)
- Water Environment Research Foundation (WERF)
- University of Waterloo
- University of British Columbia
- University of Sheffield, England
- Ministry of the Environment and Climate Change (MOECC)

- Region of Peel
- Regional Municipality of Durham
- City of Toronto

Research supports innovation in the delivery of water and wastewater services

York Region faces numerous operational and regulatory changes in managing complex, multifaceted water and wastewater systems. Environmental Services recognizes the importance of anticipating challenges and undertakes numerous initiatives to remain engaged and in step with advances in technology. Research and innovation is essential to achieving success. The technical support group in Operations, Maintenance and Monitoring generates projects that not only develop new design and operational processes using forefront technology, but also optimize operations at existing facilities and investigate current conditions to foresee potential problems before they occur. Research has broadened our knowledge horizons resulting in more informed decisions on water and wastewater operations by pursuing new technologies, new approaches and new paradigms. Examples of benefits from research initiatives since 2008 include:

- Better understanding of membrane biofouling, impacts to membrane lifespan and optimal membrane maintenance for top quality wastewater effluent
- Understanding why cyclically operated biologically active carbon contactors work well and why keeping our current media to a cost savings of \$400,000 was a good decision for water quality
- Rapid small scale column tests on granular activated carbon to understand carbon longevity resulting in modified technical specifications
- Improved understanding of disinfection by-products and public health impacts
- Application of adenosine tri-phosphate (ATP) monitoring as a tool for biomass growth in filters and distribution pipes
- Development of a multi-barrier approach to mussel control and continuous mussel monitoring system
- Reductions in energy costs and greenhouse gas emissions from heat recovery projects
- Adoption of the “One Water” philosophy

Highlights from ongoing and future projects include:

Source Protection Projects

Early Detection and Treatment of Blue-Green Algae Toxins

Keeping in step with emerging issues related to blue-green algae blooms in source waters, and associated human health impacts, the Drinking Water Research Group in partnership with York Region and four other Ontario municipalities, obtained federal funding toward a three-year project for early detection and treatment of blue-green algae toxins. This research will provide utilities with knowledge and tools for early

detection and mitigation of their impacts to drinking water treatment. Treatment possibilities include granular activated carbon filters, ozone and advanced oxidation processes.

Anticipated Completion: 2019

Mussel Control at Drinking Water Intakes

Building on previous research done by the Drinking Water Research Group and lake monitoring by Lake Simcoe Region Conservation Authority, further work is underway to develop new monitoring techniques and alternate physical and chemical control strategies to reduce the impacts of invasive mussels (Quagga) on drinking water intakes and water treatment plants. Renata Claudi from RNT Consulting Ltd., a global leading mussel researcher, is part of the research team. Alternatives under investigation include pH suppression, coatings and biocides. Monitoring approaches are being investigated and implemented along with additional research on mussel mortality and life cycle. Results will be relevant to all Southern Ontario utilities with surface water plants as these invasive mussels are prevalent in most freshwater systems.

Anticipated Completion: 2019

Investigation of Alternative Sources of Disinfection By-Products

York Region has recently participated with the Drinking Water Research Group on a Water Research Foundation project to explore the issue of emerging disinfection by-products in source water. Typically, these chemicals form in the water during disinfection. An example of an emerging disinfection by-product is nitrosodimethylamine (NDMA), regulated in Ontario to 9 parts per billion in drinking water to protect public health. Research will investigate alternative sources of precursors through the water cycle.

Anticipated Completion: 2019

Investigation of Alternative Groundwater Treatment Strategies

In order to address distribution challenges associated with groundwater, York Region commissioned the Groundwater Treatment Strategy in 2016 with CH2M Consulting Services was retained to evaluate alternative treatment methods at Region groundwater wells to address iron and manganese water quality issues. The project also pilots treatment methods to understand impacts on the distribution systems. This work further gauges the impact of Health Canada's recently proposed guideline for manganese.

Anticipated Completion: 2018

Investigating Emerging Contaminants at the Source

Environmental Services, under the York Region Sewer Use Bylaw 2014-23, is working on a field research program with the Ministry of the Environment and Climate Change to assess wastewater discharges from pharmaceutical manufacturers and funeral homes as potential sources of emerging contaminants. Working with business owners as part of a collaborative research undertaking, results will provide greater insight into

contaminant loadings from these point sources and identify methods to control emerging contaminants. International research has shown that pharmaceutical manufacturing facilities can be significant sources of pharmaceutical loading to wastewater treatment plants. Preliminary results indicate this is also true of York Region's pharmaceutical manufacturers. Staff have shared results from the funeral home research at recent conferences and anticipate submission of the pharmaceutical research to the Science of the Total Environment journal in Q2 2018.

Anticipated Completion: 2018

Process and Energy Optimization Projects

Optimization of Biological Filtration

In partnership with the Drinking Water Research Group, a pilot is ongoing at the Georgina Water Treatment Plant to better understand biological filtration in the granular activated carbon filters with the goal of optimizing operations and improving water quality in the distribution system. Recent work focused on cyclical operation of the filters and new test methods have determined why this feast-famine operation removes the greatest amounts of organic carbon. These research findings have reinforced the suitability of our current operational strategy. This strategy has resulted in lower disinfection by-products and greater distribution water stability.

Anticipated Completion: 2019

Monitoring Toronto's Corrosion Control Plan in the York Water System

City of Toronto uses a phosphorus product to prevent lead corrosion within old piping as part of the City's Corrosion Control Plan. Phosphates are added to prevent lead from entering into drinking water. To better understand impacts, York Region actively monitors phosphorus throughout the York Water System. Results are regularly reported to the City, local municipalities and Public Health. Given current and anticipated lead regulatory levels, phosphate addition by the City of Toronto will continue into the future with seasonal adjustments to dosing.

Anticipated Completion: 2019

Innovative Upgrades to Improve Water Quality in Local Municipal Distribution Systems

York Region has recently commissioned three rechloramination facilities at Aurora South Reservoir, East Vaughan Booster Pumping Station and Newmarket Glenway Reservoir to improve water quality in the local distribution systems. Additional projects are underway for the Aurora Ridge Road Pumping Station, Holland Landing West and Schomberg Elevated Tank. These facilities are some of the first of their kind in North America and are proving very effective in maintaining chloramine residuals for the local systems.

Anticipated Completion: 2019

Data Analytics to Drive Energy Optimization

Environmental Services has partnered with York University's Schulich School of Business Dr. Murat Kristal to complete three data analytics projects at Vaughan Pressure District 7 Water System, Newmarket and Aurora Sewage Pumping Stations. Through these projects, data analytics techniques have identified efficiencies in pumping patterns to inform new operational approaches resulting in energy and cost savings. Annual savings resulting from these optimization activities at one facility are approximately 14,500 kilowatt hours, \$2,500 in power costs, and over 1,116 kg of GHG. More savings are anticipated as this optimization strategy is rolled out across other facilities. Environmental Services continues to seek opportunities to better leverage existing data and data analytics techniques.

Anticipated Completion: 2018

Heat Recovery and Water Reuse Projects

Effluent Heat Recovery and Reuse Project

Wastewater contains thermal energy that is typically discarded when the treated effluent is discharged. An energy audit was completed at Keswick Water Resource Recovery Facility, which highlighted that the largest heating load was the immersion electric heater that warms the membrane clean-in-place solution. In 2017, a heat recovery feasibility study examined various heating alternatives, including: thermal solar, geothermal, natural gas boilers, and effluent heat recovery. The alternatives were compared based on capital and operational costs, operational flexibility, reliability, greenhouse gas emissions, and innovation. The heat recovery option included extracting heat from the treated wastewater stream and using that heat to warm the membrane clean-in-place solution. This option had the lowest life cycle cost, lowest annual energy consumption, and lowest greenhouse gas emissions. The effluent heat recovery system will be located in the basement of the plant and will extract water from the effluent water storage tank. A capital project has recently been initiated to design and construct the system. The Region will apply for the Federation of Canadian Municipalities Green Municipal Fund and other funding sources to implement this project. The project was also included in York Region's submission to the Municipal Greenhouse Gas Challenge Fund initiated by the province in 2017.

Anticipated completion: 2019

Water Reuse Research Demonstration Project

Environmental Services recently completed the first phase of the Water Reuse Research Demonstration Project. This phase included completing five technical memos including final Research and Sampling Plans. The Project will use reclaimed water from the Mount Albert Water Resource Recovery Facility to irrigate a test plot of sod for two growing seasons at an operating sod farm starting in 2018. The research will be conducted by an academic research team led by Soil Resource Group with University of Waterloo and Agriculture Canada. The team will evaluate the effects of reclaimed water on plant health, soil properties along with water quality and quantity. Results will help

York Region better understand the technical, regulatory and environmental implications of water reuse. Ministry staff expressed interest in emerging contaminants and water reuse. Region staff have submitted a request to the Ministry to include analysis of emerging contaminants in reclaimed water in their 2018 laboratory tests as part of the Water Reuse Research Demonstration project.

Anticipated Completion: 2020

Research to Enhance System Understanding

Hydraulic Pipe Management for Distribution System Water Quality

In collaboration with the University of Sheffield, York Region is currently conducting research to better understand the mechanics of pipe wall interactions and chlorine residual stability. This research is expected to improve our understanding of the physical and biological interactions occurring inside distribution pipes. This insight will help inform future best practices for operation of the water distribution system and residual levels for our local partners.

Anticipated Completion: 2019

Optimization of Membrane Performance during Cold Weather Conditions

York Region is currently facilitating a federally funded research partnership with Suez (membrane manufacturer) and the universities of British Columbia and Waterloo to optimize the biological processes and membrane treatment at the Keswick Water Resource Recovery Facility. This partnership with internationally recognized experts in wastewater treatment will provide a strategy to better address cold water challenges. It has the potential to increase membrane life, advance operations and assist in improving the quality of water returned to Lake Simcoe. This inaugural project sets out the framework for industry leading wastewater research and better understanding of membrane performance in the Canadian climate.

Anticipated completion: 2020

Organochloramines Research

In partnership with the Drinking Water Research Group and Water Research Foundation, York Region has undertaken research to enhance the understanding of the mechanism of formation of organochloramines and their impacts on the water system. The research will lead to optimizing operations and improving water quality in the distribution system.

Anticipated Completion: 2020

York Region continues to promote shared knowledge and showcase excellence as a member of 'Leading Utilities of the World'

Research and innovation initiatives have and will continue to improve plant operations, asset management programs and inform capital projects. Staff engagement with industry experts has created opportunities to modify practices to meet regulatory requirements as well as develop new programs and tools to anticipate the needs and challenges the industry faces.

Articles pertaining to research projects lead by York Region have been published in numerous manuals and journals, including American Water Works Association (AWWA) manuals, Water Research Foundation and Water Environment Federation (WEF) publications.

York Region staff have conducted presentations to various technical committees of AWWA, Ontario Water Works Association (OWWA), Water Environment Association of Ontario (WEAO), and the Water Environment Federations Annual Technical Exhibition and Conference (WEFTEC). York Region staff have also participated in industry leadership programs such as WEF's Water Leadership Institute and are active members of local and international technical committees.

Our improved knowledge better positions York Region, as a member of the 'Leading Utilities of the World' network, to advocate and respond to proposed advancements in regulatory governance. These ongoing efforts demonstrate York Region's commitment to continuous improvement, leadership and operational excellence in the highly regulated delivery of water and wastewater services.

Erin Mahoney, M. Eng.
Commissioner, Environmental Services

RH/vt
#8104482