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Toronto Water's GHG inventory and mitigation journey

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Net Zero Water

CASE STUDY

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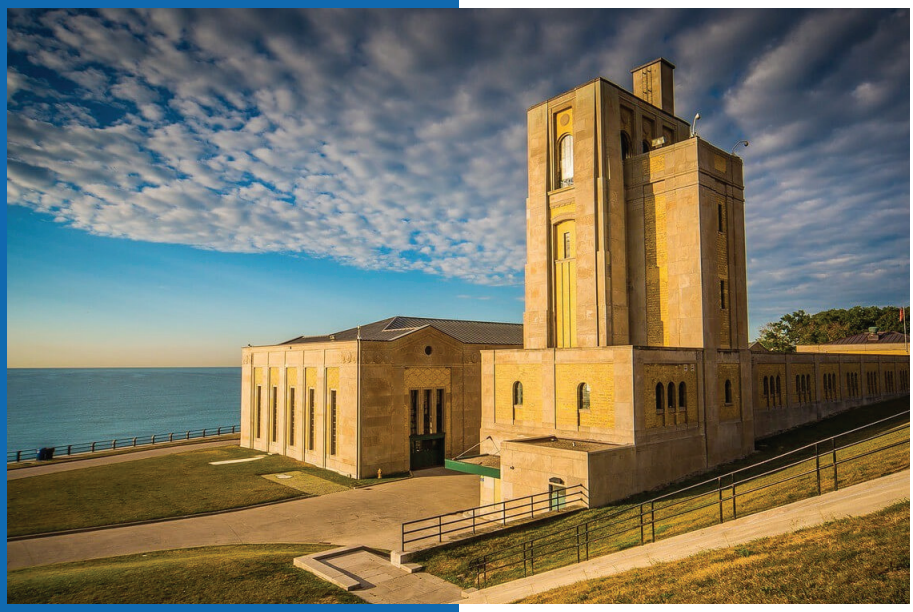
Key insights

- Senior leadership support is necessary to drive large-scale mitigation action.
- Completing a greenhouse gas (GHG) inventory is the first step toward effective GHG mitigation. An inventory provides an understanding of the emission sources and helps focus mitigation efforts.
- When developing mitigation plans, it is critical to identify key stakeholders across your utility and to engage them early. Take the learning journey together!
- Partnering beyond usual networks can lead to new insights. Academia can provide insights from other sectors and research disciplines.
- Exchanging success stories and lessons learned accelerates progress and benefits everyone.



TORONTO

Background

In July 2017, Toronto City Council unanimously approved the TransformTO Net Zero Strategy, which outlined long-term, low-carbon goals and strategies aimed at reducing City wide greenhouse gas (GHG) emissions by 80 percent by 2050, using 1990 levels as the baseline. In October 2019, Toronto City Council declared a climate emergency and in December 2021, Toronto set even more aggressive targets for scope 1 and 2 emissions, aiming for a 30 percent reduction by 2020, 65 percent by 2030, and net zero by 2040.

The City of Toronto and Toronto Water began reporting GHG emissions in 2014 to meet regulatory requirements under the Mayor's Pact from the Paris Climate Conference. In 2016, Toronto Water's reporting requirements expanded to the Ontario provincial government, and in 2017, to the federal government. During this time, staff became increasingly aware that emissions reported to regulators did not encompass all the direct and indirect emissions that might be within Toronto's control. Toronto Water was also interested in understanding its non-reportable emissions such as indirect emissions from purchased chemicals.

Completing a GHG inventory

Toronto Water partnered with the University of Toronto in late 2020 to develop an operational GHG Inventory. The assessment included emissions from drinking water treatment, wastewater treatment, water distribution, and wastewater collection. The inventory also incorporated Life Cycle Assessment (LCA) principles. LCA is a systematic approach to tracking and evaluating environmental impacts throughout the entire life cycle of a piece of equipment, product, or process. This approach resulted in Toronto Water's inventory being one of the most comprehensive utility GHG inventories in North America.

The first step in developing the inventory involved determining which emission sources to include by considering whether the emission was likely to be significant, how challenging it would be to quantify, and whether it could be effectively controlled. This step is critical for all utilities, as resources are often limited, and significant effort can be required for quantifi-cation. As illustrated in the table below, emissions from construction, methane from sewers, and biosolids management were excluded using the considerations noted above. However, Toronto Water continues to investigate these emission sources and may incorporate them in future stages.

Table 1: Toronto Water GHG Inventory Sources

	Scope 1	Scope 2	Scope 3
Included	• Fossil fuel combustion (natural gas & diesel) • Biogas combustion • Sludge incineration • Process N_2O emissions • Fugitive N_2O emissions • Fugitive CH_4 emissions • Fleet vehicle emissions	• Electricity Consumed	• Purchased chemicals • Upstream electricity • Upstream fossil fuel combustion (natural gas, diesel, gasoline)
Excluded	• Sewer methane		• Construction emissions • Embedded emissions • Offsite biosolids management

The inventory provided insight into the relative size of each of Toronto Water's operational emissions sources, as well as the uncertainty associated with each estimate. As shown in Figure 1, process and fugitive emissions of nitrous oxide (N_2O) and methane (CH_4) are both the largest of Toronto Water's emissions, and the most uncertain. Error bars below illustrate uncertainties associated with various sources and highlight the need for additional research.

While electricity can be a major contributor to some utility GHG inventories, Ontario's low-carbon electrical grid meant that electricity was a relatively minor contributor to Toronto Water's emissions.

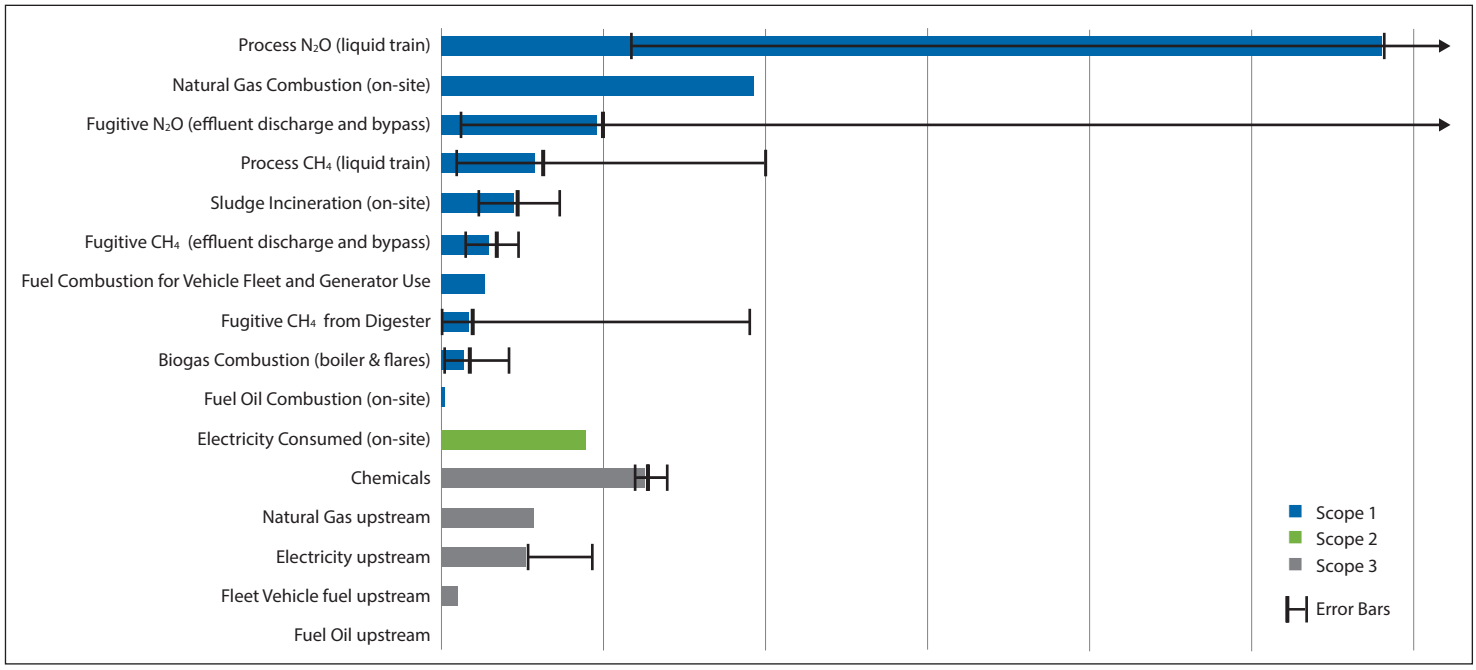


Figure 1: Toronto Water's GHG inventory results by activity with errors bars

Developing a GHG inventory was instructive for Toronto Water in several ways. It increased the focus on process emissions, and several projects are now underway to better quantify, monitor and mitigate these sources. It also increased attention on Scope 3 emissions, such as those associated with chemical use, and caused Toronto Water to begin to consider how to start integrating life cycle analysis into decision-making processes. The City's partnership with University of Toronto provided a system-scale sustainability analysis perspective based on engineering, science, economics, and public policy.

Taking action for mitigation

Following the completion of the GHG inventory, Toronto Water began engaging stakeholders to develop targeted mitigation strategies. The following mitigation activities are now underway:

- **Monitoring and modelling of N_2O and CH_4 process emissions at Ashbridges Bay Wastewater Treatment Plant (WWTP):** Led by Toronto Metropolitan University and in collaboration with stakeholders includ-ing Brown & Caldwell, Dynamita, Metro Vancouver, the City of Calgary, and others, monitoring is underway to support hybrid mechanistic/AI process modeling of N_2O emissions. Methane monitoring is also in progress, using a network of ground-based sensors, a sampling campaign with drones and aircraft, and optical gas imaging cameras.
- **Modeling N_2O emissions at Humber WWTP:** One of Humber's aeration tanks is being modeled to assess N_2O emissions, analyze formation mechanisms, and develop mitigation strategies using computational fluid dynamics–biokinetic modeling. Additionally, liquid N_2O sensors are being installed to inform future modeling efforts.
- **Capital projects aimed at reducing emissions:** projects underway include a new pelletizer facility at Ashbridges Bay WWTP, a new fluidized bed incinerator at Highland Creek WWTP incorporating heat recovery, and multiple maintenance and reliability upgrades for boilers and building automation systems at Humber WWTP.

In 2025, Toronto Water will begin development of a GHG Mitigation Strategy. The strategy will capture existing knowledge, identify gaps, and guide Toronto Water's future GHG reduction activities in line with global best practices. The strategy will support Toronto Water by establishing specific targets that align with corporate direction while balancing associated costs against the existing capital program and tailoring them to the unique challenges of the water industry—recognizing that emission reductions extend beyond simply electrifying building systems, which has traditionally been the corporate focus. While the goal of achieving net zero remains, multiple scenarios will be developed to ensure a comprehensive understanding of costs and implications before committing to specific GHG reduction targets.

Stakeholder engagement and partnerships

Internal stakeholder engagement is crucial to drive action in a large organization. Toronto Water's comprehensive GHG inventory proved to be a pivotal step in securing buy-in from senior leadership and other internal stakeholders for mitigation efforts, as well as obtaining the necessary resources to sustain and expand those mitigation efforts.

One of the first initiatives was the creation of a Nitrous Oxide Mitigation Task Group, which includes representatives from all of Toronto Water's wastewater facilities, as well as its central process engineering team. The group is learning together about nitrous oxide emissions monitoring, modelling, and mitigation, with the aim of establishing a roadmap for addressing nitrous oxide emissions.

To support development of its GHG Mitigation Strategy, Toronto Water has established a GHG Mitigation Working Group with representatives from all sections of the division. This group will oversee the strategy's development and implementation. The strategy will analyze a wide range of emission reduction alternatives, develop practical tools for staff, and establish a communications plan to ensure a shared understanding of mitigation efforts across Toronto Water and stakeholders.

External partnerships have also had a profound impact on Toronto Water's GHG mitigation journey. A key factor in the success of Toronto Water's journey was learning from other utilities, research organizations, and water associations, both locally and internationally. Toronto Water has been involved in committees and research projects through the Water Environment Foundation (WEF), Ontario Water Works Association (OWWA), Water Environment Association of Ontario (WEAO), International Water Association (IWA), Water Research Foundation (WRF) and the Canadian Water Network (CWN). Understanding the lessons learned and successful strategies already implemented by others has helped to avoid redundant work and has accelerated progress.

After it was finalized, Toronto Water's GHG inventory was used to develop the **OWWA/WEAO Greenhouse Gas Emissions Inventory Tool**. Hosted and maintained by the OWWA/WEAO Climate Change Committee, this tool is free, transparent, and designed to accept inputs that utilities commonly already have on hand. Development of the GHG Inventory Tool highlights how knowledge sharing can drive industry-wide progress and innovation. Since its release in 2023, numerous North American utilities have used the tool to develop GHG inventories, and it is also in use as a teaching tool in universities.

To learn more about how GHG Inventory aligns with CWN's "Charting the Course to Net Zero Water in Canada" project, contact info@cwn-rce.ca.

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