Guidehouse
Outwit *Complexity*

Survey of Water Energy Intensity and Residential Ratepayer Costs in Canada

November 2023

Natural Resources Canada | Ressources naturelles Canada
Canada

CWWA ACEPU
Canadian Water and Wastewater Association | canadienne des eaux potables et usées

Agenda

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Project Overview

Objectives

Estimate energy intensity for the treatment and delivery of potable water and disposal of wastewater in Canada

Estimate the average residential ratepayer costs

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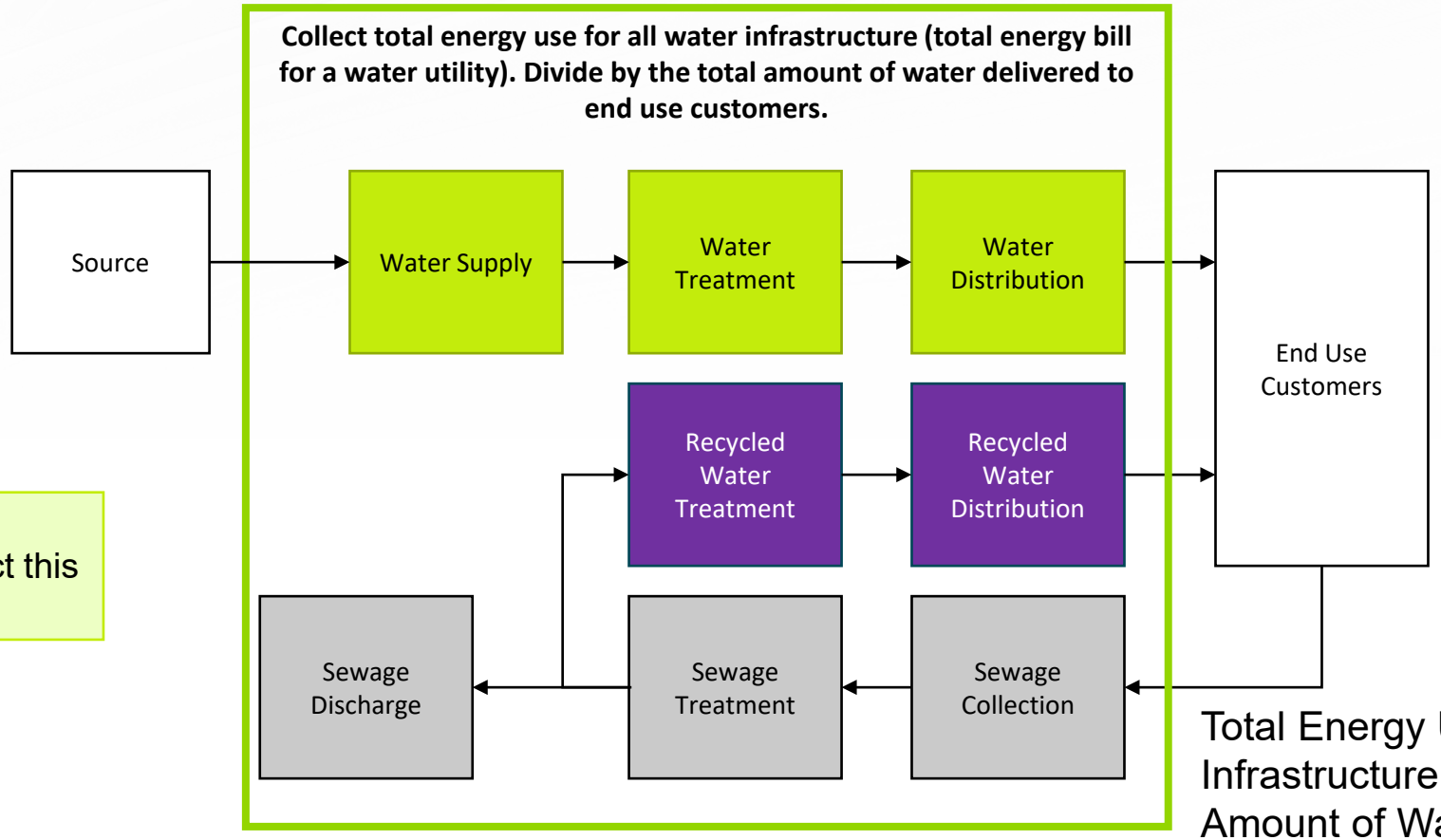
Tasks

- Develop a survey
- Conduct, monitor and manage the survey
- Validate and perform analysis of data collected
- Report and Recommendations

Approach: Simple Energy Intensity Calculation Using Control Volume Approach



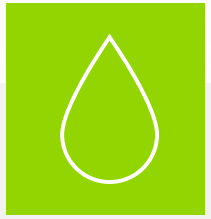
Easy for a survey respondent to collect this energy data

Total Energy Use for All Water Infrastructure Divided by the Total Amount of Water Delivered to End Use Customers

Approach: Survey Content

Descriptive Information

- Background information such as name and customers served
- Water source types
- Treatment technologies
- Treatment capacity



Water Data

- Total water withdrawals and wholesale purchases
- Total water delivered to customers (potable vs. raw vs. recycled)
- Total water treated by each treatment plant

Energy Data

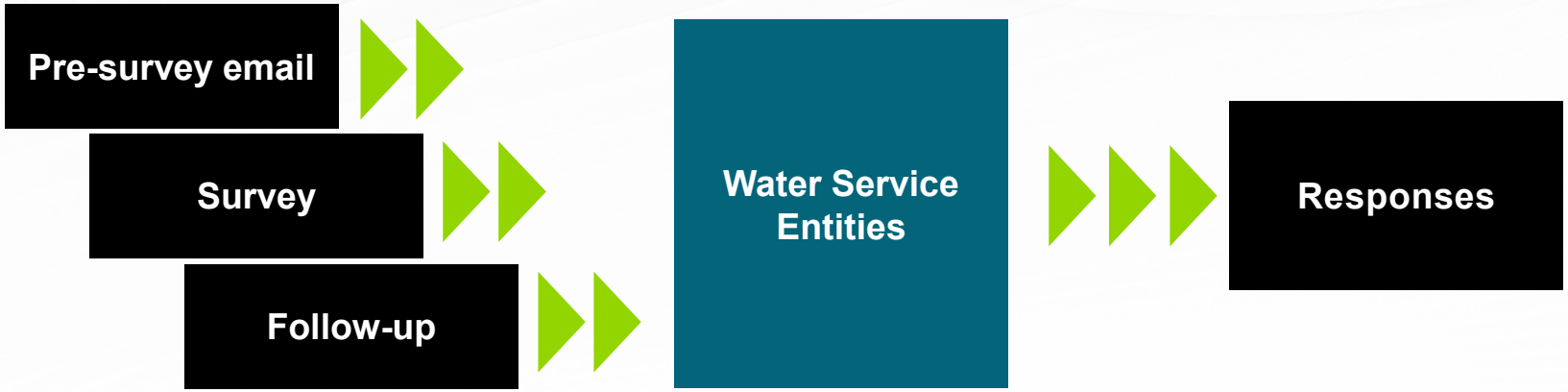
- Energy Intensity
- Total energy use by potable water systems and wastewater systems
- Total energy use for each treatment plant
- Energy source(s)

Rate Paid by Customers for their Data

- Average incremental rate
- Tiers of demand
- Are customers billed directly or through taxes

Driving Indicators of Energy Intensity of Water: Water source, treatment methodology, facility size, distribution distance and elevation and water losses

Approach: Communication Plan



Pre-survey email

- Originates from CWWA
- Introduces Guidehouse on behalf of NRCan
- Explains purpose of forthcoming survey and importance of participation
- Shares importance of aggregated results

Survey

- Originates in email from CWWA with Qualtrics survey link, materials include NRCan and CWWA logos
- Concise and collects necessary and sufficient data to encourage participation and reduce survey burden

Individual follow-up

- With attention to privacy protection, Guidehouse follows up via emails and/or phone calls to enhance participation
- Provides clarification to survey respondents and answers questions
- Ensures quality responses

Increasing Participation

- As we noticed the survey was taking longer to complete than anticipated multiple extensions were given
- CWWA and Guidehouse sent multiple reminders
- Sent individual reminders to entities who had partially completed the survey
- Included French Translations

Approach: Survey Distribution and Potential Gaps

- Distribute survey to CWWA members
- Regional associations to distribute to their respective members
- To fill the gaps seen in the CWWA list, Guidehouse sent the survey to additional water and wastewater utilities
- This list was derived from a StatCan list of wastewater entities and highest population regions were prioritized
- Together the list covers 90% of the population

	Population Represented	
Regions	**CWWA**	**Additional List**
British Columbia	3,947,705	1,083,517
Prairies	3,897,163	3,007,430
Ontario	14,960,261	1,383,857
Quebec	2,185,942	2,881,424
Atlantic	1,223,310	1,190,837
Territories	84,481	35,870

Data Collection: Response Rate by Region

Coverage by response number

Regions	Sent	Partially Completed	Completed	Percent Covered
British Columbia	39	9	5	**13%**
Prairies	75	11	15	**20%**
Ontario	78	15	10	**13%**
Quebec	47	2	1	**2%**
Atlantic	93	18	9	**10%**
Territories	5	1	0	**0%**
Total	337	56	40	**12%**

Coverage by population

	Sent	Partially Completed	Completed	Percent Covered
British Columbia	5,262,921	934,942	3,055,357	**58%**
Prairies	7,151,510	374,531	3,408,874	**48%**
Ontario	17,257,776	1,412,996	5,924,887	**34%**
Quebec	5,067,366	1,789,833	246,855	**5%**
Atlantic	2,454,863	179,954	705,725	**29%**
Territories	165,174	28,201	0	**0%**

*Population data is not fully representative of customers served as census data was used for utilities service areas and may not align.

Data Collection: Gathering Survey Results

Guidehouse reviewed the data against other respondents' data and energy intensities observed in prior studies.

Guidehouse reached out to respondents for clarification on responses where outliers were found

We leveraged the finalized and validated dataset to develop averages and correlations

Results: How does our data compare?

We reviewed previous studies focused on the energy intensity of water and based in Canada and the United States. Through this research we:

- Identified processes using energy
- Identified key variables that influence energy used
- Reviewed energy intensity values from prior studies

Weighted* Survey Results:
Water: 0.58 kWh/m^3
Wastewater: 0.55 kWh/m^3
Both**: 1.96 kWh/m^3

- Weighted by population
- ** Not additive

Category	Description	ACEEE Study (Young, June 2015)	WE Calculator (California Public Utilities Commission, 2021)	Ontario Every Drop Counts (Environmental Comissioner of Ontario, 2017)	Ontario Water Energy Nexus (Mass, 2010)	Energy for Water (Water in the West, August 2013)
Water supply	Local Surface	0.05-0.48	0.07	1.20	0.65	0.04-0.32
Water supply	Ground Water		0.24-0.57			0.14-0.77
Conveyance			0.10- 0.56			0.30
Water treatment		0.08-0.71	0.17			0.38
Distribution		0.18	0.01 -0.26			0.32
Wastewater treatment		n/a	0.59 - 1.40	1.04	0.52	0.18-0.78

Results: Rate Data

Average Residential Ratepayer Costs of Water and Wastewater Service Weighted by Population

Region	Water Average Rate ($/m^3)	Wastewater Average Rate ($/m^3)	Combined Average Rate ($/m^3)
National	**1.38 (26)**	**1.67 (16)**	**3.34 (25)**
British Columbia	0.70 (4)	-- (1)	-- (1)
Prairies	2.44 (9)	1.63 (8)	3.84 (11)
Ontario	1.74 (7)	1.63 (6)	3.93 (9)
Atlantic	1.07 (4)	-- (1)	2.92 (3)

* Numbers in brackets show the entity count

Results: Energy Intensity Data

Average Energy Intensity by Region and Entity Type Weighted by Population

Region	Water Energy Intensity (kWh/m^3)	Wastewater Energy Intensity (kWh/m^3)	Both Energy Intensity (kWh/m^3)
National	**0.58 (9)**	**0.55 (4)**	**1.96 (30)**
British Columbia	0.09 (2)	N/A (0)	1.28 (4)
Prairies	1.86 (2)	N/A (0)	1.90 (11)
Ontario	0.65 (3)	0.99 (2)	1.97 (8)
Quebec	N/A (0)	-- (1)	N/A (0)
Atlantic	-- (1)	-- (1)	2.24 (7)

* Numbers in brackets show the entity count

Results: Energy Intensity Data

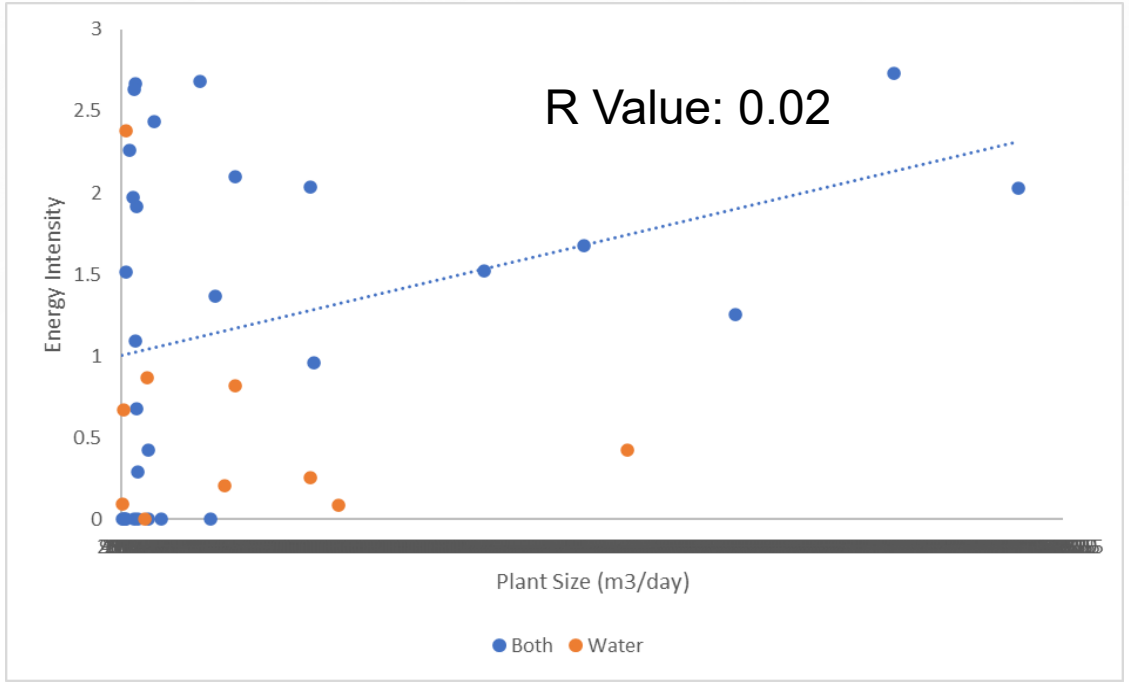
Average Energy Intensity for Water Entities based on Ground or Surface Source Type Weighted by Population

Entity Type	Ground Energy Intensity (kWh/m^3)	Surface Average Energy Intensity (kWh/m^3)	Both Ground and Surface Average Energy Intensity (kWh/m^3)
Water	0.44 (3)	0.46 (4)	0.71 (2)
Both	2.26 (9)	1.95 (14)	1.87 (9)

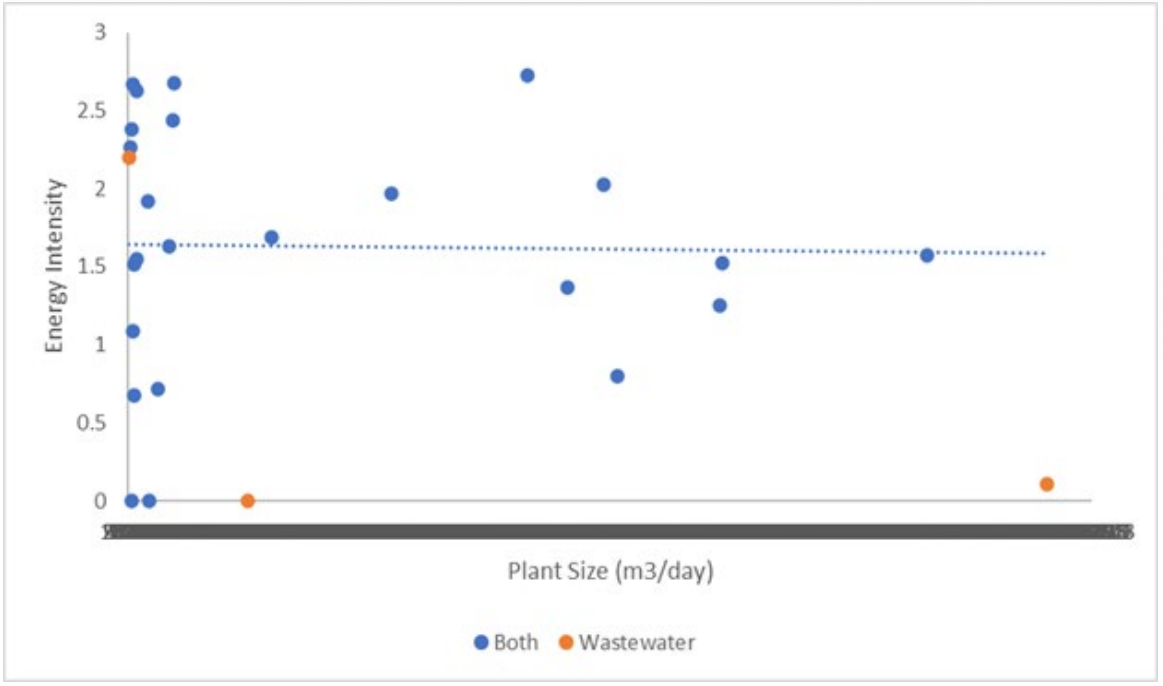
* Numbers in brackets show the entity count

Results: How does plant size effect energy intensity?

Energy Intensity vs. Water Plant Size

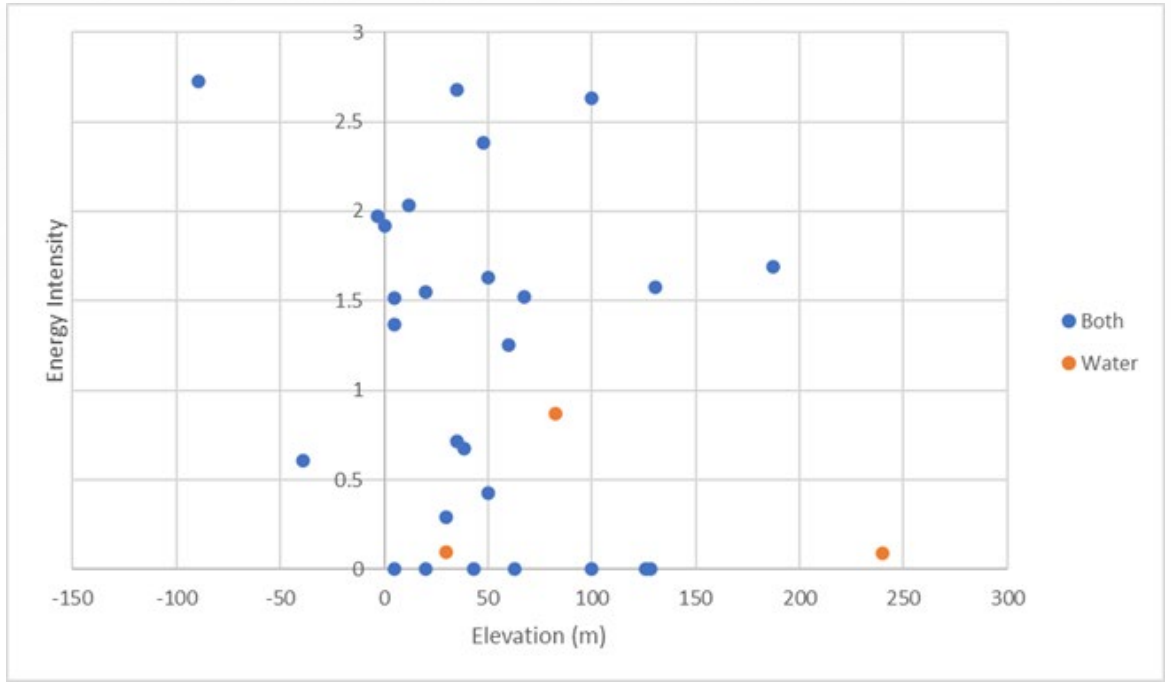


Energy Intensity vs. Wastewater Plant Size

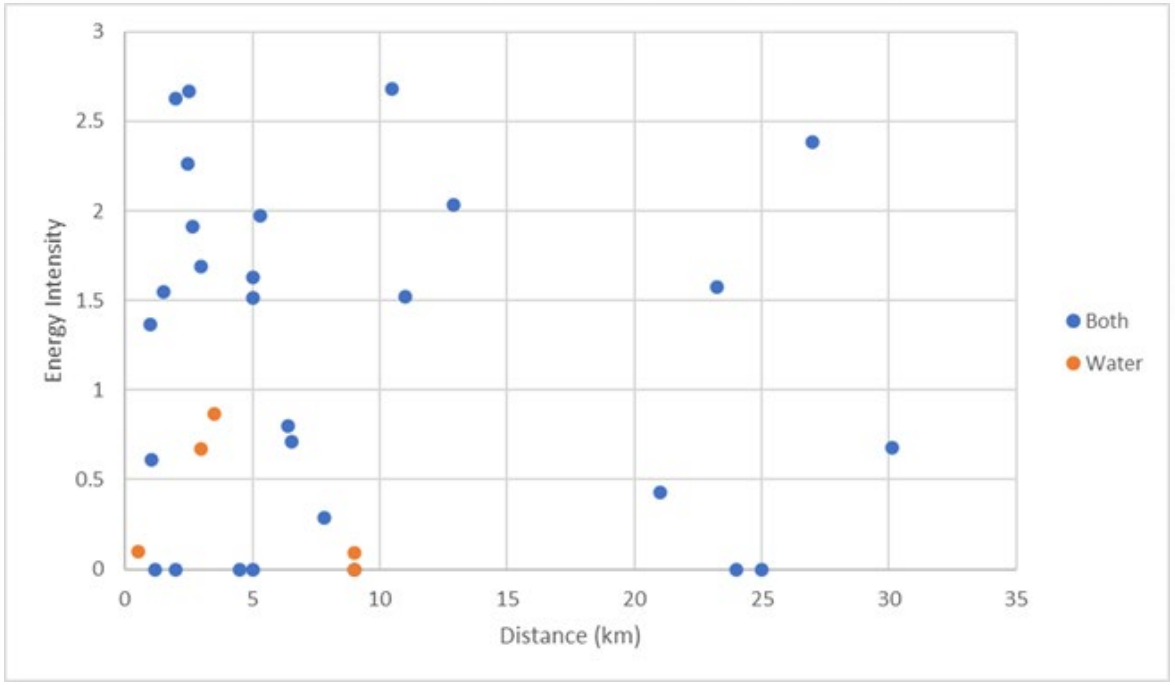


Results: How do distribution network characteristics effect energy intensity?

Energy Intensity vs. Elevation



Energy Intensity vs. Distance



Results: Average Energy Intensity by Treatment Types

Average Energy Intensity by Water Treatment Type Weighted by Population

Primary Water Treatment Types	Average Energy Intensity for Entire System	Number of Entities
Conventional sedimentation and filtration	1.74	12
Dissolve air flotation and filtration	2.66	2
Direct filtration or deep bed filtration	2.53	3
Ion exchange	--	1
Microfiltration	0.84	6
Reverse osmosis/nano-filtration	--	1
Natural settlement (no treatment)	0.17	2
Other	2.13	9

Results: Treatment Types

Average Energy Intensity by Wastewater Treatment Type Weighted by Population

Primary Wasterwater Treatment Types	Average Energy Intensity	Number of Entities
Activated Sludge	1.72	15
Trickling filtration	--	1
Membrane bioreactor	--	1
Lagoons	1.80	4
Other	2.24	5

Results: Québec

Guidehouse performed specific outreach to provide context for the low response rate:

- Most entities do not have the detailed data needed for the survey due to the nature of metering in Québec
- Seen as a duplicative effort with Government of Québec's "Stratégie municipale d'économie d'eau potable"

Customers are charged for water consumption as part of municipal taxes

Limitations and Recommendations for Future Study

- Survey distribution centered on CWWA members, and therefore entities serving most populated areas
- Data consistency and recommendation to increase data verification with respondents
- Provide suitable advanced notice of the survey so entities can have their data assimilated in the format requested
- Coordinate with existing survey and data collection efforts (such as Statistics Canada and provincial government efforts)
- Better streamline the survey instrument itself

Acknowledgements

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