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Data Sources and Methods: Municipal Wastewater Treatment Indicator

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1. Introduction

The Freshwater Quality Indicator is a part of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues.

2. Description and rationale of the Municipal Wastewater Treatment Indicator

2.1 Description

The municipal wastewater treatment indicator measures the level of wastewater treatment provided to the Canadian population. Higher levels of wastewater treatment reduce the risk of pollutants from raw wastewater reaching the environment, where they pose risks to human and environmental health. This indicator is not a measure of municipalities' compliance with municipal, provincial or federal wastewater regulations or treatment standards.

2.2 Rationale

Municipal wastewater is one of the largest sources of pollution, by volume, to surface water in Canada.¹ Treated wastewater may contain grit, debris, disease-causing bacteria, biological wastes, nutrients and chemicals with the potential to damage human and environmental health. The higher the level of treatment provided by a wastewater management system, the cleaner the effluent and the less the impact on the environment.

3. Data

3.1 Data source

Data for 1983 to 1999 come from Environment Canada's Municipal Water Use and Pricing (MUD) surveys. In 2001, the survey was revised to become the Municipal Water and Wastewater Survey (MWWS). Data for 2004 to 2009 are taken from the MWWS. Survey results are available on the Municipal Water and Wastewater Survey's Data and Publications website (<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=ED0E12D7-1>).

3.2 Spatial coverage

Prior to 2001, the MUD survey was only sent to municipalities across Canada with populations greater than 1000. Since 2001, the survey has been sent to all municipalities with a population greater than 1000 and a sample of over 600 municipalities with fewer than 1000 residents. Municipalities on federal lands and First Nations communities are excluded from the MUD surveys and the MWWS.

3.3 Temporal coverage

The MWWS and its predecessor, the MUD survey, have been conducted every two to three years since 1983. The MUD survey was reformatted following the 1999 survey and the first MWWS was

¹ Government of Canada. 2010. Proposed Wastewater Systems Effluent Regulations - Canada Gazette. 144(12) March 21, 2010. (<http://www.gazette.gc.ca/rp-pr/p1/2010/2010-03-20/html/reg1-eng.html>)

conducted in 2001. The 2001 MWWS has been excluded from the CESI indicator due to the low response rate to questions about sewage treatment levels.

3.4 Data completeness

Prior to 2001 the MUD survey collected information only from Canadian municipalities with a population greater than 1000. In 2001 the survey was expanded to include Canadian municipalities with populations less than 1000. In 2004 and 2006, the MWWS sampled 616 and 630 such municipalities, respectively. In 2009, the survey was expanded to include 1000 municipalities with fewer than 1000 residents. Overall, data remain comparable among surveys, because small municipalities have little effect on aggregate statistics due to population weighting.² For more information on changes to the survey sample and methodology, see Environment Canada's Municipal Water Use Reports (<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=ED0E12D7-1#wateruse2006>).

Survey response rates vary by survey year and question. In the 2009 MWWS, residential sewage disposal information was available for a responding population³ of 28 122 846 Canadians and wastewater treatment information was available for a responding population of 23 618 481 Canadians served by municipal sewers.⁴ Given the survey's response rate of approximately 70% of the Canadian population, it is assumed for the purposes of this indicator to be representative of the entire Canadian population.

3.5 Data timeliness

The MWWS is conducted every two to three years with data released approximately two years after the calendar year to which the collected data apply.

4. Methods

The MWWS categorizes the sample population based on whether it is served by municipal sewer systems. Municipalities with sewer systems are asked to classify their sewage treatment level as no, preliminary, primary, secondary - mechanical, secondary - waste stabilization or tertiary treatment. For the purposes of this indicator, the population not served by municipal sewer systems is assumed to have septic systems or private haulage for their sanitary waste.

Wastewater treatment levels for this indicator were categorized based on the definitions used in the MWWS⁵:

No treatment/preliminary treatment: Wastewater receives no treatment or preliminary treatment only. Preliminary treatment removes relatively large solids from wastewater and refers to processes such as grit removal or skimming, or the use of screens or bar racks.

Primary treatment: treatment processes that allow undissolved solids in raw sewage to settle out of suspension, forming sludge. Some common techniques include primary sedimentation/clarification, plate/tube settlers, and chemical precipitation/flocculation.\

² Environment Canada (2007) 2007 Municipal Water Use Report: Municipal Water Use 2004 Statistics. (<http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=8D951F7A-3866-47AA-98D6-1C49AB04E1BA>)

³ Responding population refers to the population of the municipalities that responded to a specific survey question.

⁴ Environment Canada (2011) 2011 Municipal Water Use Report: Municipal Water Use 2009 Statistics. (<http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=B77CE4D0-80D4-4FEB-AFFA-0201BE6FB37B>)

⁵ Environment Canada (2009) Municipal Water and Wastewater Survey Variable Description Document. (<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=ED0E12D7-1#wateruse2006>)

Secondary treatment: treatment processes for the removal of organic matter from sewage to reduce biochemical oxygen demand and suspended solids. This result may be achieved using mechanical systems or lagoons and waste stabilization ponds (WSPs). Mechanical systems include conventional activated sludge, extended aeration activated sludge, pure oxygen activated sludge, other types of activated sludge, oxidation ditches, trickling filters, rotating biological contactors, and sequencing batch reactors. Lagoons and WSPs may be aerated, aerobic, anaerobic, facultative or storage ponds.

Tertiary treatment: enhanced treatment to remove specific substances of concern to achieve a particular level of desired effluent quality. It can be accomplished using a number of physical, chemical or biological processes. In 2006 and prior surveys, plants with any nutrient removal process were classified as tertiary; in 2009, only municipalities identifying their treatment processes as tertiary were classified as tertiary.

Septic system: an on-site wastewater disposal consisting of a buried concrete septic tank that holds the solid waste from a home's plumbing waste drains, and a septic drain field that distributes the wastewater to the ground where it disperses through the soil or evaporates.

Haulage: systems where wastewater is pumped from a collection tank and taken to a disposal site. Sewage haulage mostly occurs in Northern communities.

To calculate the Municipal Wastewater Treatment indicator, the percentage of the population served by sewers is compiled using data from the MWWS. The population served by sewers is divided by the responding population for the survey question. Population percentages served by no, primary, secondary and tertiary treatment are calculated by dividing the population per wastewater treatment level by the responding population for that survey question. The population per wastewater treatment level is then applied to the percentage of the population served by sewers to obtain the final data for this indicator.

Not all municipalities report the treatment level of their population served by sewers, creating a small population served by sewers for which there is no information about wastewater treatment. For example, in 2009, the MWWS reports data for 24 498 272 Canadians living in municipalities served by sewers. Out of that population, the survey reports wastewater treatment level results for 23 618 481 Canadians. Given that information on treatment levels is missing for less than 8% of the total survey population, the distribution of wastewater treatment levels is applied directly to the population served by sewers.

5. Caveats and limitations

The representativeness of the survey sample with respect to community size has changed over time. From 1983 to 1999, the MUD survey collected data only from municipalities with a population greater than 1000 residents. In 2001, the MWWS was expanded to sample municipalities with populations less than 1000. Although improvements have been made, municipalities with small populations remain under-represented in the MWWS, while municipalities with large populations are over-represented. It is likely the percentage of the population on private septic systems is underestimated.

Both the MUD survey and the MWWS exclude municipalities on federal lands and First Nations communities.

Changes in the survey methodology likely account for the decrease from 2004 to 2006 in the percentage of the responding population reported as receiving secondary treatment. In 2004, a portion of the data was imputed from 1999 values, at which time municipalities were placed in the secondary treatment category if they used a combination of primary and tertiary treatment. In 2006, secondary treatment was taken to mean only mechanical or waste

stabilization processes, while tertiary treatment was reserved for municipalities using at least one nutrient removal process.

Changes in the survey methodology likely account for the decrease from 2006 to 2009 in the percentage of the population receiving tertiary treatment. In 2006, municipalities were considered to have tertiary or advanced treatment if they used just one nutrient removal process, regardless of the treatment that the effluent had received. In 2009, the question was revised to reflect treatment levels rather than treatment processes. As a result, some municipalities that fell into the tertiary treatment category in 2006 were classified in the secondary or primary treatment category in 2009.

In 2009, the methodology to calculate the percentage of the population served by sewers changed so as to be based on the entire municipal population. The MWWS data for 2004 and 2006 are based only on the municipal population on sewer systems. The indicator results have been corrected so that the 2004 and 2006 results are calculated with the 2009 methodology. Small differences may exist between the data used for the CESI indicator and the MWWS 2004 and 2006 data.

Although this indicator assumes municipal wastewater plants are functioning at their design level, equipment failure and weather conditions may prevent them from doing so. Severe storms can cause overflows in combined sanitary and stormwater sewer systems. During such events, the everyday treatment level is not applied and raw sewage is released directly to surface waters.

No treatment information is available for sewage treated by private septic systems. Treatment levels depend on the efficiency and maintenance of the septic system. Similarly, no information is collected on the destination of hauled sewage or its treatment level.

This indicator is not a measure of compliance with municipal, provincial or federal wastewater regulations or treatment standards. For more information on the Government of Canada's role in wastewater management, see Environment Canada's Wastewater Management website (<http://www.ec.gc.ca/eu-ww/default.asp?lang=En&n=0FB32EFD-1>). For more information on national efforts to develop a harmonized regulatory framework for municipal wastewater treatment, see the Canadian Council of Ministers of the Environment's Canada-wide Strategy for the Management of Municipal Wastewater Effluent (http://www.ccme.ca/ourwork/water.html?category_id=81).

6 References and further reading

6.1 References

Environment Canada. Municipal Water Use Database (MUD) 1983-1999. Retrieved on 7 July, 2011. (<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=ED0E12D7-1>)

Environment Canada (2007) 2007 Municipal Water Use Report: Municipal Water Use 2004 Statistics. Retrieved on 7 July, 2011. (<http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=8D951F7A-3866-47AA-98D6-1C49AB04E1BA>)

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6.2 Further reading

Canadian Council of Ministers of the Environment (2011) Canada-wide Strategy for the Management of Municipal Wastewater Effluent Retrieved on 8 July, 2011. (http://www.ccme.ca/ourwork/water.html?category_id=81).

Environment Canada (2009) Wastewater Management. Retrieved on 8 July, 2011.
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