



KEEPING A GREAT PLACE TO LIVE, WORK AND PLAY

A COLLECTION OF YORK REGION CASE STUDIES ADDRESSING
THE CANADIAN ENGINEERING GRAND CHALLENGES



KEEPING A GREAT PLACE TO LIVE, WORK AND PLAY

A COLLECTION OF CASE STUDIES ADDRESSING THE CANADIAN ENGINEERING GRAND CHALLENGES

TABLE OF CONTENTS

Forward	4
Erin Mahoney, 2021 Douglas Wright Engineer-In-Residence	5
About the Canadian Engineering Grand Challenges 2020-2030 ...	6
About York Region.....	8
Driving I&I Reduction Through Resilient Infrastructure	10
Creating Opportunities to Access Affordable, Reliable and Sustainable Energy	12
Providing Clean, Safe Drinking Water	14
Supporting Inclusive, Safe and Sustainable Cities	16
Achieving Inclusive and Sustainable Industrialization Through Circular Economy	18
Increased Access to Inclusive STEM Education	20






York Region



FORWARD

NADINE IBRAHIM

TURKSTRA CHAIR IN URBAN ENGINEERING URBAN ENGINEERING

By Nadine Ibrahim

Inspiring action on the Canadian Engineering Grand Challenges (CEGCs) empowers us to collaborate to improve life for Canadians and the world. The CEGCs were central to many of my conversations this year, and certainly, many professionals and academics have used a Grand Challenges approach to focus their respective professions. Recognizing the critical role that engineers play as technological leaders and stewards, the engineering profession has a pressing responsibility to address these challenges with urgency, and respond to the world's call to action on the United Nations' Sustainable Development Goals.

I am very grateful that this publication brings the CEGCs to light and to showcase a number of projects and initiatives from York Region relevant to addressing each of the grand challenges. By raising awareness about these challenges, students will develop attributes and competencies by working in collaboration with people from other disciplines. These attributes include: ability to design and create, ability to integrate and solve, understanding of business and innovation, the practice of being multicultural and diverse and the commitment to social consciousness and community.

I wish to extend many thanks and appreciation to all who contributed to this publication.

Thanks to Elise Rao, first year Civil Engineering student, for leading and assisting with design of this publication as a Legacy Project for the 2021 Douglas Wright Engineer-in-Residence, Erin Mahoney, in the

hopes that this publication continues to be compiled for future Engineers-in-Residence representing different municipalities across Canada.

Thanks to York Region staff, Lindsay Harrison, Clare Faulds, and Samantha Sheppard who contributed to the ideas, development, and design of this publication.

Thanks to York Region staff Wendy Kemp, David Szeptycki, Beth Weir, Mike Rabeau, Laura McDowell, and Michelle Swan, who reflected on and contributed very meaningfully to each of the Canadian Engineering Grand Challenges from their areas, respectively.

Thanks to Erin Mahoney, Commissioner of Environmental Services at York Region for giving her time, energy, insight and experience to the University of Waterloo as the 2021 Douglas Wright Engineer-in-Residence.

Thanks to Engineering Deans Canada (EDC) for creating and endorsing the Canadian Engineering Grand Challenges as a framework that reflects the unique characteristics of our people, our natural landscape and the challenges we face as Canadians, which motivates and inspires our collective problem-solving sights.

Thanks to Carl Turkstra for his vision to establish the Turkstra Chair in Urban Engineering that creates excitement for our future cities, and makes this work possible.

Thanks to the all the readers who will find this valuable.

ERIN MAHONEY, 2021 DOUGLAS WRIGHT ENGINEER-IN-RESIDENCE



ABOUT ERIN MAHONEY

Erin Mahoney is Commissioner of Environmental Services for York Region and holds a Master of Engineering degree from the University of Western Ontario. She oversees water and wastewater services, waste management, forestry, corporate energy and corporate asset management for 1.2 million residents and 28,000 businesses. Erin leads a team of about 500 staff in the Environmental Services department, which was inducted into the Leading Utilities of the World network in 2017.

Erin is the 2021 Douglas Wright Engineer-in-Residence for the Civil and Environmental Engineering Department at the University of Waterloo. She is also a Board member of the Federal Sustainable Development Technology Canada.

She has over 30 years of public and private sector leadership experience on water and wastewater service delivery, policy, environmental legislation and public engagement.

“Deepening my understanding of the Canadian Engineering Grand Challenges was a great learning experience for me.”

REFLECTIONS FROM ERIN MAHONEY

It is my hope this collection of case studies not only reflects my contribution as the 2021 Douglas Wright Engineer-in-Residence, but also illuminates the possibilities of Canada’s Engineering Grand Challenges and their underpinning United Nations’ Sustainable Development Goals (SDGs). To achieve these SDGs by 2030, we need to think differently about sustainability in the very decisions we are making today. The examples from York Region shared on the following pages show how we are thinking and acting differently in tackling these critical challenges.

2030 is right around the corner – we know if we have any chance of achieving the sustainable prosperity we want and need, we must accelerate the pace at which we are adopting clean technology and sustainable solutions. On a positive note, we know that the costs of climate technology are declining which will help us move away from our high carbon status quo.

Creating sustainable cities will indeed take all of us – government, academia, companies and citizens - working hard together and bringing our best integrative thinking to achieve the SDGs in this decade of action. We must be

innovative and collaborative. We must engage with each other to undertake vital research, identify barriers and develop solutions to create more sustainable cities. And we must bring all that thinking into making the best decisions we can for our vital infrastructure and systems which are the life blood of our cities.

Today, young people affected by the threat of climate change are unimpressed with the boomer generation’s impact on our shared planet. Efforts to address “social and environmental responsibility” can no longer be a box that governments and organizations merely tick. Our progress on these Grand Challenges must be measured, demonstrated and reported in a way that is meaningful to our communities.

As strong and innovative Canadians, I think we are prepared to meet these Grand Challenges head on. I appreciate the Dean’s work in synthesizing the SDGs into these Canadian Engineering Grand Challenges and have benefited from using them as a lens to assess our infrastructure projects and environmental programs in York Region.

ABOUT THE CANADIAN ENGINEERING GRAND CHALLENGES 2020-2030

The United Nations' 17 Sustainable Development Goals (SDGs) are our world's call to action on the most pressing challenges and opportunities facing humanity and our natural world. Recognizing the critical role that engineers play as technological leaders and stewards, the Canadian Engineering Profession and Engineering Deans Canada believe engineers have a pressing responsibility to address these challenges with urgency.

The six Canadian Engineering Grand Challenges focus the thoughts and actions of our engineering community on the most compelling and critical issues facing Canada and Canadians today and over the next decade. More information can be found at engineeringdeans.ca.



CANADIAN ENGINEERING GRAND CHALLENGES



Resilient Infrastructure

Infrastructure is key for a prosperous Canada. When fit for purpose, it enables economic productivity; supports a healthy lifestyle and can address issues of social inequality. Infrastructure in Canada is most at risk due to climate change. Coastal communities rely on the management of climate risks on essential infrastructure that is reaching or exceeding its useful life. The consequence of damage and failures to infrastructure and buildings increases due to the changing stresses from climate change. When infrastructure fails, it can disrupt everything from homes to businesses. The dependency relationship between infrastructure and other areas is a key issue when it comes to risks facing Canada.



CANADIAN ENGINEERING GRAND CHALLENGES



Access to affordable, reliable and sustainable energy

Energy is a critically important facet of the Canadian social and economic landscape. Due to its climactic conditions and relatively sparse landscape, Canadian residents and industries consume significant amounts of energy.

Canada's energy sector is also a substantial driver of the Canadian economy, contributing to over 11% to the national the gross domestic product. Ensuring that future energy systems will be clean, safe, reliable, accessible and affordable for all Canadians is a key issue.



CANADIAN ENGINEERING GRAND CHALLENGES



Access to safe water in all communities

Water is life. Provision of safe water is a basic human right. Issues of flooding, water scarcity, and invasive biological contaminants threaten the provision of safe water to communities and are further heightened through climate change.

While Canada has an abundance of water its freshwater systems are under significant strain due to climate change, aging infrastructure and contamination. Also, the provision of safe water continues to be delivered, but there are significant challenges for small urban and Indigenous communities.



CANADIAN ENGINEERING GRAND CHALLENGES



Inclusive, safe and sustainable cities

Cities are home to over 80% of Canadians – and are the arenas where many of Canada’s toughest environmental and socio-economic challenges play out. Complex environmental stresses, including climate change and global biodiversity loss, among others, intersect with social challenges of widening inequality, and changing demographics. The ‘design’ of cities has substantial impacts on human health, linked to auto-dependent lifestyles. Addressing these challenges will necessitate changes to the ways that engineers participate in the planning of urban infrastructure and the development of urban technologies more broadly.

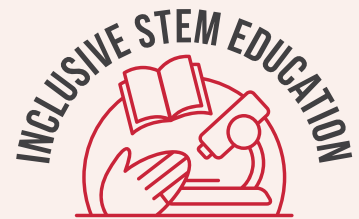


CANADIAN ENGINEERING GRAND CHALLENGES



Inclusive and sustainable industrialization

Inclusive and sustainable industrial development depends on achieving long-term economic prosperity from industrial activities while minimizing resource use and safeguarding our natural environment. Inclusive industrialization ensures that industrial development in Canada and internationally offers equal opportunities to everyone and ensures an equitable distribution of the benefits from industrialization. Technological progress is vital in this process and can mobilize and contribute to the energy-efficiency of our industries and minimize the use of our natural resources or waste generated.



CANADIAN ENGINEERING GRAND CHALLENGES



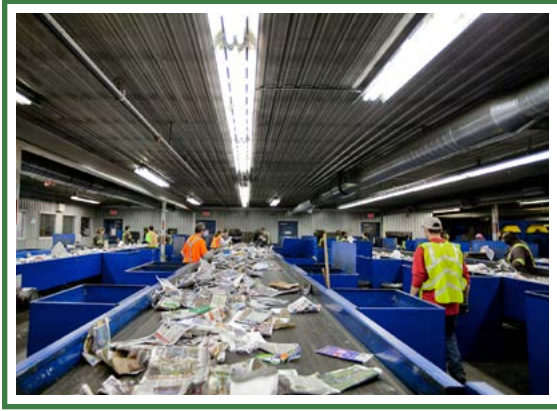
Access to affordable and inclusive stem education

Although engineering education in Canada has grown substantially over the past 165 years, female enrollment in engineering programs persists at 20 percent despite focused efforts to close the gender gap over the past decade. Also, Indigenous peoples are significantly underrepresented in Canadian engineering programs; Indigenous peoples make up 4.9 per cent of the Canadian population but only account for 1.2 per cent of total undergraduate enrollment in engineering programs. Diversity in education and the workforce would significantly contribute to economic growth; diversity of thought will benefit future innovation.

ABOUT YORK REGION

The Regional Municipality of York is in the heart of the Greater Toronto Area and encompasses nine local municipalities including the Cities of Markham, Vaughan and Richmond Hill, the Towns of Aurora, East Gwillimbury, Georgina, Newmarket, and Whitchurch-Stouffville and the Township of King. York Region provides services to 1.2 million residents spread across an area of 1,762 square kilometres. York Region is a fast-growing municipality and by 2051, the Region's population is forecast to be 2.1 million residents.

Services provided by York Region include transportation services, transit, water, wastewater, solid waste management, policing, paramedic, human and planning services. As York Region continues to grow, the needs of its customers continue to evolve.

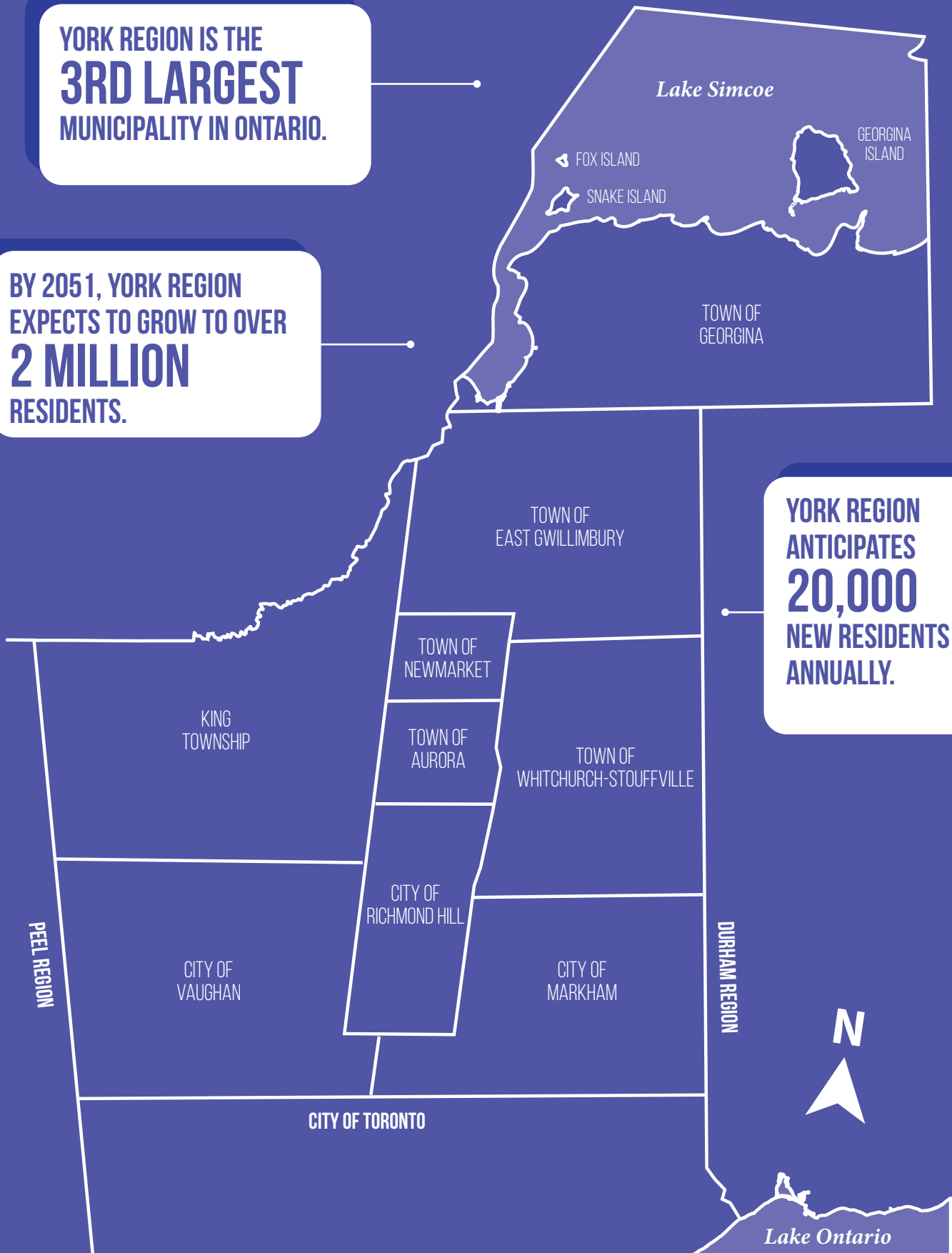


From left to right, top to bottom: Assessing water infrastructure for Inflow & Infiltration, Bill Fisch Forestry Centre, York Region delivers clean safe drinking 24/7, sewer rehabilitation, materials recovery facility, celebrating women in engineering

**YORK REGION IS THE
3RD LARGEST
MUNICIPALITY IN ONTARIO.**

**BY 2051, YORK REGION
EXPECTS TO GROW TO OVER
2 MILLION
RESIDENTS.**

**YORK REGION
ANTICIPATES
20,000
NEW RESIDENTS
ANNUALLY.**





DRIVING I&I REDUCTION THROUGH RESILIENT INFRASTRUCTURE

Infrastructure is key for a prosperous Canada. When infrastructure fails it can disrupt everything from homes to businesses. The dependency relationship between infrastructure and other areas is a key issue when it comes to managing risks facing Canada.

“Infrastructure must adapt to an ever-changing dynamic due to climate change, requiring cross-disciplinary teams from engineering to planning and water resources to work together to strengthen our resiliency and protect human health.”



WENDY KEMP

DIRECTOR, INFRASTRUCTURE ASSET MANAGEMENT,
ENVIRONMENTAL SERVICES



New construction of storm and wastewater infrastructure

THE IMPORTANCE OF INFLOW AND INFILTRATION REDUCTION

Inflow and Infiltration (I&I) happens when groundwater, stormwater or snowmelt enters the sewage system through sump pumps, downspouts, foundation drains and/or holes and cracks in the pipes. York Region's strategic approach to I&I reduction allows for cost-effective means to reduce or avoid future expenditures and promote sustainable growth and development. This proactive work stretches the life, use and capacity of our existing and future assets.

YORK REGION'S I&I REDUCTION STRATEGY

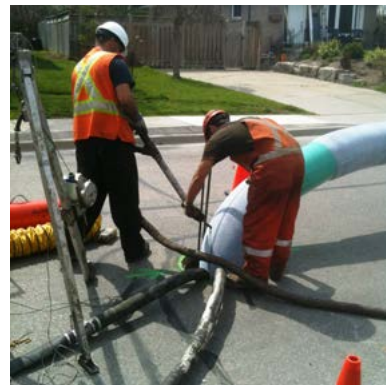
In 2011, the Region developed our first I&I Reduction Strategy in collaboration with our nine local municipalities. A target was set to achieve 40 million litres per day of I&I reduction in the York Durham Sewer System by 2031.

The Region's long-term flow monitoring program is one of the largest and most advanced flow and rainfall monitoring programs in North America, with more than 70 rain gauges and 290 flow monitors in the Regional and local municipal wastewater systems. It covers about 90% of the systems within the Region. The monitoring program provides accurate, continuous, near real-time and reliable flow and rainfall monitoring data. This data is then used to analyze peak wet weather flows and average dry weather flows to locate areas of the system that are highly responsive to I&I.

The Region will continue to analyze this data to track I&I reductions and drive investigative and rehabilitative work in high response areas in the existing wastewater system.

Not only are we working to drive I&I out of our systems, we are also working to design tighter new sewers. The Region's strategy for new developments is to ensure sanitary sewers are constructed to comply with watertight standards. Developing and implementing our I&I New Development Standard will ensure consistent design, construction, inspection and testing requirements for sewers servicing new developments across the Region.

In 2021, halfway through the I&I Reduction Strategy, York Region, local municipalities and development industry partners have reduced I&I by more than 22 million litres per day.



Photos left to right: I&I pilot study assessment, pipe gusher, cured in place pipe application



CREATING OPPORTUNITIES TO ACCESS AFFORDABLE, RELIABLE AND SUSTAINABLE ENERGY

Energy is a critically important facet of our Canadian social and economic landscape. Ensuring future energy systems will be clean, safe, reliable, accessible and affordable for all Canadians is a key issue.

“Public works infrastructure underpins the health, prosperity and vitality of our communities. We must focus on innovation as we build and renew infrastructure to avoid energy use where feasible and embed conservation in everything we do.”



DAVID SZEPTYCKI

DIRECTOR, STRATEGY AND INNOVATION,
ENVIRONMENTAL SERVICES



DESIGNING AND BUILDING WITH SUSTAINABILITY IN MIND

Creating a green building means it is environmentally responsible, resource efficient and that we are helping minimize environmental impacts while providing a healthy environment for staff and residents who access the building.

BILL FISCH FOREST STEWARDSHIP AND EDUCATION CENTRE

York Region's Forest Stewardship and Education Centre is a unique and inspirational building that is a Leadership in Energy and Environmental Design (LEED®) Platinum certified and in 2018 became the first in Canada and twenty first building world-wide to successfully become Living Certified under the Living Building Challenge.

The Living Building Challenge is a program of the International Living Future Institute and has seven performance areas: site, water, energy, health, materials, equity and beauty. According to the International Living Future Institute, "Living buildings give more than they take, creating a positive impact on the human and natural systems that interact with them."

Some of the innovative features of the building include:

- All wood construction including cross laminated timbers
- All new wood material used in the building is Forest Stewardship Council (FSC) certified

- Through the use of solar panels, LED light fixtures, heat pumps, radiant heating and triple glazed windows, the building generates more energy than it uses
- The building's canopy gathers rainwater and snow melt to service bathroom facilities
- All water used comes from the site and is treated and discharged on site, resulting in net-zero water use
- Much of the building materials were sourced from local manufacturers to reduce carbon emissions

The typical construction and operation of a building have significant impacts on the environment. This building is a shining example of how a facility can exist in harmony with its site, in this case the forest, and has been described as a model example of humanity's ability to reconcile our relationship with nature.



Photos left to right:
The Bill Fisch Forest
Stewardship and
Education Centre



PROVIDING CLEAN, SAFE DRINKING WATER

Water is life. Provision of safe water is a basic human right. While Canada has an abundance of water, its freshwater systems are under significant strain due to climate change, aging infrastructure and contamination.

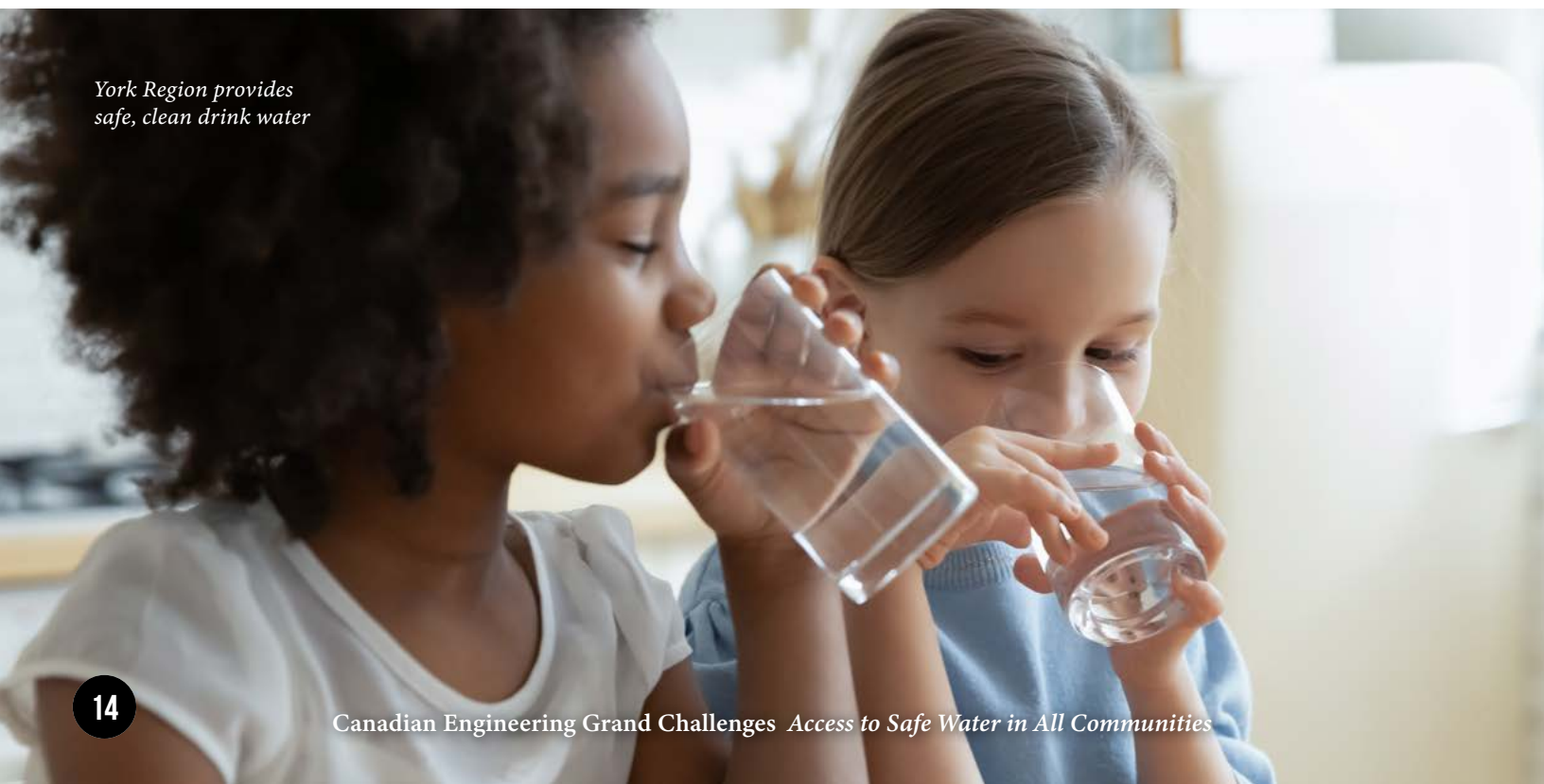


“Always look for opportunities to provide insights to protect public health and the environment.”

BETH WEIR

DIRECTOR, OPERATIONS, MAINTENANCE AND MONITORING, ENVIRONMENTAL SERVICES

York Region provides safe, clean drink water



MAINTAINING ACCESS TO SAFE WATER IN ALL COMMUNITIES

York Region is a leader in delivering clean, safe drinking water to its residents and businesses, achieving the top overall score (water quality and inspections) among GTA municipalities in the most recent report of the province's chief drinking water officer, with a 100% inspection rating. In light of the challenges caused by COVID-19, York Region remains more committed than ever to protecting water resources.

During the early stages of the pandemic, municipal wastewater testing was identified by researchers globally as a possible COVID-19 warning method. York Region became one of the first utilities to commit to the Canadian Water Network's wastewater surveillance laboratory study. This study assesses Canada's ability to develop method detection for COVID-19 in wastewater.

WHAT IS THE SARS COV-2 WASTEWATER SURVEILLANCE PROJECT

The SARS-CoV-2 Wastewater Surveillance Project was initiated to understand the COVID-19 viral signal in wastewater, to help public health agencies target resources to areas of interest or hotspots. Recognizing the severity of the pandemic, this pilot project established new partnerships between the University of Waterloo, York Region Public Health, York Region Environmental Services and the Ministry of the Environment, Conservation and Parks. It used existing wastewater monitoring infrastructure to measure trends of COVID-19 in the community, including variants of concern.

As public agencies mobilized to respond to the COVID-19 pandemic, York Region and its partners recognized the importance of learning more, while using existing resources to monitor developments and inform data-driven decision making. This Project resulted in two valuable outcomes: (1) it created the science, processes, and partnerships that produced reliable information, which informed timely, data-

driven decision making and (2) enabled York Region to contribute to emerging research in this vital field.

Results showed alignment between the COVID-19 viral signal in wastewater and the number of COVID-19 clinical cases in various jurisdictions. This allowed York Region to understand the prevalence of COVID-19 in the community, including asymptomatic cases, without the need to test the entire population on a regular basis. For example, by March 5, 2021, York Region conveyed preliminary results that suggested the Alpha variant was approaching 30% to 40% of total COVID-19 cases, illustrating an impending surge in cases from a more-transmissible variant of concern. The Ontario COVID-19 Science Advisory Table used this data to inform the province on the risk of a third wave. Additionally, the pilot provided continued insight on emerging variants that were not being detected through clinical testing.



Photos left to right:
Lab testing, clean
water, Keswick Water
Resource Recovery
Facility



SUPPORTING INCLUSIVE, SAFE AND SUSTAINABLE CITIES

The ‘design’ of cities has substantial impacts on human health, linked to auto-dependent lifestyles. Addressing these challenges will necessitate changes to the ways that engineers participate in the planning of urban infrastructure and the development of urban technologies more broadly.

“It is imperative we continue to build our toolbox of engineered solutions. Challenges are only going to increase over time and multiple response options will be needed to ensure infrastructure resiliency.”



MIKE RABEAU

DIRECTOR, CAPITAL PLANNING AND DEVELOPMENT,
ENVIRONMENTAL SERVICES

16th Avenue Sewer Rehabilitation

EMBRACING AN INNOVATIVE APPROACH TO ASSET REHABILITATION

The 16th Avenue Sanitary Trunk Sewer Rehabilitation project involved repair of partially deteriorated sewer located in Markham, Ontario. This 3 kilometre section of 2.6 metre diameter trunk sewer tunnel is located at depths between 35 metres and 47 metres below ground surface.

After a successful pilot study, York Region used geopolymer as the permanent structural sewer lining to be completed in two phases. Geopolymers provide comparable or better performance to traditional cementitious binders, along with advantages of significantly reduced greenhouse emissions, increased fire and chemical resistance and reduced water use. This innovative approach was the first time the geopolymer lining system was used in Canada and under site specific condition at the depth installed and under artesian condition and high-water table.

To meet the project implementation and spending timelines set out by our funding partners Infrastructure Canada, an innovative approach to work planning was taken. The rehabilitation work was implemented using a collaborative approach with the general contractor and design consultant to implement the sewer rehabilitation works. The contract, including terms and conditions, was also developed with the design consultant and general contractor.



Photos left to right: Grouting, Cleaning, Sewer after completion



ACHIEVING INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION THROUGH CIRCULAR ECONOMY

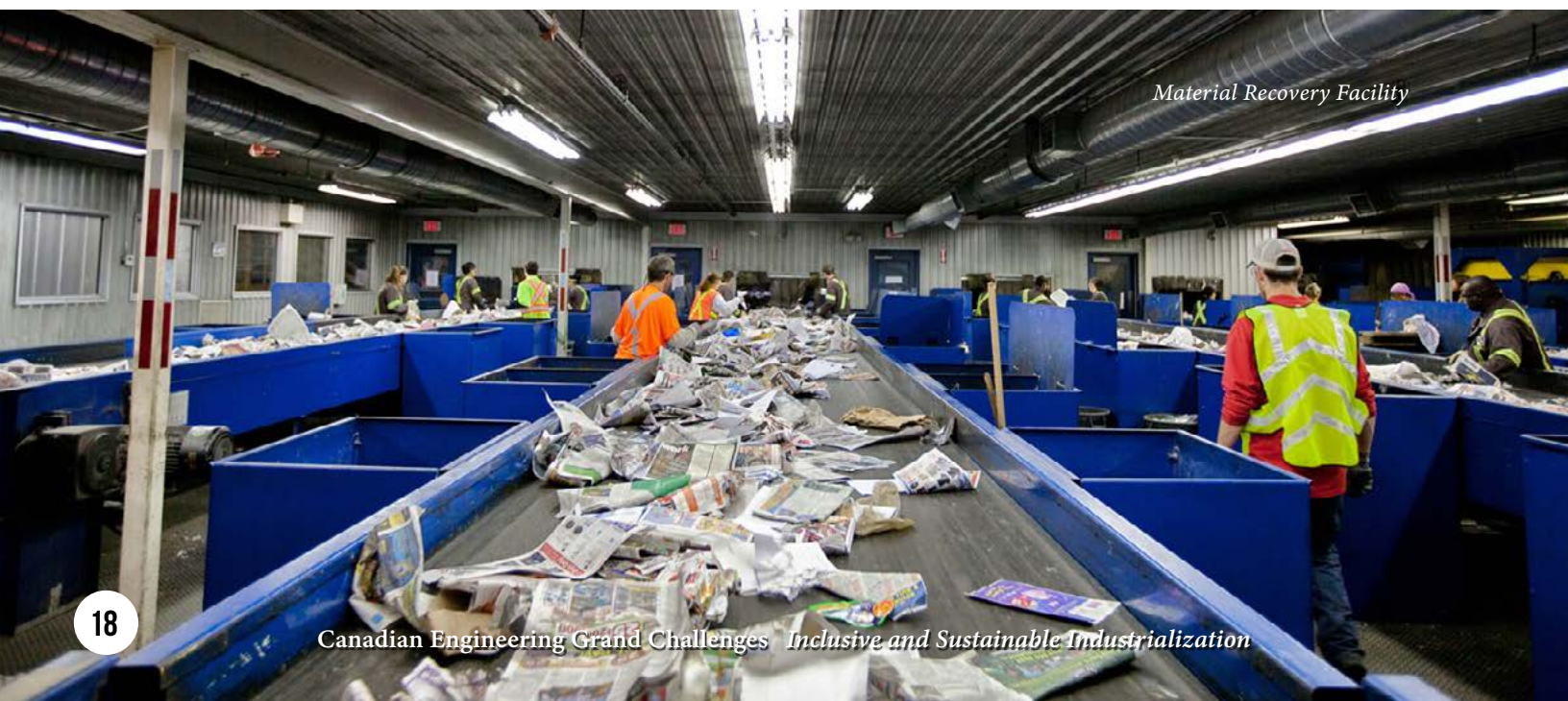
Inclusive and sustainable industrial development depends on achieving long-term economic prosperity from industrial activities while minimizing resource use and safeguarding our natural environment.

“ Reuse, repair or hand down items and find ways to reduce abundance and consumerism. This change can create a more sustainable future, shifting approach from a linear economy to a circular economy.”



LAURA MCDOWELL

ENVIRONMENTAL PROTECTION AND PROMOTION, ENVIRONMENTAL SERVICES



Material Recovery Facility

WHAT IS A CIRCULAR ECONOMY?

A circular economy is one in which resources are used and reused continuously, rather than used once and discarded. It is based on principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems.

YORK REGION'S SM4RT LIVING PLAN

York Region's Integrated Waste Management Master Plan, known as the SM4RT Living Plan, sets the stage for waste diversion and prevention to 2051 and beyond. A key component of this plan is a transition to a circular economy, to achieve a visionary goal of a world in which nothing goes to waste. There are several initiatives that will help achieve this vision.

- The Lendery is a partnership with three York Region public libraries in Markham, Newmarket and Vaughan. It allows anyone who lives, works, attends school, or owns a property in York Region free access to browse and borrow common household items and tools for a short period of time rather than having to purchase their own. This program directly supports the circular economy by reducing the number of under-used goods brought into our community that will ultimately end up in the landfill.
- Since 2018, York Region has hosted Repair Cafés in partnership with NewMakeIt and local community partners and libraries. Repair Cafés bring together people with items to repair and volunteer fixers willing to share their skills and tools, building a culture of repair into our community.
- The Circular Economy Initiatives Fund provides financial support for grassroots or local organizations to get community driven, innovative projects off the ground. Successful recipients advance a circular economy in York Region through initiatives that design out waste and pollution.
- York Region was chosen as one of 15 local governments across Canada to participate in the Canadian Circular Cities and Regions Initiative's (CCRI) Peer-to-Peer Network. This pilot provides local governments in Canada with the knowledge and tools needed to accelerate circular economy solutions. It is a place to share best practices, receive mentoring and develop a unique circular economy roadmap for municipalities.



*Photos left to right:
Lendery, Repair
Cafe, Blue Box
program*



INCREASED ACCESS TO INCLUSIVE STEM EDUCATION

Although engineering education in Canada has grown substantially over the past 15 years, there continues to be a lack of diversity in students and faculty. Encouraging Diversity in education and the workforce would significantly contribute to economic growth; diversity of thought will benefit future innovation.



“It is important to lay out a vision for the future where all Engineers will have lifelong access to high quality STEM education.”

MICHELLE SWAN

DIRECTOR, BUSINESS PLANNING AND OPERATIONS SUPPORT



Celebrating International Women in Engineering Day

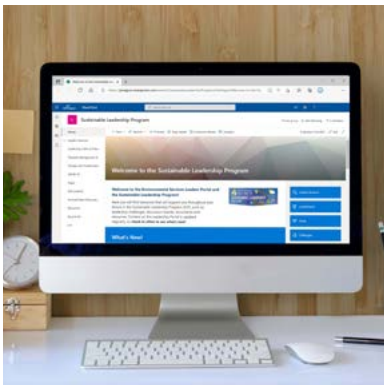
CREATING AN INCLUSIVE WORKPLACE

York Region is home to 1.2 million people of all ages and ethnic backgrounds. It is also one of Canada's fastest growing communities, and the third largest municipality in Ontario. Our diverse population includes more than 230 distinct ethnic groups.

With such rich and growing diversity, it is important purposeful steps are taken to promote inclusivity within York Region where accessibility, diversity, equity and inclusion work is grounded on the principle of Nothing About Us Without Us; equity-seeking group members know what is best for them and their community and must be valued as integral and essential contributors and drivers of activities and communications about them.

A number of initiatives at York Region support an inclusive approach:

- Professional Access into Employment program is a bridge training program that helps internationally trained environmental professionals launch their careers in Engineering, Geoscience, Environmental Science and Planning. York Region has used this program over the years with great success, finding integral members who remain employees today.
- In 2013, we created the Sustainable Leadership Program in Environmental Services to provide increased opportunities for leaders to collaborate, strengthen relationships, and better understand one another. This program allows a chance for leaders to speak out about challenges they face and work together to problem solve and brainstorm solutions, where diversity of thought and approach are welcomed.
- Universal Locker Rooms are an inclusive solution that meets the needs of a variety of users including privacy, gender anonymity, and accessibility
- In careers that may typically show gender bias, York Region creates opportunities for women to participate and lead, breaking down the societal view of how women fit in male dominated roles



Photos left to right: Sustainable Leadership portal, York Region Inclusion Charter, Universal Locker Room Sign Concept



UWATERLOO.CA/URBAN-ENGINEERING-CITIES

CONTACT:

NADINE IBRAHIM, TURKSTRA CHAIR IN URBAN ENGINEERING
NADINE.IBRAHIM@UWATERLOO.CA

