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Region of Waterloo's approach to understanding greenhouse gas emissions associated with drinking water treatment

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CASE STUDY

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Key insights

- The GHG inventory tool developed by the Ontario Water Works Association (OWWA) and Water Environment Association of Ontario (WEAO) enables municipalities to assess GHG emissions from their water treatment facilities and support informed decision-making.
- The tool accounts for both direct and indirect emissions from drinking water treatment plants, which offers a full picture of the facility's production.
- Using this tool, the Region of Waterloo identifies the Mannheim and Greenbrook facilities as the highest emitters. The primary contributors to these emissions are chemical production and transportation.
- The inventory results help the Region understand how factors such as raw water quality, treatment process optimization, and facility production rates influence GHG emissions for drinking water treatment.
- The tool is adaptable for both simple and complex systems, making it a valuable resource for any municipality or utility seeking to evaluate GHG emissions from existing infrastructure and take action towards a low-carbon future.

Region of Waterloo

Background

The Ontario Water Works Association (OWWA) and the Water Environment Association of Ontario (WEAO) offer a greenhouse gas (GHG) inventory tool that supports efforts to reduce emissions from drinking water treatment. Maintained by the OWWA/WEAO Climate Change Committee, the tool focuses on operational GHG emissions. It stands out for its ability to quantify both direct and indirect emissions associated with water treatment facilities.

Measuring both types of emissions is essential to obtain a full picture of a facility's GHG emissions. Historically, the focus on direct emissions has limited the ability to make holistic decisions related to GHG emission reductions. By capturing both direct and indirect emissions, the inventory tool supports collaboration with other departments (e.g., procurement) and external partners (e.g., chemical producers and energy utilities) to inform decisions and drive meaningful changes.

This case study highlights how the Region of Waterloo uses the GHG inventory tool to guide decision-making for the integrated urban system long-term water supply strategy. The integrated urban system supplies drinking water to the cities of Cambridge, Kitchener and Waterloo, as well as to some communities in the Townships of North Dumfries, Wilmot, and Woolwich. It includes 26 drinking water treatment facilities — one surface water treatment plant, 12 centralized groundwater treatment plants and 23 groundwater system wells — that produce an average daily flow of 152,000 m3/d.

The Region of Waterloo is currently working to update its water supply strategy for the integrated urban system to review current water supply sources, assess future water demands, and investigate possible new water supply sources.

As part of this process, the Region of Waterloo is using the OWWA/WEAO GHG inventory tool to assess current conditions, identify opportunities to reduce GHG emissions, evaluate new water supply sources, and generate quantitative data to support an informed decision-making process.

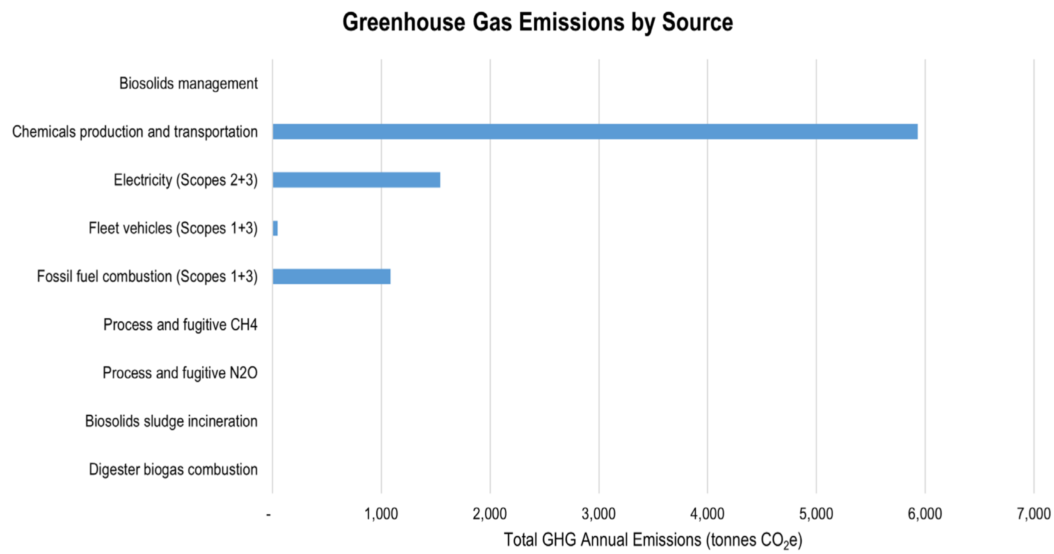

Figure 1: Emissions by source for the integrated urban system.

Opportunity

The Region of Waterloo identifies the GHG inventory tool as a valuable resource for quantifying GHG emissions from drinking water treatment and supporting evidence-based decision-making. This initiative is part of the Region of Waterloo's long-term water supply strategy for the integrated urban system, which is being carried out as a master plan in accordance with the Municipal Class Environmental Assessment process.

Drinking water facilities vary in design and operation based on factors such as available flow from supply sources, raw water quality, treatment process design and system demand. These differences must be taken into consideration when interpreting the results from the GHG emissions inventory. Understanding which factors most significantly influence GHG emissions, and how those factors are shaped by regulatory requirements, provides a strong foundation for a transparent and defensible decision-making process.

Strategy

Inventory analysis

The Region of Waterloo uses the GHG inventory tool to assess emissions across its drinking water facilities by both scope and source. Facilities are then ranked based on the quantity of emissions associated relative to their service requirements.

As shown in Figure 1, chemical production and transportation are the primary contributors to GHG emissions in drinking water treatment. Electricity is the second-largest source, followed by natural gas.

The dangers of oversimplification

Data snapshots can be misleading. At first glance, it may appear that more resources should be focused on reducing electricity consumption (1,544 tCO2eq/yr) than fossil fuel consumption (1,085 tCO2eq/yr), as electricity has larger emissions in comparison.

However, more facilities are powered by electricity than by natural gas. When comparing emissions on a per-facility basis, electrically powered sites emit significantly less than those using fossil fuels. Understanding the data is important for accurately interpreting results and ensuring that efforts to reduce emissions are strategically allocated.

Comparing facilities to each other is complex and requires deep institutional knowledge of each facility to fully understand the results of the comparison. Table 1 provides a summary of information for the three facilities with the highest total GHG emissions in the integrated urban system: Mannheim, Greenbrook, and Middleton water supply facilities.

Observations from Table 1 include:

- Manheim, a surface water treatment plant, typically requires more extensive processes and chemicals than groundwater treatment.
- Greenbook, a groundwater facility, uses an advanced oxidation process that treats 1,4-dioxane. This process relies on hydrogen peroxide as an oxidizing agent. This has a higher emission factor than sodium hypochlorite, which is the oxidizing agent used at Middleton. While chemicals are a significant contributing factor to emissions, treatment process performance/efficiency also needs to be taken into consideration.
- Middleton's treatment process is optimized based on the raw water TCE concentration, including the number of UV lamps in service and chemical dosing, which lowers the emissions the facility produces. In contrast, these opportunities are not feasible at Greenbrook due to the raw water characteristics. This reinforces the importance of continually reviewing strategies for optimization on a site-by-site basis.
- Although Middleton ranks among the top three facilities in total GHG emissions, its high production volume results in a low CO2 equivalent per cubic meter of water produced.

These findings show that factors such as chemical use, the largest emission source system-wide, and production flow should be considered when interpreting the results. Understanding individual facilities, the treatment processes in place, the regulatory drivers for each process, and other contributing factors will enable a more strategic approach for reducing GHG emissions in the future.

The results also challenge assumptions, such as the belief that conventional surface water treatment results in higher GHG emissions because it requires a more intensive level of treatment than groundwater. While this may be true in some cases (e.g., when comparing Mannheim to Middleton), advanced treatment for groundwater (e.g., at Greenbrook) can also lead to high emissions.

Table 1: Comparison of Mannheim, Greenbrook, and Middleton water supply facilities.

Facility	Mannheim	Greenbrook	Middleton
Source water	Surface water	Groundwater	Groundwater
Treatment	Conventional surface water treatment	Advanced oxidation treatment for 1,4-dioxane	Advanced oxidation treatment for trichloroethylene
Flow rate (m3/day)	~44,000	~5,900	~19,500
Emissions by Facility (thousand tCO2eq/ yr)	~4.4	~1.1	~0.9
Emission intensity (gCO2eq/m3	~268	~490	~120
Scope 1 +2 (tCO2/ year)	~1.0	~0.2	~0.3
Scope 3 tCO2/year (Chemical production and chemical transportation)	~3.8	~0.8	~0.5

Planning for the future

Insights from existing facilities can inform planning for new water supply sources. For example, if source water quality for a new supply indicates advanced oxidation treatment is anticipated, the treatment approach can be further assessed to determine the type of oxidant required and the efficiency of the treatment process. Combined with projected production rates, emissions can be estimated using either Greenbrook or Middleton as reference points.

Facility-specific approach

Analyzing emissions at the facility level helps the Region of Waterloo identify the most impactful opportunities for GHG reduction. By quantifying the effects of source water quality, treatment processes, chemical selection and production rates, the Region can prioritize changes that are within its control, while recognizing constraints like regulatory requirements and supply availability. This targeted approach supports more strategic and effective resource allocation to reduce emissions from drinking water treatment.

Impact

The GHG inventory tool enables the Region of Waterloo to compare emissions across facilities and processes, which supports more informed decision-making and strategically focuses GHG reduction efforts.

The tool also offers value beyond the Region of Waterloo. Utilities across Canada can use it to prioritize resource allocation and plan future infrastructure that aligns with their GHG reduction goals, all while delivering high-quality services. The GHG inventory tool can help municipalities create quantitative results to inform decisions that will improve future infrastructure and sustain existing infrastructure.

Lessons learned

The GHG inventory tool offers a comprehensive and adaptable framework for understanding emissions from drinking water treatment. It accommodates systems of varying complexity and enables analysis at both the system-wide and facility-specific levels.

Institutional knowledge plays a key role in interpreting the results. A deep understanding of the factors that drive emissions, and which of those can be modified, enables a more strategic approach to identifying meaningful opportunities for reduction. This insight can also be used to forecast emissions for future supply sources, making the tool a valuable asset in long-term water supply planning.

By combining quantitative analysis with operational expertise, municipalities can build a defensible, data-driven foundation for reducing emissions and planning sustainable infrastructure.

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