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Subject: Private Customer Leak Detection Notification Technologies

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CITY OF GUELPH
PRIVATE CUSTOMER LEAK DETECTION NOTIFICATION TECHNOLOGIES

C3 WATER INC.
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1.0 INTRODUCTION

The 2015 Water Efficiency Strategy Update will identify a set of preferred program alternatives, associated water savings, program implementation forecasts, and supporting program resources required to achieve the water demand reduction of the 2014 Water Supply Master Plan. As part of the strategy scope, a series of technical memos are being prepared on technology and policy areas of opportunity, as identified through ongoing program operation, industry best practice research and common areas of customer/stakeholder inquiry. The objective of this report is to outline private customer leak notification technologies.

2.0 PRIVATE CUSTOMER LEAK NOTIFICATION TECHNOLOGIES

2.1 *Definition*

Perhaps the greatest waste of water in a municipal system is water lost through leakage, both in the distribution system and after it has been delivered to the customer. Even a relatively small leak can lead to significant water loss if the water is lost 24 hours per day. While a customer can easily identify a dripping faucet or showerhead, some leaks are more difficult to identify. For example, a leaking toilet can waste 700 litres of water per day yet go unnoticed for months. Some leaks can be underground, like an irrigation system leakage, or hidden, as with a water softener stuck on bypass. While the presence of a large leak can make itself known to the customer via an unexpected "spike" in the water demand and an associated increase in the water bill, smaller leaks may cause only a moderate increase in water demand and, therefore, go unnoticed by the customer. The United States Environmental Protection Agency estimates that the average household loses about 100 litres per day in leakage with the top 10 percent of homes losing more than 340 litres per day in leakage (United States Environmental Protection Agency, 2015).

2.2 *Types of Programs*

2.2.1 Passive Informational Programs

Information to help customers find and repair leaks can be found on many municipal websites, including the City of Guelph's Fix a Leak Web page, and included with customer water bills (see Figure 1). Other municipalities have advertised on radio, TV, magazines, etc. Messages can include:

- Identifying average per capita or per household water demands within the community.
- Noting the customer's current demand is higher than their average demand for the same time of year to prompt the customer to check for leakage within the home,
- Noting the customer's demand is higher than the average demand in their neighbourhood to prompt the customer to check for leakage within the home,
- Noting that an unusually high water bill may be the result of a leak.

Do you have a leaky toilet?

Small leak, big bucks.

If your toilet is running constantly, you could be wasting up to 700 litres of water every day!

If your toilet is leaking, the cause is most often a faulty toilet flapper. This rubber component may degrade or be subject to mineral buildup over time. It is easy and inexpensive to replace the whole flapper and it pays for itself in no time. For assistance look up your toilet manual on line or consider consulting your plumbing contractor or plumbing supplier for assistance.

If you do need to replace your entire toilet, look for a WaterSense labelled model. By replacing old 13L toilets in your house, a family of four can save up to \$2,000 in water bills over the lifetime of the toilets.

Just peel and toss into your toilet tank.
Two dye test strips

toss
one dye test strip into your toilet tank. Wait 20 to 30 minutes.

check
the water bowl. If the colour changes, you have a leak.

repair
with our easy to follow tips OR contact your local plumber.

www.guelph.ca/ourstoconserve
For information regarding your water usage please contact Water Services at 519-837-5627

Did you know?
The City of Guelph offers a \$75 rebate when you replace a 13L toilet with a new high-efficiency WaterSense® model. For more information or to view eligibility of WaterSense® approved models, visit the City's water conservation rebate programs website at guelph.ca/rebates.

Does your toilet have a leak?

It could be your flapper valve.

Check the water level
Is it **below** the overflow tube?

YES Turn off your water valve & flush your toilet to drain the water from the tank.
Check your flapper valve.

<p>Is the Rubber Peeling? Make sure to take your flapper with you to the store to match it to the replacement.</p>	<p>Is the Chain Kinked? Replace it with a ball type chain.</p>	<p>Is the Float Rod Rising and Falling Freely? If rubbing on side of tank or not floating freely the fill tube will keep running.</p>
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NO **Check the water level**
The water level might be too high, running into the overflow tube.
Adjust the float rod
Turn screw clockwise to lower the water level below the overflow tube.

www.guelph.ca/ourstoconserve
For information regarding your water usage please contact Water Services at 519-837-5627

Figure 1 – Example of Bill Stuffer

Other messages explain how the customer can use their water meter to check for leaks. For example, the customer can read their water meter right before they go to bed and then again first thing in the morning, or after any extended period when no water is being used. If the meter reading is higher on the second reading there may be some leakage in the home. Or, if their water meter has a low flow indicator, they can inspect this during a period when no water is being used in the home – a rotating low flow indicator might indicate the presence of leakage (Figure 2).

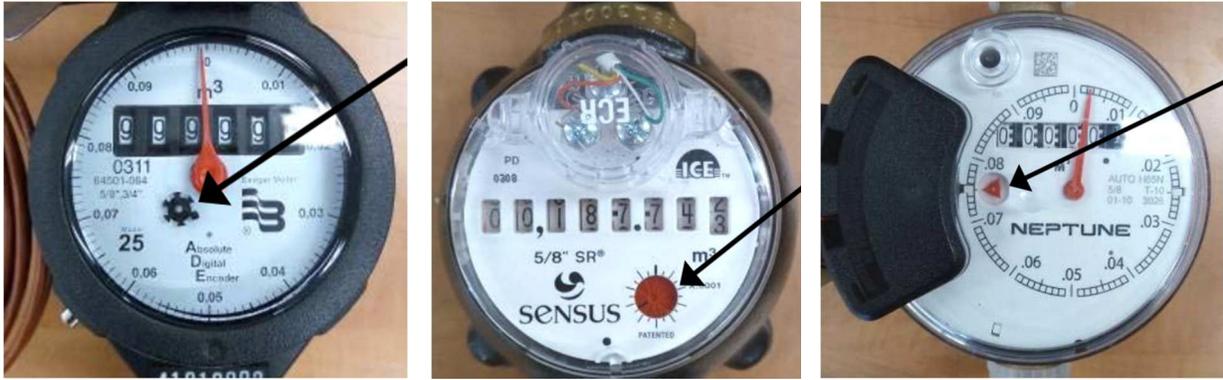


Figure 2 – Examples of Low Flow Indicators

If the homeowner suspects leakage they should inspect all faucets and valves for drips and leaks indoors and outdoors, including: water heaters, water softeners, floor drain primers, clothes washers, dish washers, hose bibbs and irrigation systems. If no leak can be found the homeowner should inspect their toilets as the most common source of leakage in the home. First they should look and listen for obvious signs of leakage, such as the toilet is re-filling even though it wasn't flushed, or the water in the bowl has ripples. Next they should add food colouring, a toilet dye strip, or a leak detection tablet to the water in the tank and, without flushing, wait a few minutes – if the coloured water in the tank has seeped into the bowl then there is a leak.

It is important to engage customers to periodically check for leaks since it is very difficult for the municipality to determine if there are leaks unless they are significant. Unfortunately, small leaks may also be ignored or unnoticed by the customer. However, even the water lost through apparently small leaks can add up. For example, a faucet leak of one drop per second wastes 25 litres per day and a small toilet leak of 0.1 litres per minute would equate to a water loss of 144 litres per day, an extra \$167 per year on the water bill. Note that the City of Guelph, like many other municipalities, does not have cost forgiveness policies for water lost through leakage, so it is in homeowners' interest to monitor and manage leakage to avoid potentially significant costs.

2.2.2 Active Notification Programs

Communities using automatic meter reading technology for water customers can access near real-time demand data for each customer. As such, it is possible to determine if a customer's water use pattern is indicative of leaking in the home. For example, a continuous demand over several days or unusually high demands may indicate a leak. Some communities with automatic meter reading systems use programs to evaluate their customers' water demands on a continual basis and send notifications to customers with demand patterns that may indicate leakage. Automatic meter reading systems using wireless radio frequency-based technology work best for this application as they do not require a meter reader to 'walk by' or 'drive by' each customer.

2.2.3 In-home Measures

There are two basic types of home leak detection devices: flow-based and sensor-based. Flow-based systems use a flow sensor and automatic shut off valve; any flow through the meter that could indicate a potential leak will trigger an alarm and shut off the water supply to the home or, in some cases, to the

appropriate appliance. Sensor-based systems rely on placing sensors in high-risk locations within the home, such as near a water heater or clothes washer. When the sensor detects water it can sound an alarm and/or send a signal to shut off the water supply to the home.

An example of a flow-based device is the FloLogic (FloLogic, 2015). This device has a flow sensor that can detect both major leaks (e.g., a burst pipe) and slow leaks (e.g., a leaking toilet flapper). When a potential leak is identified, the device can automatically send a text alert to a smart phone and/or automatically shut off the water supply to the home. The cost of the FloLogic system is approximately \$2,000. Other examples of similar devices include:

- Leak Defence System, approximately \$2,700 (Water Security Solutions, 2015)
- Water Hero (Water Hero Inc., 2014) - note: this product does not appear to be commercially available at this time
- LeakSmart (leakSMART, 2014) - note: this product does not appear to be commercially available at this time

An example of a sensor-based device is the FloodMaster (Flood Master, 2015). The device has a sensor puck that is placed in an area within the home that might be prone to leakage, such as near the water heater or clothes washer. If the sensor puck comes in contact with water the device can sound an alarm and/or shut off the water supply to specific appliances such as a clothes washer or water heater, or to the entire home with the shutoff motor. The cost of the FloodMaster is approximately \$300. The sensor-based systems tend to be less expensive than the flow-based system because they only monitor for the presence of water and not the pattern of water demands in the home.

Other examples of similar devices include:

- WaterCop, approximately \$500 (DynaQuip, 2015)
- PipeBurst Pro, approximately \$850 (PipeBurst Pro, 2015)
- Floodstop, approximately \$250 (OnSite PRO Inc., 2015)
- leakSMART (leakSMART, 2014) note: this product does not appear to be commercially available at this time
- Leak Gopher, approximately \$450 (Leak Gopher, 2015)

There are also less expensive sensor-based leak detection devices that can send a notification to smart phone if they come in contact with water but are not able to shut off the water supply to the home. These devices are designed to help reduce property damage caused by broken pipes or a leaking basement rather than to identify a leaking toilet, faucet, or showerhead where the leaking water just flows down the drain and not onto the floor. Two examples of this type of leak detection device are:

- INSTEON Leak Sensor approximately \$40 (The Home Depot, 2015)
- Zircon Leak Alert, approximately \$20 (Zircon, 2014)

2.2.4 Customer Portals

Some agencies, like Park City, Utah, enable customers to review their current and historical water demands online via a customer portal. Customers can log on to their account and view a detailed analysis of the home water use and receive personalized water savings recommendations. Park City's system, which employs an advanced meter infrastructure system, will also email customers if their water

demand pattern indicates a potential leak. As of May 2014, Park City (population 8,000) had delivered over 150 potential leak alerts to customers, 70 percent of which were addressed within 10 days of receiving the notification (WaterSmart Software, 2015).

Another customer portal system - the AquaHawk system – is used by the Dublin San Ramon Services District in California (Dublin San Ramon Services District, 2015). This system allows the customer to set their own water demand targets in volume or cost and to receive texts or email notifications if they exceed their target or if their demand pattern is indicative of leakage. Note that homes must be connected to a wireless automatic meter reading system. The portal provides homeowners with a great deal of information - a screenshot of the portal is provided below (Figure 3).

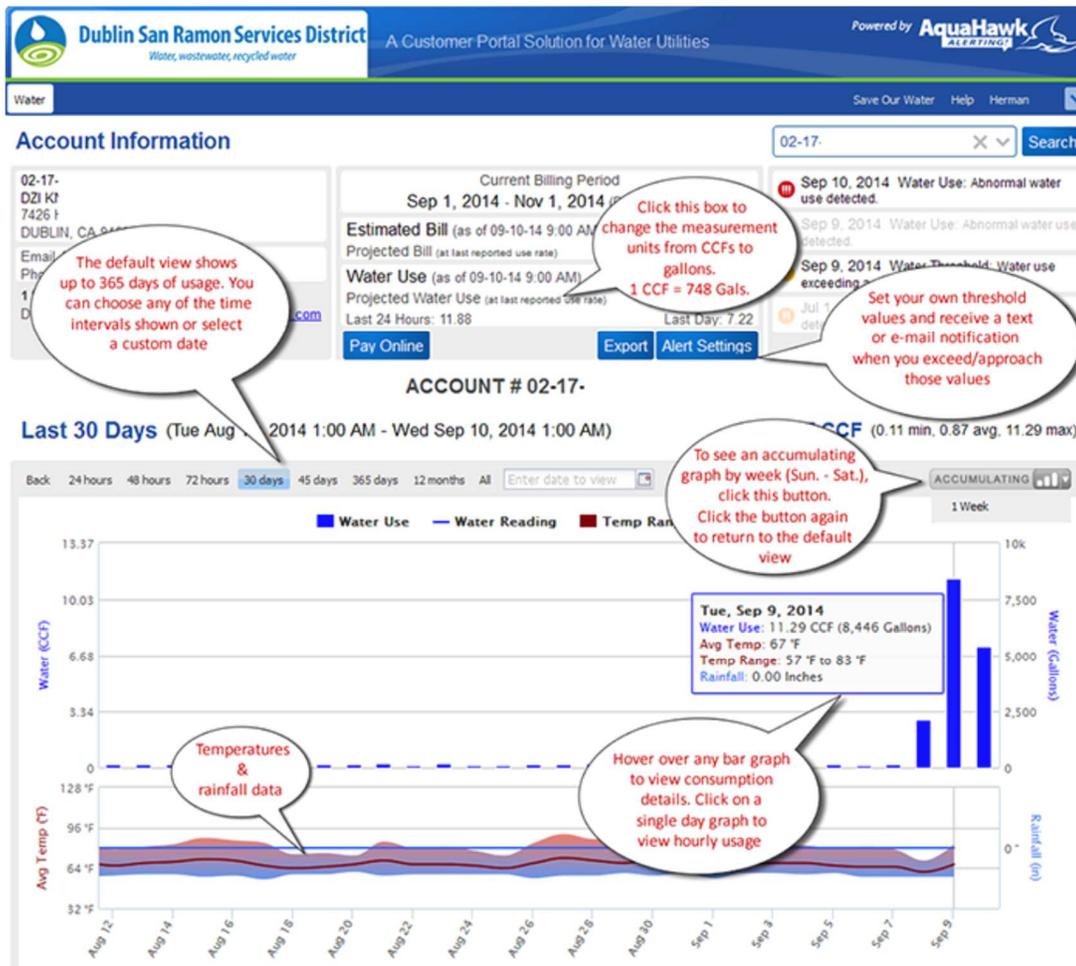


Figure 3 – Example of a Customer Portal

2.3 Current Municipal Practice

2.3.1 Passive Informational Program

Passive information programs include having dedicated webpages, dedicated programming weeks, and notices about how to determine if leaks are presented. A few examples are presented below.

- Guelph currently has a “Fix a leak” web page dedicated to reducing customer leakage (City of Guelph, 2013).
- Peel Region has similar information on their website including a video showing customers how to use their water meter to look for leakage (Region of Peel, 2013).
- Halton Region which provides information on how much water can be wasted via a dripping faucet or leaking toilet, how to check if your toilet is leaking, how to apply for a toilet rebate, and to select WaterSense® fixtures when replacing older fixtures (Halton Region, 2011)
- Region of Waterloo which provides information on how much water can be wasted via a leaking toilet and how to check if your toilet is leaking (Region of Waterloo, 2010)
- Durham Region provides comprehensive information on how to use your water meter and low flow indicator to check for leaks in the home, the financial cost of leakage on water bill, how to check if your toilet is leaking, and how water is used within the home (Durham Region, 2015), and many others.

Non-municipal agencies are also active in promoting “fix a leak” type programs. For example, the United States Environmental Protection Agency’s WaterSense® program has operated a program called “Fix a Leak Week” since 2009. The dedicated website contains information on how to fix leaks, facts and figures, educational resources, and videos – as well as highlights from previous years (United States Environmental Protection Agency, 2015). Recently, the third week of March was selected as the “Fix a Leak Week” and activities such as family fun runs, leak detection contests, and WaterSense® demonstrations were organized in many United States cities as part of the program.

The Arizona Municipal Water Users Association has produced a “Smart Home Water Guide – Find & Fix Leaks” guide available online that includes step-by-step instructions and the following six sections: How to Read Your Water Meter, Outdoor Visual Leak Inspection, Indoor Visual Leak Inspection, Isolation Method for Continuous Leaks, Water Efficiency Around the Home, and Glossary and Resources (Arizona Municipal Water Users Association, 2015).

Another method recommended by some agencies such as Ramona, California asks the homeowner, or technician, to attach a pressure gauge to one of the home’s hose bibbs or laundry sink and then turn on the valve to pressurize the gauge. Next, ensure all of the water-using equipment in the home is turned off. Next, the main water shut-off valve to the home is closed. If the reading on the pressure gauge remains steady for 10 to 15 minutes there is no leak in the home; if the reading drops slowly there is a small leak in the home; if the reading drops quickly there is a large leak or some water-using device was not properly closed (Ramonas Plumber, 2010).

2.3.2 Active Notification Programs

Active notification programs include use of mandatory programs. Examples are provided below.

The City of Guelph is moving to monthly billing in the fall of 2015. They are also developing an application that will use the monthly billing data to evaluate customer water demands on a neighbourhood-by-neighbourhood basis. The City will send a notice to customers if they are using significantly more water than their “neighbours” suggesting that they check for leaks or consider installing efficient fixtures and appliances when it is time to replace their existing models.

Toronto is in the process of replacing their old water meters with new meters connected to an automatic meter reading system. The new “smart” meters will deliver information four times a day to the city. Once the new system is in place it will be possible for the city to track residential customer water demands and notify customers when demand patterns are indicative of potential leakage (note that non-residential customers often have highly variable water demands and, as such, it is not normally possible to flag potential leakage based on changes in demand patterns).

New York City, New York, has expanded its Leak Notification Program to include multi-residential buildings (homes with as few as four units). This program, monitored by the Department of Environmental Protection, alerts customers via email, if their water usage triples for five consecutive days. This allows the Department of Environmental Protection to proactively alert customers to potential water leaks on their property. Since the program began in 2011, the City has sent out nearly 32,000 leak notifications resulting in an estimated savings of \$26 million in reduced leakage (New York Department of Environmental Protection Public Affairs, 2012). For the program to work, customers are provided the opportunity to sign up online to receive email notifications. Therefore, enabling homeowners to quickly respond to potential leaks and fix them before they become a serious billing problem. This program requires wireless meter readers that record water demand data four times per day.

League City, Texas, has a leak detection notification program where customers are notified via email if their meter records continuous flow for 24 hours (League City, 2015). Customers must register for the program. The website links to the Environmental Protection Agency’s WaterSense® Fix A Leak Week website to provide information to customers on how to find and repair leaks in their home.

San Francisco Public Utilities Commission has launched a pilot program to notify single-family customers if they have a potential leak. This program is made possible via the use of wireless water meters that record water demand data hourly. Homes are notified via a postcard stating “You may have a LEAK” if the meter records continuous flow of at least 28 litres per hour for three days. The postcard directs the homeowner to a city website that states that about one in five San Francisco homes have an ongoing plumbing leak and identifies ways to check for leaks in the home as well as how much money a leak can cost you (San Francisco Public Utilities Commission, 2015). Customers can also call the Public Utilities Commission to schedule a free in-home water-wise evaluation (San Francisco Public Utilities Commission, 2015).

The city of Abbotsford, British Columbia, has a detailed webpage regarding water leaks (City of Abbotsford, 2015). The site provides information on what the customer should do if they believe their water bill is inaccurate, as well as information on how to find and repair water leaks within the home. The City’s advanced meter infrastructure technology also allows them to monitor customer water demands for continuous flows that may indicate leakage. If potential leaks are identified, a letter is mailed to the customer advising them of the continuous consumption. The City may mail a second or third letter if the continuous consumption continues. The city does not monitor non-residential customer meters for leaks because of the varied nature of water consumption within these facilities. The City will also arrange for someone from their Engineering Department to check for leaks on a customer’s property if the customer suspects they may have a leak and contacts the City. One time leak adjustments are

available to owner-occupied residential properties after prompt repairs have been done. In order to qualify for a bill adjustment, repairs must have been done within two weeks of the possible leak notification letter or the billing date, whichever is earlier. Billing adjustments are based on the average daily consumption prior to the leak. The cost of repairs are the responsibility of the property owner.

2.4 Benefits and Barriers

The expected benefits and barriers in implementing leak detection notification technologies are listed below in Table 2-1.

Table 2-1: Summary of benefits and barriers associated with leak detection.

Benefits	Barriers
<ul style="list-style-type: none"> • Lower customer water bills. • Reduced potential for water-related property damage. • Lower municipal water demands, which results in lower operational costs related to energy, chemical demands, and potentially lower capital costs related to avoided, downsized, or deferred infrastructure. • Better customer service and response time to leaks noted. • Increase in the level of information received by customers helps avoid billing disputes for unknown leakage, etc. • Higher level of information available to customers (e.g., customer portal, re-designed water bills). 	<ul style="list-style-type: none"> • Customers may lack motivation to check for visible and hidden leaks. • Customer’s capacity to complete expensive or difficult leak repairs. • Customers may lack sufficient motivation to repair leaks. • Small leaks may not register on the water meter, thus more difficult for an automatic meter reading system to identify. • Relatively high cost of installing a flow-based in-home leak detection and water shut-off system. • Inability of sensor-based in-home leak detection system to identify fixture and appliance leaks that do not result in flooding. • Cost of installing and operating wireless automatic meter reading equipment. • Lack of understanding that even a relatively small leak can amount to a large volume of water wastage and a significant water bill. Customers may lack sufficient motivation to repair the leak.

2.5 Local Feasibility

Guelph, like many other area and North American municipalities, provides detailed information on a City website that customers can use to help them check for leaks. While these types of sites offer a great

deal of information, they are *passive* by design and rely on customers to access the site to look for information. Notification programs, on the other hand, are *active* by design insofar as they do not require any action from the customer other than a one-time signing up to participate in the notification program. Guelph does not currently have advanced meter infrastructure in place for automatic reading of customer water meters and, therefore, cannot immediately implement a leak detection notification program that can notify customers of leakage at the time of the event. As stated earlier, the City does currently mail notifications to both residential and non-residential customers if their demands are 150 percent or more compared to the same billing period in the previous year.

Implementing a meter replacement program to upgrade or replace existing single-family customer meters to an automatic meter reading system suitable for identifying customer leakage on a timely basis may be costly – especially if the conversion is done over a short period of time. Preliminary analysis by the City estimated a cost of \$4.33 million (\$96.22 per user) for 45,000 meters installed without accounting for operation and maintenance costs. The City could begin requiring automatic meter reading capable meters to be installed in new development or when older meters require replacing. This strategy would spread the program costs over many years by extending the time required for full conversion.

There are other benefits associated with using automatic meter reading, or advanced metering infrastructure besides customer leak detection, such as:

- providing better demand data for hydraulic modeling or demand forecasting
- lowering meter reading costs, vehicle fuel and maintenance costs, and associated greenhouse gas emissions
- better customer service, for instance because the City would be better able to address customer complaints with immediate access to their water demand data
- better enabling use of seasonal water demand rates, excessive daily demand rates, or even time-of-day rates

3.0 KEY CONSIDERATIONS

Active customer leak notifications are expected to be much more effective at reducing leakage than the more passive method of posting information on “how to find and fix leaks” on municipal websites. While Guelph is moving to a monthly billing cycle in the fall of 2015 and they are developing a screening program where they will identify and notify customers with unexpectedly high monthly demands to check for leaks, the most effective leak notification programs take advantage of the more granular water demand data that can be generated via automatic meter reading systems where customer water meters are read one or more times per day per day such that unusual water demand patterns or extended periods of continuous use can be identified almost immediately. Should the City of Guelph decide to convert to an automatic meter reading/advanced meter infrastructure system, it would be able to implement an active customer leak notification program and/or to develop a customer water use portal that would enable customers to retrieve more detailed and almost real-time data regarding their water use and potential water efficiency measures.

Of the two types of home-based leak detection systems, flow-based and sensor-based, it appears that flow-based systems would be the most effective at flagging the most common type of leakage within the

home. For instance, in cases where fixture/appliance leaks tend to discharge to drain rather than cause flooding. Unfortunately, the relatively high cost of these systems of around \$3000 may make the widespread use of these systems unlikely. While sensor-based systems are significantly less expensive, ranging from about \$30 for an alarm-only system to about \$300 for a system that can shut off the water supply to the home, they are only effective if they come in contact with water. These are leaks that would be readily obvious to the homeowner, ergo sensor-based systems are more suited to prevent flood damage than to reduce water demands and water bills.

Another challenge faced by Guelph and other municipalities is a general lack of understanding by customers of the information contained on the water bill. Customers pay water and wastewater costs based on how many cubic metres of water they use during the billing cycle but it is likely that most customers are more familiar with litres or even gallons than cubic metres. Based on the results of interviews with customers in other jurisdictions and a survey completed by the University of Indiana, it appears that very few customers are fully aware of how much water they use on a daily basis, whether they would be considered efficient or inefficient, or how this demand compares with other homes in their neighbourhood (Yoshida, 2014).

Guelph may want to consider taking advantage of delivering monthly water bills to residential customers, beginning in the fall of 2015 to re-design their water bill to provide more comparative information in an easy to understand manner.

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