CWN Webinars

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Changing Trends in Water Use

(registration required)

Backgrounder

Welcome to this two-part webinar series on mitigation strategies to manage the impacts of changing trends in water use for water and wastewater system operation (webinar #1) and more efficient design of future infrastructure (Webinar #2). This backgrounder is intended to establish a Canadian context for these trends and their implications for operation, planning and design across water and wastewater systems.

Canadian Trends in Water Use and Wastewater Generation

Water use in the United States decreased by 9% between 2010 and 2015 (U.S. Geological Survey, 2018). Statistics Canada also reports that water use patterns are changing in Canada:

- The number of people served by drinking water plants in Canada has increased by approximately 6% — from 28.97 million in 2011 to 30.79 million in 2015 (Statistics Canada, 2018a).
- Potable water volumes processed by drinking water plants in Canada decreased by approximately 2% — from 5,124 million m^3 in 2011 to 5,021 million m^3 in 2015 (Statistics Canada, 2018b).
- Average daily residential use per capita decreased by approximately 6.5% — from 251 litres/person in 2011 to 235 litres/person in 2015 (Statistics Canada, 2018c).

Some experts attribute declining water use to the rising use of water-efficient fixtures and appliances in residential and commercial settings, likely resulting from municipal water conservation outreach or subsidies, updates to plumbing and building codes, and an increasing trend in customer water metering.

Data from the 2014 National Water and Wastewater Benchmarking Initiative (NWWBI) indicated that their participating utilities are moving toward fully metered systems, with 82% of utilities metering multi-family, industrial and institutional connections, and 68% metering single-family connections (CWN, 2018). Available data suggests a correlation between metering and decreased water use. Canadian households equipped with water meters increased by 6% from 1991 to 2011. During this same time period, average daily water use decreased from 342 litres/person in 1991 to 251 litres/person in 2011, an overall decrease of 27% (Statistics Canada, 2017).

Other potential factors contributing to decreasing per capita use are urban densification where homes have smaller lawns as well as changes in industrial water use, such as the closure of large water-using industries.

Many Canadian municipalities have also been reducing inflow and infiltration into collection systems — which can represent approximately 17% of sewer flows — to manage combined sewer overflows and bypass events, and to extend sewer and treatment plant capacity (Statistics Canada, 2012). This can include downspout disconnection programs and sewer pipe lining projects. Inflow and infiltration reduction programs may also contribute to decreases in wastewater generation.

Potential Impacts to Operations and Design Implications

Decreasing water use and wastewater generation have long-term economic and environmental benefits. There are impacts to the operation and design of infrastructure to consider in effectively managing municipal water systems.

Financial Implications

An overall impact of decreasing water use is reduced revenue generated from volumetric-based water use. For most Canadian utilities, the bulk of revenue is generated through volumetric-based water sales. Therefore if water usage decreases, revenues also drop (Canadian Water Network, 2018). This impact may pose a key challenge, especially considering the pressure experienced by many municipal utilities to maintain and replace aging infrastructure, manage affordability and build system resiliency while serving a growing consumer base.

A lower demand for water could result in energy savings, lower treatment costs and reduced capital expenditures on capacity expansions over the long-term. However, in the short-term, the vast majority of costs for providing service and maintaining basic infrastructure are fixed, regardless of how much water is used. Canadian utilities have indicated loss of revenue due to declining usage as their top economic concern and new financing practices and water rate structures are likely needed to address this concern (Canadian Water Network, 2018).

There are also impacts to system operation which may increase operating and maintenance costs, as outlined below.

Drinking Water Distribution System Impacts

A decrease in demand for potable water results in lower flows through drinking water distribution systems, which are typically designed to manage higher flows. These lower flows may impact water quality, operating costs, energy consumption and public health (U.S. Environmental Protection Agency, 2016). Decreased water use may also lead to impacts such as:

- Greater loss of residual disinfectants and the potential formation of biofilms due to lower flows, and therefore longer travel times, through the distribution system. The formation of biofilms creates a more conducive environment for pathogens such as *Legionella pneumophila and Mycobacteria*.
- Increased corrosion, the deposition of corrosion by-product sediment, mobilization of trace metals and a decrease in corrosion control treatment effectiveness due to lower flow rates and longer contact times with distribution system components.
- Higher levels of disinfection by-products due to increased contact times within the distribution system and storage tanks.

(U.S. Environmental Protection Agency, 2016)

Wastewater Collection and Treatment Impacts

Decreasing wastewater generation as a result of reduced potable water use may lead to impacts at the wastewater treatment plant such as:

- Increased biological oxygen demand (BOD) concentration
- Increased total suspended solids (TSS) concentration
- Increased concentrations of ammonia, organic nitrogen, sulfates, and inorganic phosphates

Although the concentrations noted above generally increase as wastewater generation decreases, the actual species loading to the treatment plant is highly variable. Loading rates may increase slightly or experience no change when compared to typical operating conditions. This is potentially due to solids settling out in the sewer system before arriving at the treatment plant (Min & Yeats, 2011). Decreasing wastewater generation may also lead to sewer collection impacts such as:

- Increased sedimentation, leading to the accumulation of solids in sewer pipes
- Increased anaerobic decomposition, leading to the generation of methane and hydrogen sulfide gases

Hydrogen sulfide generation in sewer pipes is particularly problematic because it causes odour and corrosion problems (Min & Yeats, 2011). The generation of methane and hydrogen sulfide can also create safety issues for operations staff who are exposed to these gases (U.S. Environmental Protection Agency, 1991). Inflow and infiltration reduction initiatives may also exacerbate sedimentation and anaerobic decomposition in sewer pipes under typical operating conditions, as peak flows from inflow and infiltration may have been significant. Overall, there is a need for a better understanding of the impact of inflow and infiltration given decreasing wastewater generation.

Water and Wastewater System Planning and Design Implications

When determining the required capacity of infrastructure that will have a useful life of 25 to 50 years (and in some cases over 100 years), there is an inherent need to project future conditions. We live in a time of changing conditions where past conditions are no longer a useful predictor of future conditions, and local design guidelines and standards which outline capacity requirements based on static per capita rates are unlikely to accurately reflect these future conditions.

In general, more robust water demand forecasts require an understanding of the various factors contributing to that demand. In recent decades, water demand models (versus water requirement models) are growing in use. Water requirement models assume that the volume of water required is constant over time. In contrast, water demand models estimate water use given a variety of factors, such as water pricing, water conservation initiatives, weather, proportion of housing types and types of industry/commerce (Rinaudo, 2015).

There is a wide range of literature on demand forecasting, from academic journal articles to technical guidelines on implementing forecasting methods. However, there is currently a gap in the availability of information on how water utilities have implemented demand forecasting methods to guide infrastructure planning and design, particularly in a Canadian context. For example, water demands outlined in design guidelines and standards may not be reflective of decreasing water demands and wastewater generation. Standards relating to fire flow requirements, which significantly impact storage and distribution system pipe sizing in distribution systems, may also need to be re-examined in the context of decreasing demands and impacts on distribution system quality.

Definitions

Water demand: The observed amount of water consumed by residential, public, commercial and industrial customers connected to a water distribution system, including assumed system losses.

Wastewater generation: The amount of wastewater collected by municipal sewer systems before being treated at a wastewater treatment plant. In this case, the wastewater collected by municipal sewer systems includes sanitary sewage from residential, commercial, institutional and industrial sources, as well as groundwater infiltration and stormwater from rain or melting snow entering into the sewer system.

Short-term forecasting: Estimates of water demand over the upcoming hours, days or weeks. This type of forecasting is undertaken to optimize system operation given changes to weather, consumer behaviour and other factors.

Intermediate-term forecasting: Typically spanning 1 to 10 years, this type of forecasting estimates water demand by a fixed or slowly increasing consumer base. Demand is estimated based on factors such as weather cycles, characteristics of the consumer base and/or economic conditions.

Long-term forecasting: Typically spanning 20 to 30 years, this type of forecasting is used to estimate water demand when building water supply infrastructure. Due to the longer time frame, there are many factors that could impact both the consumer base and the per unit water consumption. As such, *uncertainty* is a key challenge in long-term forecasting.

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