Outdoor Water Use Reduction Manual

OWWA Water Efficiency Committee

June 2008

Ontario Water Works Association
A Section of AWWA

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The Water Efficiency Committee of the Ontario Water Works Association, a section of the AWWA, would like to thank the Ontario Ministry of the Environment for the financial support that made this manual possible, and the municipalities that provided data and program information.

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The views expressed in this manual are the views of the Ontario Water Works Association and do not necessarily reflect those of the Ontario Ministry of the Environment.

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Executive Summary

Many elements of municipal water treatment and distribution systems are sized based on peak demands, i.e., the high water demands that occur after extended periods of hot and dry weather. For the remainder of the year, however, the system is largely over-sized and under-utilized. While infrastructure expansion is very expensive (it may cost between $500,000 to $2 million to add 1,000$m^3$ of capacity to a system), the revenues collected from the sale of 'peak day water' are relatively minor (the 'extra' water demand on peak days often accounts for less than 1 percent of annual water production). As a result, municipalities, especially growing municipalities, can often save millions of dollars by reducing peak day water demands and, therefore, the need for infrastructure expansion.

Not only is reducing peak water demands fiscally responsible, it is also environmentally responsible. Reducing peak demands will reduce the amount of water we draw from lakes, rivers, and aquifers and, while actual values will vary from system to system, it has been estimated that, because of the energy used in water treatment and distribution systems, about 0.8 kg of greenhouse gas will be saved for every cubic metre of water saved. A home reducing irrigation demands by 100 litres per day would help reduce greenhouse gas emissions by approximately 7.4 kg each summer.

Research completed during the development of this manual identified some very important aspects that municipalities will find useful when developing their outdoor water use reduction programs, for example:

- Historically, Ontario municipalities receive about 240mm of precipitation during June, July, and August (average of slightly less than ¾-inch per week). The period from 2000 to 2007, however, has been, on average, somewhat dryer – averaging only about 177mm of rain during these same months (slightly more than ½-inch per week).
- An analysis of summer rainfall data from 2000 to 2007 indicated that, on average, 150mm (83 percent) of precipitation fell in just 5.8 major rainfall events each summer, i.e., an average major rainfall event during this period was 25mm (1-inch).
- On average, only 27mm (approximately 1-inch) of precipitation fell in minor rainfall events distributed throughout the rest of each summer.
- Because Ontario municipalities receive the majority of their precipitation in just a relatively few major events each summer, there are often extended periods with little or no rainfall at all. During these dry periods virtually all irrigation demands must be met using potable water and municipalities experience peak summer water demands.
- The average single-family home applies much less than 25mm (1-inch) of water to their lawns each week (including precipitation). In fact, an analysis of billing data from the Regions of Peel and Waterloo indicate that the average single-family customer applies only about 7mm (less than $^1/_3$

of an inch) of water each week. The commonly marketed message that lawns need "1-inch of water per week" may actually promote over-watering. Municipalities may want to consider re-packaging the message to promote watering less than 1-inch per week.

- A water demand analysis of 151 homes in an Ontario municipality identified that the 10 percent of homes with automatic irrigation systems applied an average of about 95mm (3-$^{3}/_{4}$-inch) of water each week, while the 90 percent of homes with manual irrigation systems applied an average of only 7mm ($^{1}/_{4}$-inch) each week. While these results are not necessarily indicative of all customers with automatic/manual irrigation systems, they highlight the potential for high irrigation demands associated with automatic systems.
- These results are, in general, agreement with the Pareto principle, i.e., that a small percentage of customers are largely responsible for peak summer water demands. This is good news for municipalities as it allows programs to focus on just a few 'high-use' customers to achieve their savings targets.
- The downside is that automatic irrigation systems typically operate during the night, making it difficult to identify homeowners that disregard municipal by-laws unless night patrols are conducted. What's more, automatic systems are more common on larger lots owned by affluent customers – customers that may be less affected by irrigation reduction measures such as conservation-based rates or small fines.

Outdoor water use reduction programs should be part of an overall *Water Efficiency Master Plan* and should include both broad-based measures, such as by-laws and public outreach, and customer-specific measures, such as landscape audits (sometimes called landscape consultations) and rebates.

Water made available through improving efficiency is now considered to be a legitimate new 'source' of water – equally as valuable to the municipality as water derived from traditional sources, such as a well field. What's more, the cost of sourcing water through efficiency is considerably less than developing more traditional water sources. While there are many reasons to reduce water demands, for example environmental stewardship, source protection, etc., ideally, demand reduction programs will also be cost-effective to the municipality, i.e., that it will cost less to meet increasing water demands through efficiency than it does through infrastructure expansion.

By far the biggest contributor to outdoor demands is irrigation and, while this manual touches on outdoor uses such as vehicle washing, pool filling, and water wasting, the focus is clearly on reducing the irrigation demands that are responsible for high peak (max) day water demands. Both 'control' and 'reward' measures are included in this manual. Measures, such as watering restrictions and watering bans, are considered 'control' measures because they constrain the

homeowners' opportunity to irrigate. Measures, such as public outreach programs or offering incentives, are considered 'reward' measures because they are used to modify a customer's behaviour concerning water use.

Research indicates that the most common type of watering restriction in Ontario is the Odd/Even Day watering restriction. This type of restriction allows homeowners to water every second day based on their address (even-numbered homes can water on even-numbered calendar days and vice versa) even though research has shown that most lawns only require watering once or twice per week. There is a growing movement in the U.S. to adopt One-Day-per-Week restrictions, i.e., homes would only be allowed to irrigate on one specific day each week. At least one Ontario municipality, Waterloo Region, has also adopted this type of watering schedule. What's more, Waterloo Region puts a positive spin on their program by referring to this type of schedule as a "conservation schedule" rather than a watering restriction.

Both Odd/Even and One-Day-per-Week restrictions are commonly combined with Time-of-Day restrictions, i.e., homeowners are only allowed to irrigate during specific periods of the day, e.g., from 6:00 to 9:00 a.m. and from 6:00 to 9:00 p.m. Time of day restrictions prevent customers from irrigating during mid-day when much of the water applied may be lost through evaporation, while still providing more than ample time for a homeowner to provide the necessary irrigation – for instance, a garden hose operating at a flow rate of 25 litres per minute can apply 25mm (1-inch) of water to 180m^2 of lawn in just three hours. During the summer months, municipalities may experience their highest water demands between 6:00 to 9:00 p.m. because of evening irrigation. Municipalities with a large number of automatic irrigation systems may experience their highest demands between 2:00 and 4:00 a.m.

During droughts or periods of severe water shortages, municipalities may be forced to implement a complete ban on irrigation or other outdoor water uses. Some municipalities, for example the City of Guelph, have a tiered watering ban, with the lowest level (level 1) of the ban always in place. Always having at least some level of ban in place helps raise customer awareness to the fact that water should always be used wisely and never wasted. As drought conditions worsen, Guelph increases the level of the ban appropriately. Watering bans and other municipal by-laws will be much more effective if they are adequately supported through public outreach programs and enforced via issuing fines. Waterloo Region, for example, typically provides fines of $150 per offense to customers that disregard water use by-laws.

Based on the principle that higher costs result in lower consumption, conservation-based water rates should be effective at reducing discretionary demands, such as irrigation. Higher rates would be expected to have less impact on non-discretionary uses, such as toilet flushing and bathing, since there is no close substitute for potable water to which the consumer can turn, and because water bills generally account for only a small portion of a household's total expenditures.

There are several types of conservation-based rates, though they all share the basic premise that consumers should pay a higher unit rate for discretionary water use. Increasing-block rates and higher seasonal rates are just two examples of conservation-based rates that set out lower rates for water used for essentials such as toilet flushing and bathing, while charging higher unit rates for water used to wash vehicles and water lawns. Increasing the billing frequency for the single-family customer sector, which is typically every three months, would also be expected to enhance the impact of conservation-based rates.

Many municipalities implement public education and outreach programs aimed at reducing outdoor water demands. Some measures, such as planting water-efficient demonstration gardens or subsidizing rain barrels, are intended more as public education tools than as measurable/quantifiable water efficiency measures, while other measures, such as providing residential landscape water audits or offering incentives towards the purchase of 'smart' irrigation controllers are expected to expressly save water. This manual reviews the following public education and outreach measures:

- community-based social marketing,
- residential landscape audits,
- rain barrels,
- rainwater harvesting,
- grey water reuse,
- rain gauges,
- hose timers,
- water-efficient demonstration gardens,
- automatic irrigation systems,
- 'smart' controllers with automatic irrigation systems, and
- offering incentives and rebates.

This manual provides an overview of each measure and evaluates the relative effectiveness of each measure to achieve the program target, i.e., to reduce peak summer water demands.

The final section of the manual summarizes the findings and provides some specific advice to help municipalities develop effective outdoor water use reduction programs. For example, the manual recommends municipalities first set realistic water saving targets based on their specific needs, and then select the appropriate measures to implement based on these targets, available budget, and the urgency for savings.

While reducing peak water demands will help protect our precious water sources and lower greenhouse gas emissions, it is difficult to accurately quantify the water savings and cost-effectiveness of many outdoor water use reduction measures. Water production and billing data can be analyzed to assess the level of savings achieved by a program, though, because of the natural variation in weather patterns from year to year, it is likely that the true effectiveness of a program will not become clear until several years' worth of data is collected.

While there are a number of outdoor water use reduction measures being used by Ontario (and North American) municipalities, some measures appear to be more effective than others in reducing peak summer water demands. This manual is designed to assist persons tasked with developing an outdoor water use reduction program to better understand and evaluate these measures with respect to the specific water saving goals of their municipality.

ORGANIZATION OF THIS MANUAL

Section 1 Introduction lists various summer outdoor water uses and identifies irrigation as the primary contributor to peak demands. This section also explains that the information contained in this manual is intended to help municipalities set realistic water savings targets and select measures that are best suited to meet their specific program goals and targets.

Section 2 Background describes the natural variation in seasonal water demands that Ontario municipalities experience, why peak summer water demands occur, and why it is so beneficial to a municipality to reduce these peak demands.

Section 3 Water Use/Production Meters discusses the importance of knowing and tracking how water is used within a system, i.e., seasonal variations in demand, demands in different customer sectors, use of billing data and bulk metering, etc.

Section 4: Program Goals and Targets identifies which customer sectors are most responsible for peak water demands during the summer months and discusses the need to target customers that offer the greatest opportunity for savings.

Section 5: Peak Day Demands discusses how peak day demands affect the sizing of various water treatment and distribution elements, and how reducing peak demands can help defer or avoid the need for costly infrastructure expansion. This section also compares actual peak day demand ratios with design demand ratios and discusses the use of peak week demand ratios vs. peak day demand ratios.

Section 6 Effects on Revenues discusses the minimal effect that reducing peak summer water demands will have on revenues.

Section 7 Choosing the Right Measures outlines various outdoor water use reduction measures and discusses how effective each measure is at reducing peak water demands. Measures discussed in this section include: water restrictions and bans, water rates, community-based social marketing, and the use of incentives, rebates, and other education/promotion/marketing measures.

Section 8 Planning the Right Program provides information on the various elements that should be included in a comprehensive outdoor water use reduction program. This section also provides a summary of the measures discussed in this manual and reiterates the potential effectiveness of these measures to reduce peak water demands.

1.0 Introduction

An outdoor water use reduction program should be an important part of a municipality's overall comprehensive Water Efficiency Master Plan. This manual is intended to provide information on the outdoor water uses that contribute to the high peak day demands experienced by many Ontario municipalities and to outline the effectiveness of the various measures being used by municipalities to curb these demands. Outdoor water uses can include: landscape and garden irrigation, washing automobiles, maintaining swimming pools, cleaning sidewalks and driveways, maintaining decorative fountains, children playing under the sprinkler, and more. By far the greatest outdoor water use is related to meeting the irrigation demands of lawns and gardens. While this manual includes measures that target non-irrigation outdoor water uses, such as eliminating water wastage, its primary focus is on programs and measures that target reductions in peak irrigation demands in both the residential and commercial customer sectors.

Information contained in this manual can help guide the development of your outdoor water use reduction program.

Planning and implementing an outdoor water use reduction program will require a certain amount of time and effort and, because of the natural variation in weather patterns from year to year, the true success of a program is often hard to assess accurately. A municipality can use the information contained in this manual to better understand the potential water savings associated with various outdoor water efficiency measures. While this manual is not intended to provide a step-by-step instruction of how to develop a municipal outdoor water use reduction program, by providing information on the outdoor water demands of various customer sectors and assessing how various water efficiency measures affect customer demands, this manual will help municipal water conservation staff to set realistic water savings targets and select measures that are best suited to meet their specific program goals and targets.

This manual is designed to assist Ontario municipalities to select outdoor water use reduction measures that will help them operate their water supply and distribution systems more effectively and efficiently while meeting the expectations of their customers.

2.0 Background

The Water Efficiency Committee of the Ontario Water Works Association has produced this manual in recognition of the diverse needs and differing social and political pressures upon municipalities and water service utilities to implement summer peak demand efficiency measures and policies. This manual is intended to serve as a best practice reference and information guide with the key objective of providing proven utility-based resources and policy alternatives that can be used as tools to help reduce peak summer water servicing demands.

Peak demands are caused by excessive irrigation after extended periods of hot, dry weather.

Meeting high summer water demands, especially the peak demands that occur after extended periods of hot and dry weather, can cause significant stress to a municipality's water treatment and distribution systems. Building water treatment and distribution infrastructure to meet peak summer demands (which may occur on only a few days each year) can also be very expensive to the municipality. While the cost of expanding water supply and distribution system infrastructure will vary from municipality to municipality depending upon the size and specific requirements of the system, it is estimated that the unit cost of expansion could range from $500 to $2,000 per cubic meter of additional daily capacity (based on data provided by City of Toronto, Region of Peel, Region of Durham, and the Region of Waterloo). For example, the cost of expanding the capacity of a water supply/distribution system by 10,000 m^3/day may cost between $5 million and $20 million. Worksheet #4 provided in Appendix G can be used to help determine the unit cost of infrastructure in your municipality.

While most municipalities have the capacity to meet peak demands over relatively short periods of time, peak demands that are very high or last for an extended time can reduce municipal water storage to dangerous levels, potentially resulting in lower system pressures and compromising the municipality's ability to fight fires. In severe instances, system storage may be largely depleted in a matter of just a few hours yet take several days to refill.

Peak demands are primarily caused by landscape and garden irrigation in the residential and commercial customer sectors. A garden hose running for only two hours can provide more water than is used by a typical

household in three days! A survey by Statistics Canada[1] indicates that 61 percent of Ontario homeowners irrigate their lawns and 84 percent irrigate their gardens.

While water systems have only one true peak demand day each year, they often have several "peak-type" demand days.

As illustrated in Figure 1, while there is only one true peak day (sometimes referred to as max day) each year - the day with the largest water demand in the year - there are generally several high water demand days or "peak-type" days throughout the summer. Peak day values vary from year to year depending upon weather conditions. Figure 1 also illustrates that the water supply system, which must be sized to meet the peak day water demand, is underutilized most of the year.

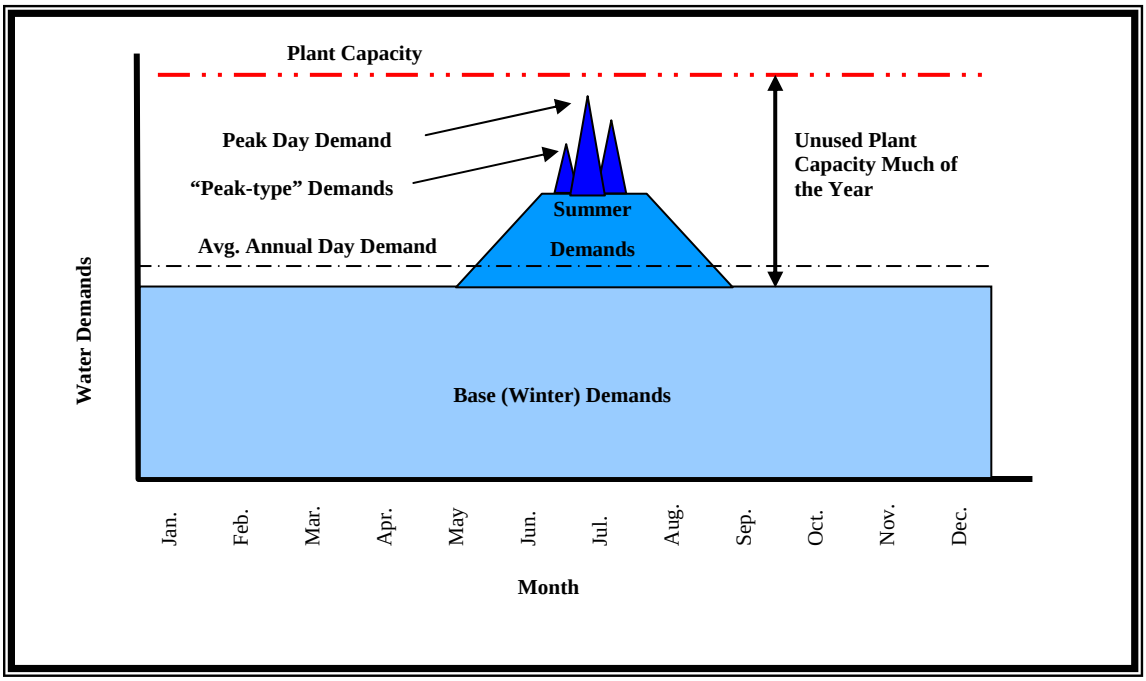


Figure 1 – Typical Schematic of Seasonal Water Demands

Most people accept that as long as homeowners continue to plant traditional lawns and gardens municipal systems will experience greater water demands during the summer months. Most municipal outdoor water use reduction programs do not generally try to prevent homeowners from providing enough water to keep their lawns and gardens alive and healthy, but rather to prevent homeowners from *over-watering* their lawns and gardens. Over-watering is not only wasteful; it may actually be harmful to the plants by promoting lawn disease. During periods of drought or water shortages, however, when peak irrigation demands are greatest,

[1] Statistics Canada, Households and the Environmental Survey, 2006, Outdoor Water Use by Province – 2005

municipalities may ask or require homeowners to avoid watering their lawns and gardens altogether.

As stated earlier, an outdoor water use reduction strategy is usually just one important element of a much broader municipal Water Efficiency Master Plan. It is not always easy to accurately quantify the effectiveness of an outdoor water use reduction program or to compare program results from one year to the next due to reasons such as:

Too much irrigation can cause lawns to grow beyond the limits of the soil.

- the natural variation in weather patterns from year to year,
- the decline in baseline residential demands resulting from new water efficiency standards contained in the Ontario Building Code,
- the increasing market penetration of water-efficient clothes washers, and
- because not all single-family homes are metered and even those homes that are metered typically only receive water bills every three months, etc.

Worksheet #5 provided in Appendix H can be used to help define the water efficiency goals of your municipality.

3.0 Water Use / Production Metering

There is a saying "if you can't measure it, you can't manage it". This is especially true concerning water treatment/distribution systems. Until recently water was considered by many to be simply too available and too innocuous to warrant any serious attempts to properly manage it. In the past, some water system managers might have been satisfied even though they were unable to account for 20 percent or more of the water their plants produced.

Detailed and accurate knowledge of how the total water system is operating is important for many aspects of operation, for example to accurately determine levels of non-revenue water within a system, but this is especially true in connection with managing peak summer water demands. While homeowners may only evaluate their water use when their water bill arrives (in many cases only every three months), it is more important for system operators to know what is happening in their system at all times.

Program monitoring and data collection should be ongoing.

Water system managers need to know how much water is produced each day and how much is sold to each of the various customer sectors. Before a program can be established to effectively reduce outdoor water use in a municipality, it is important to know how and where the majority of outdoor water is being used. Should a program target all single-family homes, new homes, old homes, homes on large lots, homes on small lots, homes with automatic irrigation systems, homes with high summer to winter water demand rations, large commercial properties, recreational parks, etc.? Without the appropriate data it is difficult to design an effective program.

The majority of outdoor water use within a municipality is attributed to the single-family sector, yet some municipalities don't accurately segregate between single-family, multi-family, and commercial billing accounts. Assessing the potential for reducing levels of outdoor water use within a municipality is much easier if the billing data accurately delineates between the various customer sectors.

The effectiveness of a municipal irrigation reduction strategy can often be determined by analyzing the difference between summer and winter water demands in the single-family customer sector (including detached, semi-detached, and row housing). For this type of analysis, however, it is necessary to have accurate population and water billing data. Simply analyzing average day water demands divided by total population does not account for potential changes in the industrial, commercial, or institutional customer base, and can misrepresent true savings.

4.0 Program Goals and Targets

Eliminating lawns and gardens altogether, or banning the use of all non-native, non-drought tolerant plants would be an effective way to reduce irrigation demands. However, these measures are not considered practical on a wide-scale basis because many homeowers have a mistaken image of what drought tolerant, water-efficient landscapes look like. Research recently completed in Ontario indicates that most homeowners currently view water-efficient lawns and gardens as dull, colourless, and uninviting. The intent of this manual is to review and evaluate only those measures that are considered practical and achievable in today's environment.

Rainfall is not evenly distributed throughout the summer. Peak water demands occur after extended dry periods.

There is a common perception, supported by many municipal advertising campaigns, that lawns should recieve 1-inch (25mm) of water each week including both irrigation and rainfall. An analysis of single-family home water billing data indicates that lawns actually require much less than this amount to remain healthy and alive. Turf care specialists claim that 1-inch of water per week should be enough to keep a lawn lush and green, while providing only about one-quarter of this amount will prevent a lawn from dying as long as it is not infested with disease or pests.

Although Ontario municipalities receive an average of approximately 19mm (¾ of an inch) of rainfall per week during the summer months, this rainfall is not evenly distributed throughout the summer. An analysis of historical precipitation data indicates that we receive about 80 percent of our summer rainfall in only five or six major events (further information is provided in Appendix A). In other words, we often experience periods of several weeks of hot weather with little or no rainfall during the summer. It is during these periods when irrigation demands are highest and peak water demands occur.

The goal of a municipal outdoor water use reduction program is to reduce the peak demands that occur after these extended periods of hot and dry weather. Examples of several outdoor water use reduction programs currently being implemented by various Ontario municipalities is provided in Appendix B.

An effective program should target those customers and customer sectors that are the primary contributors to peak water demands, such as, single-family homes (virtually all of which have front and back yards comprised of grass and sometimes small gardens) and commercial customers with large landscaped lots and automatic irrigation systems.

While the single-family home sector as a whole is the primary contributor to peak water demands, not all single-family homes irrigate in the same manner or to the same extent.

An analysis of Kitchener's single-family home water billing data indicates that only a small number of homes are responsible for a large percentage of the irrigation demands. About 10 percent of Kitchener's homes have daily summer water demands that are more than twice their demands during winter months. Many of the remaining 90 percent of these homes have relatively low summer water demands, indicating that they are irrigating less than would be expected. This result is supported by an analysis completed on Peel Region data that indicates that the average single-family home in the Region irrigates only about 8mm (1/3-inch) of water per week – much less than expected, even when rainfall is considered. Worksheets #1 and #2 provided in Appendix E can be used to help determine the average outdoor water demands in the single-family sector for other municipalities.

Demand reduction measures should be selected based on savings targets and available budgets.

For a municipal outdoor water use reduction program to be successful it must target those areas that offer the greatest potential for savings. While a comprehensive program should include messages such as: "position your sprinkler so water lands on lawns and gardens – avoid watering driveways and sidewalks", "use a broom rather than a hose to clean hard surfaces", "wash your automobile using a pail of water rather than a hose", etc., the greatest opportunity to reduce outdoor water use is related to curbing irrigation demands. While by-laws and public education and outreach measures apply to all customers in all customer sectors, measures that focus on individual customers, such as providing landscape audits, offering rebates for the installation of smart irrigation controllers, etc., are most effective if they target those customers that are most responsible for peak irrigation demands. Luckily, as identified above, only a relatively small percentage of customers practice excessive irrigation. Water billing information, if it is available, can be used to help identify those customers that have high summer to winter water demand ratios and it is these customers that are most likely have high irrigation demands. Customers that have significantly greater water demands in the summer present a greater opportunity for savings (i.e., you can't reduce the irrigation demands of customers that don't irrigate). Since the primary goal of an outdoor water use reduction program is to reduce peak demands rather than average summer day irrigation demands, the measures implemented by the municipality should target those customers that contribute to peak demands.

As such, a successful program will:

1. Focus on reducing the irrigation demands of the relatively large number of low water demand customers during times of peak demand, and
2. Focus on reducing the irrigation demands of the relatively small number of customers that have high water demand throughout the entire summer.

It is likely that the high water demand customers also have large lots and/or automatic irrigation systems. In many cases the majority of homes with automatic irrigation systems will be located in relatively affluent neighbourhoods. Customers that can readily afford to pay more for water may be less responsive to irrigation reduction measures such as conservation-based water rates or the offer of a free hose-end nozzle. Nevertheless, it is with customers that practice excessive irrigation that the greatest potential for reducing peak water demands exists.

Some customers contribute more to peak day demands than others.

For municipalities with metered single-family homes, these high demand customers can often be identified by analyzing water billing data. In un-metered municipalities these homes can be identified through visual inspection as the spray heads of automatic irrigation systems are generally visible along property boundaries.

While it is difficult to assess the water savings and cost-effectivenss associated with individual outdoor water use reduction measures, it is important that the overall program is cost-effective, i.e., it should cost less to achieve the water savings via implementing the municipal program than it would cost to provide the water through infrastructure expansion. As an example, if we use a unit cost of infrastructure expansion of $1 per litre per day of capacity, then a measure that results in a peak day savings of 100 litres per household would be “worth” $100 per household to the municipality, i.e., it would cost the municipality $100 per household to provide this water through infrastructure expansion. Using these values, any measure or program that achieved savings of 100 litres per household but cost less than $100 per household to implement would be considered cost-effective.

5.0 Peak Day Demands

Municipal water demands vary from season to season. Base (winter) water demands are closely aligned with changes in population and/or the industrial customer base and are often relatively constant from year to year. As such, base water demands can generally be predicted with some degree of accuracy even many years in advance. Peak (max) day demands, on the other hand, which are largely influenced by the weather, cannot be accurately predicted even weeks in advance. Because of this uncertainty municipalities tend to be cautious when designing new water treatment and distribution infrastructure and over-build water supply systems. As a consequence, water systems are under-utilized for much of the year (see Figure 1 on page 2) – especially during years with wet and cool summers.

While building larger water treatment and distribution infrastructure will help a municipality meet high peak day demands, over-building is not only wasteful but, as stated earlier, it can cost millions of extra dollars to the rate payers of the city or town.

Peak day demands can vary significantly from year to year depending on the weather.

Currently, many elements of water treatment and supply systems in Ontario are designed based on the municipality's peaking factor or peak day ratio, which is the ratio of the highest daily water demand experienced during the year divided by the average annual day demand (AADD). Where actual demand data are not available systems are designed using population-based peaking factors identified by the Ontario Ministry of Environment. Since both peak day demands and average annual day demands change from year to year, so does the annual peak day ratio of a municipality. Reducing peak irrigation demands will reduce the peak day ratio and, therefore, the size requirements of many elements in a water supply system, potentially saving millions of dollars. The most efficient system would be one where demands were constant from day to day and from season to season, however, this is not the case in Ontario.

At least one Ontario municipality, the Region of Waterloo, uses the peak week ratio instead of the peak day ratio to evaluate its system's needs. The peak week demand is the average daily demand during the seven day period with the highest demands during the year. Because of the effect of averaging, the peak week demand value for a system will be lower than the peak day demand value, meaning that many aspects of the water supply system can be designed to be smaller and less expensive.

Designing elements of water treatment and distribution systems based on peak week vs. peak day demands may be something for other municipalities to consider when they expand their system.

Because peak day demands can vary significantly from year to year depending upon changes in the weather, a better indicator of true irrigation demands is a comparison between average summer day demands (Jun., Jul., Aug.) and average base (winter) demands (Nov., Dec., Jan., Feb.). The following table helps to illustrate this approach.

Table 1 – Demand Ratios in Ontario Municipalities 2005 - 07

	Lowest Ratio	Highest Ratio	Difference
Municipality A (population 115,000)			
Peak Day / AADD:	1.20	1.29	0.09
Average Summer / Base Demands:	1.07	1.12	0.05
Municipality B (population 480,000)			
Peak Day / AADD ratio range:	1.26	1.34	0.08
Average Summer / Base Demands:	1.12	1.15	0.03
Municipality C (population 580,000)			
Peak Day / AADD ratio range:	1.36	1.55	0.19
Average Summer / Base Demands:	1.18	1.32	0.14
Municipality D (population 1,150,000)			
Peak Day / AADD ratio range:	1.40	1.56	0.16
Average Summer / Base Demands:	1.30	1.41	0.11

Note: Table 1 includes information from large to medium-sized Ontario municipalities. Similar information from smaller municipalities was unavailable at the time or writing.

In all cases, there is less variation in average summer to base demand ratios. The summer to base demand ratio also provides a much clearer picture of how much irrigation occurred during the summer (rather than how much irrigation occurred on one specific peak day). For example, a summer to base demand ratio of 1.30 means that average daily demands during the summer were 30 percent greater than winter demands. Since, as we have said earlier, winter demands are relatively stable, this ratio provides a good indication of the overall irrigation demands (and summer weather patterns) of a municipality for a given year.

Reducing peak water demands can eliminate or defer need for infrastructure expansion AND it is good for the environment.

Over-building water supply infrastructure can be expensive and wasteful. Reducing the peak water demands caused by high levels of irrigation can help reduce the need for infrastructure expansion – saving money and protecting the environment. Not only will reducing water demands result in less water withdrawn from lakes, rivers, and aquifers, it has also been estimated that approximately 0.8 kg less of greenhouse gas will be

discharged into the environment for every 1.0 m^3 of water savings (based on an energy demand of about 1 kWh to treat and pump 1.0 m^3 of municipal water and a savings of about 0.8 kg of CO_2 per 1 kWh of energy savings[2]). An outdoor water use reduction program that reduces average irrigation demands by 100 litres per household per day during the summer could save approximately 7.4 kg of CO_2 per household each year.

The following section discusses how reducing peak irrigation demands will affect municipal water revenues.

[2] http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html

6.0 Effects on Revenues

As stated earlier, water supply systems must be sized to meet peak demands even though these demands may occur for only a few days each year. But, while the costs associated with building infrastructure can be significant, peak day demands actually provide very little revenue to a municipality. A multi-year analysis completed on water production data for Peel Region and Waterloo Region identified that the additional water use on high water demand days (i.e., days where demands exceeded the average summer demand by more than two-thirds the difference between the peak day demand and the average summer demand) accounts for less than one percent of total annual water production. Therefore, reducing peak day demands, even in municipalities that bill on a strictly volumetric basis, will have very little effect on revenues.

In fact, even in a municipality where average summer day demands are 30 percent greater than winter day demands, the total outdoor water use would account for only about 10 percent of the total annual water production (e.g., 8 winter months x 100% + 4 summer months x 130% ÷ 12 months = 110%). In reality, summer water demands, and therefore total revenues, vary from year to year depending upon weather patterns. Revenues related specifically to peak demands, however, will always be much lower than revenues related to total outdoor water use.

The unit cost of implementing water efficiency should be less than the unit cost of infrastructure expansion.

Municipalities that have some level of flat or base monthly rate included in their billing would experience even less impact on revenues than a strictly volumetrically-based system. Of course, an outdoor water use reduction program that results in lowering average summer demands but does not reduce peak demands would actually lower revenues while not reducing the strain on the system caused by peak demands or, potentially, the need for infrastructure expansion. For this reason, outdoor water use reduction programs should focus on reducing peak demands rather than average summer demands.

While reducing peak summer irrigation demands will have a minimal effect on revenues, it can have a significant effect on the cost of infrastructure expansion. For example, based on a unit cost of water supply infrastructure expansion of $1 per litre per day (i.e., to expand a system's capacity by 1,000,000 litres per day would cost about $1 million), a municipality growing by 10,000 new homes that is able to reduce peak day demands by 200 litres per household could potentially save about $2 million in expansion costs – even if their overall summer water demand remains constant.

7.0 Choosing the Right Measures

The previous sections discussed peak water demands (what they are, why they occur, and how peak demands affect infrastructure requirements), customer sectors and how they contribute to peak demands, and how reducing peak demands will affect revenues. This section discusses how outdoor water use reduction measures are effective at targeting appropriate customer sectors and reducing peak demands. As stated earlier, a comprehensive program should include broad-based measures such as watering by-laws and public outreach and education programs, as well as measures that specifically target customers that practice inefficient or excessive irrigation. Since there is little potential to achieve water savings from customers that practice little or no irrigation, the most effective measures should target the two types of customers, defined as follows, that are the most responsible for high peak day demands.

To maximize effectiveness, programs should target the relatively few high-use customers.

- High Summer Use Customers: These customers have high summer to winter water demand ratios and they tend to use high volumes of water on a relatively constant basis throughout the summer regardless of weather patterns. High summer use customers typically include commercial customers and single-family homes with automatic irrigation systems controlled by timers that operate the system every day or two for a preset period of time regardless of the weather.
- Low Summer Use Customers: These customers do not have high summer to winter water demand ratios. They typically have low irrigation demands throughout the summer and are more likely to irrigate their lawns and gardens, if at all, only after an extended period of hot and dry weather, thereby contributing to peak summer demands.

This section will evaluate irrigation reduction measures typically used by Ontario (and North American) municipalities to reduce peak day water demands

Customers may be more receptive to positive language. The word 'restriction' may have negative connotations.

There are two broad types of measures used by municipalities to reduce irrigation demands – controlling measures and rewarding measures – both types of measures are considered effective. By-laws, including watering restrictions and watering bans, are controlling measures that constrain the homeowners' opportunity to irrigate. The Region of Waterloo has stopped using the somewhat negative term 'water restriction' and now uses the more positive term 'water conservation' in their literature. Education,

outreach, promotion, and marketing efforts are considered rewarding measures that try to affect some level of behavioural modification by persuading the homeowner to change and improve their current irrigation practices.

Research has shown that the measures typically utilized by utilities/municipalities to help reduce peak demands include:

- by-laws (including watering restrictions and bans),
- conservation water rates,
- education, outreach, promotion, and marketing measures:
    - community-based social marketing,
    - residential landscape audits,
    - rain barrels,
    - rainwater harvesting,
    - greywater reuse,
    - rain gauges,
    - hose timers,
    - water-efficient demonstration gardens,
    - automatic irrigation systems,
    - “smart” controllers, and
    - incentives and rebates.

The following section describes these measures in more detail.

7.1 By-laws

7.1.1 Odd/Even Watering Restrictions

This type of watering restriction is very common among Ontario municipalities, though they are typically not enforced through the use of fines or other penalties.

Odd/even watering restrictions typically allow homes with even-numbered addresses to water on even-numbered days of the month and homes with odd-numbered addresses to water only on odd-numbered days of the month.

There is a growing movement away from odd/even restrictions and to one-day-per-week restrictions.

Although odd/even restrictions are relatively easy to explain to homeowners, there is some question as to their suitability in the Ontario climate, i.e., it is not necessary for homeowners to water their lawn every second day. In fact, the widely held belief is that watering deeply only once or twice a week is far better for the health of your lawn than frequent shallow watering, as deep watering promotes deep root growth.

The theory behind odd/even watering restrictions is that they allow no more than half of the municipality to water their lawns on any specific day. There are, however, very little data that verify how effective odd/even watering restrictions are at reducing irrigation demands. In fact, many people involved in water efficiency or landscape irrigation believe that odd/even watering restrictions actually promote *over-watering* by reminding people to water on their designated day (comments from individuals on the effectiveness of odd/even watering restrictions are provided in Appendix C). The trend in Canada and the U.S.A. is a movement away from odd/even watering restrictions to some form of one-day-per week restriction.

High Summer Use Customers: Odd/even watering restrictions are unlikely to significantly reduce the irrigation demands of high water users. As stated earlier, most high water users would be expected to have large lots and automatic irrigation systems. Though many automatic irrigation systems are programmed to operate every night, irrigation schedules can be easily adjusted to allow the system to apply twice as much water every second night. Systems that are currently scheduled to operate every second night (or less frequently) would not be affected at all by an odd/even restriction. Because these systems normally operate during the night (typically between 2:00 and 4:00 a.m.) it may be more difficult to witness infractions and enforce the restriction unless there is strict by-law enforcement (including night patrols or call-in hotlines).

Low Summer Use Customers: Odd/even watering restrictions are unlikely to significantly reduce the irrigation demands of the typical single-family home because odd/even restrictions do not target peak day demands. Many municipalities combine time-of-day restrictions with odd/even restrictions to further limit opportunities when a homeowner can apply

irrigation, however, a typical garden hose can provide over 4,500 litres of water in just 3 hours based on a flow rate of 25 litres per minute – or enough water to cover 178 m^2 of lawn to a depth of 1-inch (25.4 mm).

7.1.2 One-Day-Per-Week Watering Restrictions

Healthy lawns only need watering once or twice each week.

These types of restrictions allow homeowners to water their lawns and gardens only on one or two specific days of the week. For example, in one municipality a particular homeowner may only be allowed to irrigate on Mondays, while in another municipality they may be allowed to irrigate on both Mondays and Thursdays. As illustrated in the previous section, watering only once or twice per week provides ample opportunity for most homeowners to apply adequate water to their landscape.

In some cases homeowners are allowed to water on one specific weekday plus one day on the weekend. Since many landscape experts agree that healthy lawns should only be watered once or twice a week, allowing homeowners to irrigate only once or twice each week seems like a practical approach. Problems can occur, however, if it is not convenient for a homeowner to water on their assigned day. For example, a homeowner that typically leaves town for the weekend each Thursday may not be pleased if their assigned watering day is Friday. The Region of Waterloo allows a limited number of property owners to change their assigned lawn watering day for a fee, however, this complicates monitoring and enforcing the restriction. Mathematically, one-day-per-week watering restrictions ensure that no more than 1/7 (about 14 percent) of homeowners are irrigating on any specific day. In the case of Waterloo Region, no more than 1/5 (20 percent) of homeowners are allowed to irrigate their lawns on any specific weekday, and no lawn irrigation is allowed on weekends.

The Region of Waterloo switched to a one-day-per-week watering restriction from an odd/even restriction in 2005 and reports a reduction in peak demands of between 8 and 12 percent when compared with other years of similar weather.

<u>High Summer Use Customers</u>: One-day-per-week watering restrictions may effectively reduce the irrigation demands of high water users. As stated earlier, many automatic irrigation systems are often programmed to operate every night or every second night. Restricting automatic irrigation to just one or two times each week should reduce overall demands.

<u>Low Summer Use Customers</u>: One-day-per-week watering restrictions may be effective at reducing the irrigation demands of the typical single-family home during peak demand times. Although, as stated earlier, a typical yard may only require three hours or so of irrigation each week, this type of restriction would only allow about 14 percent of homeowners to irrigate on any specific day based on a 7-day schedule, and about 20

percent of homeowners to irrigate based on a 5-day (Monday to Friday) schedule. In some cases customers are restricted from irrigating on the weekend (e.g., to allow reservoir recharge) while in other cases all customers are allowed to irrigate on weekends. Some examples of how to set up a day-of-the-week schedule are: homes can water only on the same day their garbage is collected, homes with addresses ending in 1 or 2 can water on Monday, ending with 3 or 4 on Tuesday, 5 and 6 on Wednesday, etc. Or you could assign watering days to certain areas of the municipality or to entire subdivisions.

7.1.3 Time-of-day Watering Restrictions

Avoid irrigating during the hottest time of the day.

Time-of-day watering restrictions can be combined with odd/even day or day-of-the-week watering restrictions. They can be used to ensure peak hour demand does not exceed the system capacity or to prevent people from watering during the hottest time of the day when a significant portion of the water applied to lawns and gardens will simply evaporate.

Generally, time-of-day restrictions limit outdoor water to early morning or evening hours. For example, a program may only allow watering between 6:00 – 9:00 a.m. or 6:00 – 9:00 p.m.

High Summer Use Customers: Automatic irrigation systems, which are typically programmed to operate during the night, are often exempt from complying with time-of-day restrictions. Also, many automatic irrigation systems are programmed to operate for only two hours during each 24-hour period (less than typically allowed by time-of-day restrictions). Water savings may be achieved in areas where automatic systems are required to comply with time-of-day restrictions, especially if time-of-day restrictions are combined with one-day-per-week restrictions. These types of programs should be supported by by-law enforcement, including night patrols.

Low Summer Use Customers: Time-of-day watering restrictions, by themselves, will be more effective at reducing irrigation demands of homes with larger properties, i.e., properties that require several hours to achieve a proper depth of irrigation. Many time-of-day restrictions allow watering for three hours in the morning and three hours in the evening. A garden hose flowing at 25 litres per minute can apply 9,000 litres of water in six hours, enough to cover a 354 m^2 lawn with 1-inch of water. To put this into perspective, a 12m x 38m (40ft x 125ft) residential lot would typically have about 180 m^2 of lawn and garden (about 40 percent of the total lot area).

Time-of-day restrictions will be less effective at reducing the irrigation demands of smaller properties because they provide the homeowner more than enough time to apply sufficient irrigation.

7.1.4 Watering Bans

Customers are likely to be more supportive if they perceive a real need for watering restrictions.

Watering bans are typically only implemented after extended periods of hot and dry weather when irrigation demands are the greatest. The OWWA *Water Efficiency Best Management Practices* manual (September 2005) states that, while watering bans are often successful in dealing with short-term problems, they do not appear to bring about a long-term reduction in water usage. Watering bans are only effective if customers are aware of the ban and comply with the ban requirements. People are more likely to comply with a ban if they believe there is a valid reason to reduce water demands. It is important, therefore, that watering bans are supported with a significant level of public education and outreach. The messaging should explain exactly why the watering ban is being implemented and under what conditions the ban will be strengthened or lifted.

Some watering bans also include restrictions on water wastage. Examples of water wastage include: using an unattended hose that is not fitted with an automatic shut off device, having leaking, broken, or improperly maintained hoses, sprinklers, or irrigation systems, irrigating in a manner that causes excess water to be directed (either sprayed directly on or via runoff) onto driveways, sidewalks, or streets, using a hose to wash or rinse driveways, sidewalks, patios, parking areas, tennis courts, etc.

An example of a three-tier ban is illustrated as follows:

Multi-stage watering bans have different requirements based on the need to reduce demands.

<u>Level 1 – Normal Weather Conditions</u>

- No water wastage
- Day-of-the-week and time restrictions on landscape irrigation
- Watering by hand allowed on all days at any time
- No restrictions on watering trees, shrubs, flowers, gardens, new lawns, etc.

<u>Level 2 – Modest Drought</u>

- No water wastage
- Day-of-the-week and time restrictions on landscape irrigation
- Watering by hand allowed on all days at any time
- No restrictions on watering trees, shrubs, flowers, gardens, new lawns, etc.
- Municipality increases public awareness programs via newspaper ads, radio spots, portable signage, etc.
- Municipality increases level of enforcement. More street patrolling, more warnings issued.

Level 3 – Severe Drought

Water wastage is never acceptable.

- No water wastage
- Day-of-the-week and time restrictions on all irrigation, including watering by hand
- No washing of automobiles
- No swimming pool filling
- Exemptions only for watering new lawns and trees
- Municipality further increases public awareness programs via newspaper ads, radio spots, portable signage, etc., and advertises that fines will be levied for non-compliance
- Municipality further increases level of enforcement. More street patrolling, more warnings issued, fines levied.

Many municipalities implement different levels of watering bans depending on how severe the drought becomes. For example, the City of Guelph's *Outside Water Use Program* has three levels of watering ban that affect residential water use and a fourth level that primarily affects commercial water use. Guelph's level of ban is triggered by low levels in the City's water storage reservoirs and by the Ontario Low Water Response[3].

One advantage of a staged watering ban is that there is always some level of ban in place, i.e., customers are always reminded to irrigate sparingly. Watering bans may be more effective if homeowners are educated as to why different levels of watering bans have been established and what types of weather conditions are required to move the ban to the next level.

High Summer Use Customers: Watering bans may significantly reduce the irrigation demands of high water users as long as the ban is enforced. Enforcement is made more difficult as most automatic irrigation systems are programmed to operate during the middle of the night.

Low Summer Use Customers: Watering bans may significantly reduce the peak day irrigation demands of all single-family homes by preventing customers from watering. Since most manual irrigation takes place during the evening there is no need for night patrols, though the use of call-in hotlines may facilitate enforcement of the ban.

[3] http://www.mnr.gov.on.ca/en/Business/Water/Publication/MNR_E002322P.html

7.1.5 By-law Control and Enforcement

Many municipalities have developed by-laws to help control outdoor water use. In many cases, however, these bylaws are only casually enforced or not enforced at all. Homeowners may be less likely to adhere to a voluntary watering ban than a mandatory ban that includes the possibility of being fined but, in most municipalities, homeowners and businesses that are "caught" watering their lawns or gardens during restricted times are simply reminded of their appropriate irrigation schedule or, in severe cases, simply given a warning. Few municipalities actually issue fines to customers that ignore the by-law.

By-law enforcement is seen by many as a requirement for program success.

There are issues to consider when establishing a by-law fine. For example, a fine that is set too low may have a negligible effect on enforcing the by-law, whereas a fine that is set too high may be viewed as overly punitive, thereby making it difficult to enforce. As an example, the Region of Waterloo issues fines of $150 per offense to customers that fail to comply with the Region's conservation watering schedule.

Developing a lawn watering by-law is relatively easy to do; enforcing it may be more difficult. Some municipalities rely on by-law enforcement officers, while others hire summer students to 'patrol' the streets. While students don't typically issue fines, they often approach the contravening homeowner to remind them of the by-law and explain why it is in place. Students can record the addresses of homes that repeatedly disregard the by-law and provide this information to by-law control officers that can issue fines. As well as having student patrols, many municipalities have call-in hotlines to enable people to report on neighbours that irrigate on restricted days.

High Summer Use Customers: Many people believe that by-law enforcement is one of the most critical aspects to the success of any watering restriction or watering ban.

Low Summer Use Customers: Many people believe that by-law enforcement is one of the most critical aspects to the success of any watering restriction or watering ban.

7.1.6 Conservation-based Water Rates

For conservation-based water rates to be effective it is essential that the customer is metered and paying for the volume of water they use. A conservation-based rate structure is a pricing system that essentially provides a financial incentive to homeowners that reduce their water demands or, conversely, provides financial penalties to those homeowners that use excessive amounts of water. In general terms, higher volumetric water rates are considered to be more conservation-oriented than lower rates, i.e., consumers will use less of a product as the price increases. As such, conservation-based rates generally entail either:

- Increasing block rates, where the unit cost of water increases as demand increases; or
- Seasonal pricing, in which water consumed in the peak demand season (summer) is charged a higher rate than in the off-peak season.

Conservation pricing and rate design can be effective in achieving a number of different conservation objectives such as: reducing peak demand, reducing water demand during drought periods, and inducing conservation from targeted customer classes. Increasing block rates help ensure sufficient revenue generation even with reduced summer water demands. They have the added appeal of being based in economic principles and market theory[4].

The economic principle predicts that consumption will fall as the price increases.

Compared to other water management measures, costs to implement conservation water rates can be relatively low, and conservation pricing has the added benefit of being one of the few conservation strategies that does not necessarily lead to reductions in utility revenue (water loss reduction programs also save water without reducing revenues). It is important, however, that the rate structure used is both equitable to all customer sectors and able to provide adequate revenues to operate the utility in a fiscally sound manner - water rates should be designed to recover the full costs associated with providing the service.

It is expected that conservation-based water rates would have a greater impact if water bills were issued on a more frequent basis. Many residential customers receive only four water bills each year, i.e., they may not receive the bill for their August water demands until November. What's more, under a quarterly billing system the impact of periodic high water demands is lessened. For instance, homeowners that double their water demand for a full 2-week period would only see an increase in their water bill of about 15 percent. It is believed that the effect of any type of conservation-based rate structure would be more pronounced if the billing

[4] http://www.awwarf.org/research/topicsandprojects/execSum/902.aspx

cycle was more frequent and the financial impact to the homeowner was more immediate.

Some rate structures offer little or no incentive for the customer to practice water efficiency:

- *Fixed or flat rate* – customers are generally not metered and do not pay based on the volume of water used. Consumers pay the same fixed amount each billing period, regardless of how much water is actually consumed. This type of rate structure not only offers no incentive to the customer to reduce demands but it results in water-efficient customers actually subsidizing water-wasting customers.
- *Rates with meter charge included* – the consumer pays a base fee plus a volumetric fee each billing period. For example, a consumer that uses 40 m^3 per month may pay $20 per month base fee (based on the customer meter size) plus $0.50 per m^3 used for a total bill of $40.00. Although the "effective rate" (which is determined by dividing the total cost of water bill by the volume of water used) paid by the consumer appears to be $1.00 per m^3 (i.e., $40.00 ÷ 40 m^3), if the consumer reduces their water demands by 50 percent their bill would only be reduced by $10.00 (i.e., 20 m^3 reduction x $0.50 per m^3) – meaning that their "effective rate" is now $1.50 per m^3. While meter charges are typically used by utilities to help ensure that sufficient revenues are generated, this type of rate structure actually provides the same disincentive to the consumer as declining block rates because the "effective rate" in both rate structures declines as demand increases.

Some rates actually promote excess water use; others do little to discourage excess water use.

- *Minimum Charge Rates* – similar to a rate with a meter charge included but instead of paying a preset meter charge the customer pays a minimum flat rate for a preset volume of water (typically a volume that would be expected to meet the indoor water requirements of the customer) per billing period and then pays based on a unit rate for all demands in excess of this volume according to the designed rate structure. This type of rate is sometimes called an *Allocation or Excess-Use rate* because it allows a customer to use a certain volume of water at a relatively low cost, then charges a much higher fee for demands that exceed this volume. Like the meter charge rate, this type of rate structure also ensures a certain minimum revenue will be generated by water sales since all customers must pay the minimum fee. This type of rate structure may not be suitable if a municipal program also targets indoor water demands because there would be no financial incentive for the homeowner to reduce indoor water demands, but if the volumetric-based rate portion (i.e., water demands in excess of the minimum allotment) increases as demands increases this type of structure may be effective at reducing irrigation demands.

- *Declining block rates* - the consumer pays less per unit of water as more water is consumed. The rationale behind this type of rate structure is the highest cost to the utility is related to supplying the customer with their first unit of water (i.e., water treatment and distribution infrastructure is required regardless of how much water is provided) and, because it is less costly for the utility to provide subsequent units of water to the customer, the price per unit decreases. Low demand residential customers are typically charged the higher rate while high demand commercial and industrial customers are charged a lower rate. This type of rate is often adopted as a way to bring high-water using industries to an area for economic gain. The use of declining block rates could be viewed as *promoting* irrigation (i.e., the consumer would pay a lower rate for water used for irrigation than for water used indoors) and other discretionary uses. Declining block rates are the worst type of rate structure to use when developing an irrigation reduction program.

Conservation-based rates offer disincentives to customers with high water demands.

- *Uniform (constant) block rates* – the consumer pays the same unit rate regardless of how much water is consumed. Although a consumer will be charged for water in accordance with the volume they use, there is no additional incentive to use less water, because the customer will pay the same rate for water used for irrigation as for water used to flush toilets. Uniform rates are considered to offer only a limited incentive to the homeowner to reduce irrigation demands.

Given the importance of reducing discretionary water use (e.g., irrigation) it is somewhat surprising that a 2001 study of rate structures by Environment Canada showed that in 1999, 43 percent of the Canadian population served by municipal water was under a *flat rate* structure, 12 percent were under a *declining block rate* structure, and 36 percent were under a *constant rate* structure. The study showed that only 9 percent of customers were billed using a conservation-based *increasing block rate* structure[5].

Conservation-based rates provide a direct incentive to the consumer to save water. Several types of rate structures promote reduced demand.

- *Inclining block rates* – the consumer pays a higher unit rate as consumption increases through predetermined volume blocks. The rationale for this type of rate structure is that customers actually need a certain volume of water each day to maintain life and health, whereas water used for irrigation, car washing, pool filling, etc., is

[5] http://www.environnement-canada.ca/water/en/info/pubs/FS/e_FSA6.htm

considered discretionary and not required for life and health. As such, inclining block rates charge the consumer a lower rate for water needed for life and health and higher rates for water used for discretionary demands. Inclining block rates are considered to be effective conservation-based rates because they target irrigation demands.

Conservation-based rate structures should not penalize commercial customers with high non-irrigation demands.

- *Combining water and sewer charges* – many municipalities combine water and sewer charges on the customer bill. While residential customers are typically charged for both water and sewer based on their water demand (even though water used outdoors is not directed to the sanitary sewer), industrial customers that can prove a large portion of their water demand is not discharged to the sanitary sewer (e.g., beverage producers, facilities with large evaporative losses, etc.) are sometimes exempt from paying the full sewer surcharge. By combining water and sewer charges the effective rate the consumer pays for water is much higher than if they were to pay for water separately, thereby adding an extra incentive to reduce water demands.
- *Seasonal rates* – the customer pays a higher unit price for water used during the summer months when irrigation occurs than during the winter months. It is important that the seasonal rate includes an allowance for indoor water use or it could be seen as punitive to most homeowners, especially homeowners that practice little or no irrigation. Care must be taken to ensure that these types of rates do not negatively impact high water use customers that do not contribute to irrigation demands. Seasonal water rates that include a base allowance for indoor water demands and focus only on residential customers would be considered to be effective conservation-based rates because they target irrigation demands.

Conservation-based rate structures will have the greatest impact on residential customers with high irrigation demands; unfortunately, these customers tend to be some of the more affluent residents in a community (large homes and lots, automatic irrigation systems). As such, there are some questions regarding the extent that prices affect irrigation demands. Several statistical studies suggest that water use, especially indoor water use, is not substantially affected by small changes in price. Several explanations for this inelasticity[6] include:

[6] The demand for a good is considered to be relatively inelastic when the quantity demanded does not change much with a price change. Goods and services for which no substitutes exist are generally inelastic.

- Potable water has no close substitutes to which the consumer can switch.
- Water bills generally account for a small portion of a household's total utility expenditures.
- Water prices have historically been sufficiently low to undermine any incentive consumers might have to monitor and alter water use in response to price changes[7].

Higher water rates are expected to have less impact on indoor, non-discretionary demands, such as toilet flushing.

It is expected that an increase in price would have a greater effect on discretionary uses, such as irrigation. Studies in the U.S. show that conservation-oriented rate structures, when implemented in conjunction with an active water conservation program, may reduce water use[8]. One study in California, where a homeowner's annual irrigation demands often exceed their annual indoor water demands, found that doubling the water rate resulted in a 10-15 percent reduction in the water demands of high-use customers[9]. The savings resulting from a similar increase in rates may be slightly less in Ontario where irrigation demands account for only about 10 percent of the annual single-family household water budget (about $40-$50 per year). Smaller rate increases would be expected to achieve less savings.

Worksheet #3 provided in Appendix F can be used to help define your current billing structure.

High Summer Use Customers: Conservation-based rate structures will have the greatest impact on the water bills of high water use customers, however, these customers are often among the most affluent in a community and most able to afford the higher rates. The effectiveness of this measure is expected to be somewhat less in Ontario than the 10-15 percent savings achieved in the California study by doubling the unit rate.

Low Summer Use Customers: Conservation rate structures would be expected to increase the annual water bill of the typical single-family residential customer by no more than $40 to $50 per year. Based on the principle that people use less of a commodity if they have to pay more for it, it is expected that conservation-based rates would reduce irrigation demands in this customer sector. Some consumer studies indicate, however, that consumption patterns may begin to rise again as "sticker shock" wears off and people become accustomed to paying higher prices. The effectiveness of this measure is expected to be somewhat less in Ontario than the 10-15 percent savings achieved in the California study by doubling the unit rate.

[7] *Conservation rates in the real world.* Thomas Chesnutt & Janice Beecher, AWWA Journal, Feb. 1998.
[8] http://www.glc.org/wateruse/conservation/pdf/FinalDraftConBrief.pdf
[9] http://www.agecon.ucdavis.edu/extension/update/articles/v10n3_3.pdf

7.2 Public Education and Outreach

7.2.1 Community-Based Social Marketing & Public Education

Maximize the cost-effectiveness of CBSM programs by targeting customers with wasteful or excessive irrigation demands.

Education, outreach, and Community-Based Social Marketing (CBSM) programs usually form at least a part of any water demand management program. CBSM programs try to achieve behavioral change at the community level. These programs focus on removing barriers that prevent people from adopting certain behaviors while simultaneously enhancing the benefits of those behaviors. CBSM programs are developed by first considering the customer's point of view, and then trying to change as many potential barriers as possible into customer benefits. Several Ontario municipalities, including Toronto, Durham Region, Halton Region, York Region, and more, have utilized CBSM principles to affect customer water demands but there are very few scientific studies that have quantified the effectiveness of outreach and education strategies for landscape water conservation. The OWWA *Water Efficiency Best Management Practices* M*anual*, September 2005, states that the actual or potential water savings associated with the implementation of CBSM programs are not well known. There are several reasons for this lack of information, including:

- Outreach and education programs are typically only a part of a more comprehensive municipal conservation or efficiency program making it difficult to isolate savings specifically related to outreach, education, or CBSM.
- Studies have shown that there is an overall lack of information available regarding the implementation of "non-price" conservation programs and a lack of detail and consistency of information necessary to evaluate changes in demand[10].

A joint Canada Mortgage and Housing Corporation and Canada Water and Wastewater Association-sponsored study was conducted in 2000 to try to quantify the peak day irrigation savings achieved by single-family homes through the implementation of CBSM programs. The study was completed in the Regions of Durham, Halton, and York. The study involved selecting two neighbourhoods in each Region – one served as a Study Area and the other as a Control Area. Each area included between 300 - 500 single-family homes, none of which had automatic irrigation systems. The program involved providing homeowners in the Study Areas with information on how to properly irrigate lawns and gardens, rain gauges, fridge magnets containing irrigation tips, informative brochures, and hose washers. Homes in the Control Area received nothing. The water

[10] Renwick and Green, 2000; Michelsen et al., 1998a

demands of each area were monitored during the implementation of the CBSM programs.

The study concluded that CBSM programs were able to reduce irrigation demands on high demand days by approximately 220 litres per household per day. It should be remembered that high demand days may only occur for a few days or weeks during the summer. For example, a savings of 220 litres per household per day on high demand days may only equate to a savings of 10-15 litres per household per day when averaged over the entire summer. A hose bibb sub-metering study completed by the City of Toronto (*Water Efficient Landscape Visits and Residential Outdoor Water Saving Program Services*) supports this result – the average irrigation savings achieved by the Study Area homes was approximately 11 litres per day. The volume of water saved during high demand days was not evaluated as part of the Toronto hose bibb metering study.

Programs should target the high irrigation demands that occur after extended hot and dry weather.

Appendix D contains more detailed information regarding CBSM programs, including examples of CBSM programs, identifying potential barriers, outlining the steps involved in developing social marketing programs, results of market research studies, and an evaluation of the cost-effectiveness of CBSM programs.

High Summer Use Customers: The study completed in the Regions of Durham, Halton, and York suggests that peak day savings of 200 litres per home per day may be possible in the single-family sector. As such, a well designed and implemented CBSM program targeting high water use customers (e.g., customers with automatic irrigation systems) would be expected to save even a greater volume of water. The potential level of savings would be expected to be somewhat dependent on the level of program implemented and the weather conditions under which it is conducted. To improve the cost-effectiveness of implementing CBSM measures, programs should focus on customers with high summer water demands. Meeting with customers that practice little or no irrigation or that simply love gardening and enjoy talking about their landscapes may result in very little water savings.

Low Summer Use Customers: The study completed in Durham, Halton, and York Regions suggests that peak day savings of approximately 220 litres per home per day can be achieved in the single-family customer sector. As stated earlier, billing data from the City of Kitchener suggests that a small percentage of homeowners are responsible for a large percentage of irrigation demands (Pareto's Rule[11]). To improve the cost-effectiveness of implementing CBSM measures, programs should focus on customers with high summer water demands.

[11] Also known as the 80/20 rule, Pareto's Rule states that 80 percent of the consequences will come from 20 percent of the causes.

The following sub-sections discuss the effectiveness of some of the measures often included in public education and outreach programs, as well as community-based social marketing program.

7.2.2 Residential Landscape Water Audits

To aid residents in establishing their own water efficient landscapes several of the larger Ontario municipalities, including the City of Toronto and the Regions of Halton, Peel, and York are offering free outdoor residential landscaping audits (also called landscape visits or consultations).

Most programs encourage homeowners to register on-line to receive a free landscape audit. As part of the audit a trained landscape advisor visits a customer's home, inspects their lawn and garden, and provides advice on how to reduce the water demands of their landscape. The visit is generally personalized to the customer's individual landscape needs, e.g., the resident can ask for general advice or solutions to specific problems they may be experiencing with their lawn and garden. Residents participating in the program often receive a water-wise gardening kit that may include plant lists, gardening fact sheets, a rain gauge, plant seeds, discount coupons from participating garden centres, and more.

Free landscape audits should only be offered to customers that practice excessive irrigation.

At least one municipality – Peel Region – is considering changing the focus of their residential landscape water audit program to target only high-use customers – specifically homes with automatic irrigation systems.

<u>High Summer Use Customers</u>: Most high summer use customers are expected to have automatic irrigation systems. The watering schedules of these systems should be adjusted periodically throughout the summer to reflect changing irrigation requirements. Systems with simple timers need to be adjusted manually, while systems with smart controllers (see Section 6.2.10) will vary the application rate based on landscape requirements. In many cases, customers with timer-controlled systems do not properly adjust the application schedule of their systems and the default schedule often applies far more water than is required by the landscape. Default schedules often operate the system from 2:00 a.m. until 4:00 a.m. each night. An irrigation audit that includes properly adjusting the application schedule of timer-controlled automatic irrigation systems could potentially significantly reduce irrigation demands.

Low Summer Use Customers: Recent research indicates that the average Ontario homeowner irrigates only 8mm (about 1/3-inch) each week, including rainfall, far less than the general recommendation of 1-inch per week. Completing residential landscape audits of homes that practice little or no irrigation will result in little or no savings. While general public education and outreach programs should advance the message of selecting drought-resistant plants and irrigating only when necessary to all customers, residential landscape audit programs should focus on those customers that offer the greatest potential for water savings, such as customers that have high irrigation demands. In many cases, municipal programs require the customer to apply or register for a landscape audit. Programs may be more effective if free landscape audits were only offered to customers with high irrigation demands.

7.2.3 Rain Barrels

Because of their relatively small size, rain barrels are typically used for watering plants rather than irrigating landscapes.

Many Ontario municipalities promote the use of or offer rebates towards the purchase of rain barrels. Rain barrels, which typically hold between 100 to 500 litres of water, are connected to a home's downspouts to collect water during rain events that can later be used to water plants. Rain barrels are not typically used for irrigating lawns as they don't hold enough water. For example, a 500-litre rain barrel (one of the largest barrels commonly available) will only hold enough water to apply 1-inch (25mm) of water to a landscape of less than 25 m^2 (270 ft^2). What's more, very few rain barrels are equipped with pumps to enable them to be used with lawn sprinklers. Water collected in rain barrels is typically used to water flowers and potted plants. Many publications state that plants thrive better when they are watered using rainwater rather than municipally-treated water.

Unfortunately, the rainfall we receive each summer in Ontario is not evenly distributed throughout the summer. The Toronto airport received an average of 182mm of rain each summer between the years 2000 and 2007. Approximately 83 percent of the rain (150mm) fell in an average of just 5.8 major rainfall events each summer, for an average of 26mm per each major event. About 2,600 litres of water would fall on a roof area of 100m^2 during a 26mm rainfall event – a volume that might be captured by a large underground cistern but far more than could be captured by most rain barrel installations.

Some municipalities offer rain barrels to homeowners as an incentive to disconnect their downspouts from draining into the storm or sanitary sewer because increased sewer flows during storm events can overstress the

sewer system. Many municipal water efficiency coordinators support the idea that providing subsidized rain barrels to homeowners is not only a good public relations tool but the rain barrels also serve to increase public awareness regarding the need to use water more efficiently.

A typical rain barrel may cost between $50-$200. The historical long-term average total precipitation during June, July, and August in Ontario is 253 mm (Environment Canada, Canadian Climate Normal 1961-1990). If a 500-litre rain barrel is completely filled and drained 10 times each year it could offset approximately 5,000 litres of municipal water – saving the homeowner about $8.00 each year at the current cost of water.

High Summer Use Customers: Rain barrels are not typically used by high water use customers, but, in any case, they would not be expected to significantly reduce irrigation demands.

Low Summer Use Customers: Peak day water demands generally occur after an extended period of hot and dry weather when, given the limited volume of water that a rain barrel can hold, it is likely to be empty. Some municipalities provide or subsidize rain barrels in an effort to encourage homeowners to adopt other water-efficient practices and not necessarily with the intent of reducing peak day demands. Rain barrels are not expected to significantly reduce irrigation demands.

7.2.4 Rainwater Harvesting

Because rainfall is not predictable, rainwater harvesting systems often require a potable water connection to be used for 'back up' supply.

As stated earlier in this manual, rain barrels are not expected to have a significant impact on peak irrigation demands primarily because they do not hold enough water. Larger rain water harvesting systems, such as cisterns, can be sized to hold a much greater volume of water and they can be fitted with pumps or pressure vessels to allow their use with garden hoses and lawn sprinklers.

Historically, Ontario receives an average of about 240mm of rainfall each summer. Based on this rate of precipitation a house with a roof area of 100m^2 and a large enough rainwater storage tank could theoretically collect 24,000 litres of water during the summer. Based on a requirement of 1-inch of water per week, the total irrigation demands for a home with 180m^2 of lawn would be 59,000 litres. In other words, under this scenario, rainfall could provide almost half of the total water needed for irrigation during the summer months.

As stated earlier, however, an analysis of single-family home water demand data indicates that most homes apply much less than 1-inch of water to their lawns each week (including rainfall). As such, a properly designed rainwater harvesting system may be able to provide most or all of

the irrigation demands of most single-family homes during a summer with 'typical' precipitation rates. Of course, the rain water storage tank would need to be properly sized to suit the average precipitation rates experienced in your municipality but, as an example, 40mm of rain falling on a 100m^2 roof would produce 4,000 litres of water and require a tank with a volume of at least 4m^3 (e.g., 2m long x 2m wide x 1m high).

High Summer Use Customers: A rain water harvesting system could potentially eliminate most or all of the need to irrigate with potable water for many single-family homes – even homes with automatic irrigation systems provided that the size of the irrigated area is not extensive and that the irrigation system is scheduled to provide less than 1-inch of water per week. It is unlikely that a typical rain water harvesting system could provide enough water to meet all the irrigation demands of large estate properties or large commercial properties, though providing even a portion of the water needed for irrigation would be beneficial.

Low Summer Use Customers: A rainwater harvesting system could potentially eliminate most or all of the need to irrigate with potable water for many single-family homes. The volume of water collected by a system is dependent upon the amount and pattern of precipitation received during the summer and the roof area of the home. Because a relatively large storage tank is required it is likely that most homeowners would prefer to install the tank underground.

7.2.5 Greywater Reuse

Greywater, which comes primarily from bathing and clothes washing, can theoretically be used for residential water uses that do not require potable water, such as toilet flushing and irrigation. The average home would be expected to produce between 250 to 300 litres of greywater per day, or approximately 2,000 litres per week.

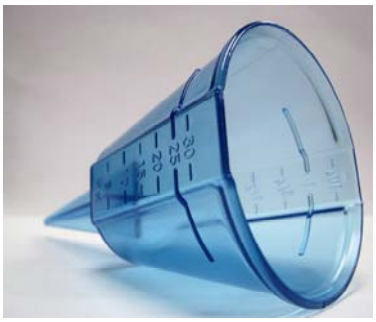
Greywater systems are generally more suitable for new homes due to piping requirements.

Based on an irrigation requirement of 1-inch of water per week, a home with 180m^2 of lawn would need to apply about 4,570 litres of water to their lawn each week. Since an analysis of single-family home water demand data indicates that most homes actually apply much less than 1-inch of water to their lawns each week (including rainfall) it appears that a greywater reuse system could provide most or all of the irrigation demands of most single-family homes. One major advantage of using greywater over rainwater is that the volume of greywater produced each day is relatively constant and not dependent upon precipitation. Of course, the greywater storage tank would need to be properly sized to suit the household demographics and irrigation demands, but, as an example, a cylindrical tank with a diameter of 1.2m and a height of 2.0m would hold 2,260 litres of water which is enough water to provide 12.5mm (half an inch) of irrigation each week to 180m^2 of lawn.

High Summer Use Customers: Greywater reuse could potentially eliminate most or all of the need to irrigate with potable water for many single-family homes – even homes with automatic irrigation systems - provided that the size of the irrigated area is not extensive and that the irrigation system is scheduled to provide less than 1-inch of water per week. A greywater reuse system would be somewhat less suitable for large estate properties with automatic irrigation systems. Commercial sites that currently discharge relatively clean cooling or process water to the sewer may be able to collect this water and use it to meet irrigation demands. Large greywater reuse systems would need to be individually designed to suit the greywater production and irrigation demand parameters of each site.

Low Summer Use Customers: A greywater reuse system could potentially eliminate most or all of the need to irrigate with potable water for many single-family homes, though, because of the difficulties related to installing the greywater collection piping in existing homes, these types of systems are far more suited for installation in new construction. The greywater collected by the system could be used for irrigation during the summer and for flushing toilets during the non-irrigation seasons.

7.2.6 Rain gauges



Even though most homeowners irrigate their lawns based on time rather than the depth of the application, most publications refer to depth of application. Without using some type of rain gauge, however, it is often difficult for the homeowner to determine when their lawns have received the proper depth of water. This difficulty is exacerbated by the fact that different types of hose-end sprinklers provide different flow rates and different distribution patterns.

Rain gauges can help homeowners from over-watering their lawns.

The general rule that lawns need 1-inch of water is a broad generalization and, in many cases, may not be accurate. The amount of water your landscape requires varies from day to day depending upon elements such as: the type of grass, the amount of shade on your property, the quality and depth of soil, the slope of your lawn, the weather, the amount of fertilizer used, etc.

While using rain gauges will not guarantee homeowners will apply the proper irrigation to their lawns, rain gauges may help prevent homeowners from excessively over-watering, i.e., adding more than 1-inch (25mm) of water in any single application.

Rain gauges are relatively inexpensive when purchased in bulk (generally, between $1 to $2 each) and comments from homeowners receiving rain gauges from their municipality are almost entirely positive. Rain gauges

can also be purchased from hardware stores and nurseries, though they tend to be more expensive. Rain gauges are seen by many municipalities as a customer awareness tool, with some municipalities including literature regarding outdoor water use in their rain gauge package. Other municipalities include other items such as: hose washers, hose bibb timers, hose trigger nozzles, soil moisture meter probes, etc., with their rain gauges.

High Summer Use Customers: Rain gauges can be used by high water use customers to help calibrate their automatic irrigation systems, however, many automatic irrigation systems are setup and maintained by professional landscape companies that are unlikely to use these types of rain gauges.

Low Summer Use Customers: Rain gauges can be used by homeowners to help ensure that they do not over-water their lawns during peak demand periods.

7.2.7 Hose Timers

Hose timers are simple devices that help control irrigation application times. Most types attach directly to a hose bibb or to a hose-Y fitting (a hose-Y fitting allows two hoses to be connected to a hose bibb at the same time). Many timers only automate water shutoff and the homeowner must turn on the hose and set the timer. Timers allow the homeowner to irrigate for a specific time even if they have to leave their house. Mechanical timers are easy to use (simply turn the dial to the desired watering time) and are relatively inexpensive, but because they have no power source or memory they must be properly set each time they are used.

Because hose timers make it easier for homeowners to water their lawns, their use may cause an increase in irrigation demands.

Battery-operated timers are generally more expensive but many of them can be set to turn the hose on and off at specific times even if the homeowner is away from home. Some models allow you to program the timer to turn on at specific intervals, such as every third day or only on certain days of the week. Some models can be programmed to repeat short irrigation cycles several times a day. While most timers control just a single hose, some are able to independently control up to four separate hoses, each with its own start time and duration. These systems operate much like an automatic sprinkler system except that the distribution piping is above ground and moveable.

High Summer Use Customers: Most high water use customers have automatic irrigation systems, as such; the use of hose timers is not expected to significantly reduce irrigation demands.

Low Summer Use Customers: Hose timers can help prevent over-watering - especially in cases where the homeowner forgets to shutoff their hose. Timers with both "on" and "off" controls essentially turn manual irrigation systems into automatic systems, making it easier for the homeowner to irrigate and, therefore, making the system less water efficient. The use of hose timers is not expected to significantly reduce the peak day water demands of the typical single-family home.

7.2.8 Demonstration Gardens

Many municipalities maintain one or more water-efficient gardens to demonstrate to homeowners that beautiful gardens can be maintained in our Ontario climate with little or no irrigation other than rain. Many of the plants used in these gardens are "native species" and are well suited to survive in their respective climate with little or no attention. These gardens help demonstrate to homeowners that there are practical and beautiful alternatives to having simple grass covered lawns.

Demonstration gardens enhance a community and serve as educational tool to help create public awareness.

The feedback from municipalities indicate that the public seems to appreciate and enjoy water-efficient demonstration gardens. As well as adding natural beauty to a municipality, demonstration gardens are intended to serve as an educational tool to create public awareness regarding water-efficient practices.

High Summer Use Customers: Municipal demonstration gardens are not expected to have a significant impact on high water use customers where the largest portion of irrigation is related to landscape watering.

Low Summer Use Customers: Municipal demonstration gardens are not expected to have a significant impact in the short-term on typical single-family home irrigation demands during peak water use periods. In the long-term, however, these gardens may help move homeowners to adopt the use of native, drought-resistant plants.

7.2.9 Automatic Irrigation Systems

In practice, most automatic irrigation systems apply more water than manual systems.

Automatic irrigation systems, which are more common on larger properties, are starting to become more popular in Ontario. Unfortunately, automatic irrigation systems tend to be operated in such a way that they apply far more water than manual systems. Research completed in one Ontario municipality included bulk-monitoring the

demands of 151 single-family homes. The data identified that the 15 homes (approximately 10 percent) with automatic irrigation systems used an average of about 2,450 litres of irrigation per day, while the other 136 homes that practiced manual irrigation used an average of only 180 litres of irrigation per day (Figure 2). The City of Toronto recommends that homes with automatic irrigation systems contact a Certified Landscape Irrigation Auditor (CLIA) to properly adjust the watering schedule of the system to avoid over-watering.

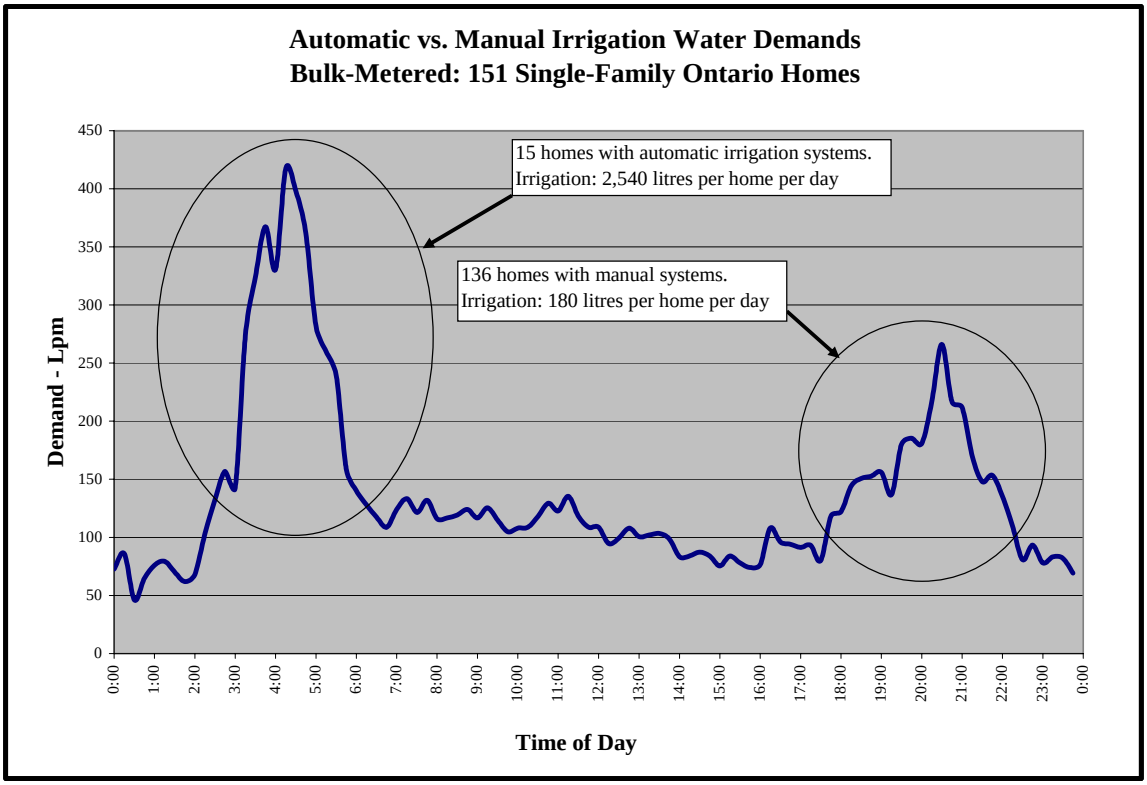


Figure 2 – Demands: Manual vs. Automatic Irrigation Systems

Many older or less expensive automatic systems rely on the use of timers to control irrigation. For example, a system may activate each night at 2:00 a.m. and run for a number of hours regardless of how much irrigation is required or if it is raining. The sprinkler heads of an automatic irrigation system must be selected and installed such that they apply water only to plants and lawns. Damaged or improperly selected sprinkler heads can spray water on driveways, sidewalks, etc., resulting in significant water wastage.

Many automatic irrigation systems are adjusted to operate at their default settings regardless of weather conditions.

Most of us have heard of automatic irrigation systems operating during a rainstorm. Homes and businesses with automatic irrigation systems should be equipped with an automatic rain shut-off device (these devices have been mandatory on automatic irrigation systems in Florida since

1991 and more recently in Illinois and New Jersey), essentially a device that prevents the automatic system from operating during rain events. These devices are relatively inexpensive (generally between $30 - $90) and can be added to most existing automatic systems.

The most efficient type of automatic irrigation system is one that changes the watering schedule based on fluctuating weather conditions. These systems use what are called smart controllers.

High Summer Use Customers: Automatic irrigation systems are typically used on large properties. Systems that are not properly installed, adjusted, and controlled use considerably more water than manual systems. Automatic irrigation systems that are controlled by simple timers are the least efficient and systems that use smart controllers are the most efficient. Properly adjusting and controlling automatic irrigation systems offers a significant potential for water savings. Because of the high potential for over-watering (and water wastage) related to the use of automatic irrigation systems, municipal programs that offer free or subsidized landscape audits should focus on and target properties with automatic systems because homes with automatic systems can apply up to ten times the volume of irrigation than homes with manual systems.

Low Summer Use Customers: Automatic irrigation systems are not typically used on small properties, though they are becoming more popular. Homes that install automatic systems tend to fall into the High Water Use Customer sector. Like the larger systems, installations that are not properly installed, adjusted, and controlled offer a significant opportunity for water savings.

7.2.10 Smart Controllers

Traditional automatic irrigation systems are controlled by timers that operate on the same schedule regardless of whether the weather is hot and dry or cool and wet, i.e., they don't account for how much water the plants require.

The use of smart controllers can improve the efficiency of automatic irrigation systems.

"Smart" irrigation controllers, which can be used in place of timers on automatic irrigation systems, adjust the watering schedule based on changes in the weather. Some smart controllers receive scheduling data from remote weather stations while others get their data directly from on-site sensors, such as soil moisture sensors. If the plants need more water because the weather is hot and dry, the smart controller will provide them with more water – potentially increasing peak water demands. If the weather turns cool and wet, the smart controller will reduce the system's run times or eliminate irrigation altogether. Some studies completed by Smart Water Application Technologies (SWAT)[12] have shown that smart

[12] http://www.irrigation.org/SWAT/Industry/case-studies.asp

controllers can reduce a high water use customer's overall average summer day irrigation demands by 20 percent or more.

Smart irrigation controllers must be used with automatic irrigation systems and are generally best suited for commercial properties, municipal parks, or large estates instead of the typical small residential lawn. It is important to remember, however that even automatic irrigation systems operated by smart controllers are, by their nature, typically still less water efficient than manual systems.

High Summer Use Customers: Studies have shown that smart controllers for automatic irrigation systems can significantly reduce the irrigation demands of high water users.

Low Summer Use Customers: Automatic irrigation systems are not typically used on small properties. What's more, the use of smart controllers on small single-family properties is not cost-effective. A typical single-family home uses less than 20 m^3 of irrigation during the summer. A savings of 20 percent equates to only 4 m^3 of water each year.

7.2.11 Incentives and Rebates

Homeowners tend to respond positively to programs offering incentives and rebates. For example, toilet replacement programs and ICI water use reduction programs are popular and typically successful. Unfortunately, homeowners do not tend to look to municipalities as an advisor when it comes to lawn and garden care. A study completed by, Freeman Associates in 2005/06 (Greater Toronto Area Market Research Studies) showed that not one of 180 survey respondents identified their municipality as a trusted advisor regarding landscape and gardening decisions. Instead, survey respondents identified Landscape Professionals and Garden Centres/Nurseries as most trusted advisor regarding landscape and gardening decisions. As such, the best solution may be for municipalities to cooperate with lawn and garden centres when offering homeowners incentives and rebates towards such things as the purchase of drought tolerant plants and lawns, the remediation of plant bed and landscape soils, etc. Garden centres may be willing to share with the municipality the costs associated with providing free hose timers, rain gauges, landscape audits, etc., to homeowners that purchase water-efficient plants. Partnering with trusted advisors may be a beneficial relationship for both the municipality and the advisors.

Municipal programs should be coordinated with the agencies most trusted by customers, i.e., nurseries and garden centres.

While automatic irrigation systems are inherently less efficient than manual irrigation systems, systems that use a smart controller to schedule irrigation are the most efficient type of automatic system. Municipalities

may wish to provide rebates towards the purchase of smart controllers to high water use customers that currently have automatic irrigation systems.

In addition to offering incentives and rebates to homeowners, municipalities could offer incentives to housing developers to provide more efficient landscapes (e.g., deeper and better quality soils, reduced turf areas, drought resistant plants, etc.). As an alternative to offering incentives, municipalities could simply make the offering of such measures a condition of receiving building permits – though this may be difficult to accomplish politically.

Some rebate programs are more effective than others.

Some municipalities in the southern U.S.A. that experience frequent droughts offer turf change-out programs which offer the homeowner a rebate based on the area of landscape removed by the homeowner. A study to determine how effective this type of measure is determined that "Good Landscape Water Management is More Important Than Changing Plant Material", i.e., paying water customers to reduce their landscape area is not cost-effective[13]. Ontario municipalities don't tend to experience droughts in the same way that they do in the southern U.S., i.e., their droughts can be months or years long whereas ours don't typically exceed a few weeks.

High Summer Use Customers: Incentives and/or rebates towards the purchase of water efficient flowers and plants are not expected to have a significant impact on overall irrigation demands (the largest component of irrigation is related to landscape watering). Studies have shown that the use of smart irrigation controllers can help reduce the irrigation demands of high water users. Offering rebates towards the purchase of smart control systems to customers that currently have automatic irrigation systems may effectively reduce irrigation demands.

Low Summer Use Customers: Incentives and/or rebates towards the purchase of water efficient flowers and plants are expected to have only a small impact on irrigation demands during peak demand periods as the largest component of irrigation is related to landscape watering.

[13] http://www.canadanursery.com/Page.asp?PageID=122&ContentID=1075

8.0 Planning the Right Program

An outdoor water reduction program should be part of an overall comprehensive Water Efficiency Master Plan.

A municipal outdoor water use reduction program should form part of a comprehensive Water Efficiency Master Plan. The most effective program would include elements from both the by-law list of measures (control measures) and the public education and outreach measures (reward measures). Your program should set specific savings targets (e.g., how much do you want to lower peak demands by, and by when), and then select the measures based on your targets and available budget. While water savings related to the installation of efficient toilets or clothes washers have been recorded and confirmed by hundreds of independent studies, there are very few studies that provide the same level of information regarding the effectiveness of irrigation reduction measures. Verifying the effectiveness of irrigation reduction programs with any significant degree of accuracy is expensive and time consuming – a study may have to be conducted over several years before the effects of variable weather patterns on program success can be established. It is important to track the results of your programs as accurately as possible and to periodically evaluate whether your savings targets are being achieved. Use billing data or information collected by field studies where possible to verify savings.

Because of the high cost associated with expanding water treatment and distribution systems, reducing peak water demands offers a potentially significant reward. Program budgets should be based on expected levels of water savings. Determine the unit cost of infrastructure expansion in your municipality and use this value to establish program levels. For instance, in a municipality where the unit cost of infrastructure expansion is $1.00 per L/day of capacity, a measure that costs $50 per home to implement but reduces a home's peak demands by 100 L/d would be extremely cost-effective (spend $50 to save $100 in expansion costs). Remember that reducing peak water demands has very little effect on revenues – only a small portion of a municipality's revenues are directly related to the additional water sales on peak demand days.

Focusing your program on high water use customers throughout the entire summer period and on typical single-family homes during periods of high demands would be beneficial. Support your program with education and social marketing – homeowners appreciate receiving tangible items like rain gauges, hose bibb timers, and rain barrels. Use these items to leverage support for your broader program. Be careful about using the message "lawns require 1-inch of water per week" as research indicates

that, in many cases, this would result in an increase in water demands. Incorporate the growing environmental awareness into your programs – i.e., saving water helps reduce greenhouse gases. Avoid terms with negative connotations, like 'restrictions' and 'bans', and use terms with positive inferences, like 'conservation' and 'efficiency'.

Choose which measures to include in your outdoor water reduction program based on target savings, program schedules, and project budgets.

There are a number of irrigation reduction measures being used by Ontario (and North American) municipalities and some appear to be more effective than others. It is difficult to calculate the cost-effectiveness of individual outdoor water use reduction measures because it is generally not possible to accurately quantify the water savings. This manual does, however, provide a general statement concerning the expected effectiveness of each measure. Use the following points to guide you in developing measures for your municipality –

1. Outdoor Water Use Restrictions: Landscapes only require watering once or twice each week. Avoid odd/even watering restrictions – there is little evidence that they are effective and there is some concern that they may actually lead to excessive watering. The best choice may be to employ one-day-per-week restrictions combined with time-of-day restrictions.

2. Watering Bans: Watering bans are used to reduce irrigation levels during extended periods of hot and dry weather. Employ multi-stage bans with the implementation of each stage dependent upon the weather. Ensure that your program fully explains to the homeowner how and why the different levels of ban are implemented and why it is important to follow the rules. Implementing an occasional watering ban is far less costly than constructing huge infrastructure expansion projects that may only be fully utilized for a few days each year. The lowest level of a multi-stage ban should address the wasting of water and should always be in effect.

3. By-law Enforcement: Enforce watering bans by levying fines to homeowners that repeatedly ignore restrictions. A homeowner is less likely to adhere to a voluntary watering ban than a mandatory ban that includes the possibility of being fined.

4. Conservation-based Water Rates: An Environment Canada study identified that in 1999 only 9 percent of Canadian homes that were serviced by municipal water had conservation-based water rates. Conservation-based rates provide a financial incentive to homeowners that reduce their outdoor water demands and, therefore, homeowners must be metered. Avoid using fixed or flat rates, declining block rates, and rates with high base charges included. Uniform block rates offer a limited incentive to the homeowner to reduce irrigation demands. Rates that target reductions in discretionary water uses, such as irrigation, include inclining block rates and seasonal rates. These types of rate structures should focus

No matter which water rate is used by a municipality it should comply with the concept of full cost pricing.

only on residential customers to avoid penalizing large water use customers that do not practice excessive irrigation.

5. Community-Based Social Marketing: Education, promotion, and marketing measures are typically included in a municipal Water Efficiency Master Plan. Research indicates that customers are far more likely to participate in a program if they fully understand the benefits of and reasons for the program. While most homeowners don't view their municipality as a prime source of information regarding landscapes and gardens, there is an opportunity for municipalities to work with the local nurseries and garden centres that consumers do consider as 'trusted advisors' when it comes to outdoor water use. You can maximize the cost-effectiveness of a community-based social marketing program by targeting only customers that practice wasteful or excessive irrigation. A CBSM program may not result in significant average summer day water savings but may be effective at reducing peak summer demands. A study completed in the Regions of Durham, Halton, and York indicates that savings of approximately 220 litres per household on high demand days can be achieved. Of course, actual savings will vary from year to year and are dependent on the level of program conducted.

While the savings related to an individual measure may be hard to quantify, it is important that the overall program is cost-effective.

6. Residential Landscape Water Audits: These types of audits are relatively expensive and time consuming. In some municipalities, for safety reasons, two students attend every audit. Because research has shown that the majority of homes do not practice excessive irrigation it may be more cost-effective for municipalities to restrict offering free residential landscape audits to only those customers with high outdoor water demands. Focusing on high use customers offers the greatest opportunity for savings and improves the overall cost-effectiveness of the measure.

7. Rain barrels: Rain barrels are typically used for watering plants rather than irrigating lawns as they don't hold enough water and are not pressurized for use with lawn sprinklers. Given the limited volume of water that can be contained in a rain barrel it is likely that the barrel would be empty after an extended period of hot and dry weather. The use of rain barrels, therefore, would not be expected to significantly affect peak summer demands. Some municipalities either provide or subsidize rain barrels with the intention of increasing customer awareness regarding efficient outdoor water use. While the barrel itself may not significantly reduce peak water demands, the measure may help encourage homeowners to adopt other water-efficient practices.

8. Rainwater Harvesting: This measure could potentially meet all of the single-family irrigation requirements. Because precipitation patterns can vary significantly from year to year, it is not possible to accurately predict the volume of water that could be captured by such a system

in any specific year. During very wet summers a rainwater system could collect a large volume of water but the irrigation demand would be less than average; during very dry summers a rainwater system would collect less water even though the irrigation demands would be more than average. Because of the size of the storage tank required it is likely that many homeowners would prefer to have the tank installed underground.

9. Greywater Reuse: Greywater reuse systems could potentially eliminate most or all the potable irrigation demands in the single-family sector. Greywater reuse has an advantage over rainwater harvesting systems because the volume of greywater produced by a family each day is relatively constant. Unfortunately, greywater reuse systems are relatively new to North America and there are not much data available on maintenance requirements, etc. Because these systems require a considerable amount of dedicated plumbing they are far more suited to new construction.

10. Rain gauges: Many municipalities view the use of rain gauges as a customer awareness tool. They are relatively inexpensive when purchased in bulk and may help homeowners avoid adding excessive volumes of water during peak demand days.

11. Hose timers: Hose timers are simple devices that help control irrigate application times. Many timers only automate water shutoff, while other models allow you to program the timer to turn on at specific intervals. Hose timers are not expected to significantly reduce irrigation demands in high water use customers, many of which have automatic irrigation systems. Timers with both “on” and “off” controls essentially turn manual irrigation systems into automatic systems, making it easier for the homeowner to irrigate and, therefore, making the irrigation system less water efficient. The use of hose timers is not expected to significantly reduce the peak day water demands of the typical single-family home.

12. Demonstration Gardens: Water-efficient demonstration gardens are used by municipalities to show homeowners that beautiful gardens can be maintained in our Ontario climate with little or no irrigation other than rain. As well as adding natural beauty to a municipality, demonstration gardens are intended to serve as educational tools for the public. Demonstration gardens tend to focus on flowers and plants rather than grass-covered landscapes. These gardens help inform customers that there are acceptable, water-efficient alternatives to traditional lawns. Demonstration gardens form part of a program’s customer outreach and education components by creating an awareness of water-efficient practices. They are not expected to have a significant impact on customer irrigation demands in the short-term.

13. Automatic Irrigation Systems: Field studies have shown that automatic irrigation systems typically apply far more water than manual systems. Their use should not be promoted as part of an outdoor water use reduction program. Many larger customers (and a growing number of smaller customers) may already have automatic irrigation systems. Automatic systems controlled by simple timers are the least efficient systems. Often these timers are left at the factory settings, meaning the system schedule may turn on each night from 2:00 a.m. to 4:00 a.m. regardless of actual irrigation demands. At the very least, automatic irrigation systems should be equipped with a rain shut-off device.

14. Smart Controllers: Existing automatic irrigation systems can be made more efficient through the use of smart irrigation controllers. These controllers adjust the watering schedule based on changes in the weather and the requirements of the plants. Studies have shown that smart controllers can reduce a high water use customer's overall average summer day irrigation demands by 20 percent or more[14] – which is significant. As such, municipalities may wish to consider offering rebates towards the installation of smart controllers on existing systems for high water use customers or, at least, offering a free or subsidized audit of the irrigation system to ensure that it is installed and adjusted to be as efficient as possible.

15. Incentives and Rebates: Homeowners tend to respond positively to programs offering incentives and rebates. Unfortunately, homeowners do not tend to look to municipalities as an advisor when it comes to lawn and garden care. As such, it may be advantageous for municipalities to coordinate with landscape professionals and lawn and garden centres when offering incentives and rebates towards the purchase of drought tolerant plants and lawns, the remediation of plant bed and landscape soils, etc. Rebate programs that focus on flowers and plants may have less impact on high irrigation demands than programs that focus on landscape care.

[14] Smart Water Application Technologies, http://www.irrigation.org/SWAT/Industry/case-studies.asp

Appendix A

Precipitation – Major vs. Minor Rainfall Events

Precipitation – Major vs. Minor Rainfall Events

It is commonly acknowledged that irrigation demands are largely related to summer weather patterns, i.e., to rainfall and temperature. It should be noted, however, that it is not just the total rainfall for a given year that affects irrigation demands but the pattern of rainfall events, the temperature, the humidity, whether sunny or overcast, etc. For example, a rainfall of only one or two millimetres during the night may have no identifiable effect on outdoor irrigation demands, and a single rainfall event of 50mm would not have the same effect as five events of 10mm each.

The following table identifies total summer precipitation at the Toronto airport between 2000 and 2007. While the historical average total June, July, and August precipitation in Ontario is about 240mm – six of the eight years between 2000 and 2007 experienced less than this amount (Environment Canada).

Note in the table below that most of the precipitation occurred in only a few major rainfall events. In this context a *major event* is a rainfall of at least 10mm occurring on a single day or consecutive days and may include 'dry' periods of no more than 24 hours. The remaining precipitation, minor or 'trace' events, may have little effect on irrigation demands, especially if these events occur during the night when they may go unnoticed.

Rainfall Events: June, July, and August

Year	Total Precipitation	Major Events (> 10mm)			Minor Events total mm	Days w/o rain[15] (min. 10 days)
		No.	mm	% of total		
2000	241	5	189	79%	52	10 & 10
2001	130	5	101	77%	29	23
2002	130	5	93	72%	37	12 & 15
2003	183	7	161	88%	22	0
2004	243	7	220	91%	23	0
2005	188	6	180	96%	8	12 & 28
2006	191	7	179	94%	12	23 & 21
2007	111	4	76	69%	35	10 & 15 & 18
Avg.	**177**	**5.8**	**150**	**83%**	**27**	**-**

Rainfall patterns are especially important to consider when designing rainwater harvesting programs. For example, a rainfall event of 25mm (1-inch) on a roof area of 100m^2 would equate to 2,500 litres of rain – a volume that might be captured by a cistern but far more than could be captured by most rain barrels installations.

[15] May include "Trace" rainfall

Appendix B

Examples of Municipal Outdoor Water Use Reduction Programs

Examples of Programs in Ontario Municipalities

Region of Waterloo

The Region is very proactive regarding water efficiency – both for indoor and outdoor water use. Region staff claim their most successful peak demand reduction measure is their Water Conservation By-law which restricts all residents and businesses to watering only one day per week from Monday to Friday. No one is permitted to irrigate on weekends. Car washing, pool filling, and the watering of trees, flowers, and shrubs are allowed only on odd/even calendar days. The by-law permits additional watering for new sod and allows for residents to switch to a different day of the week for watering if required. The conservation by-law has been approved for the next 10 years. Violators are subject to fines but are typically given warnings first. Beginning in 2005 the Region moved from an odd/even watering restriction to a one-day-per-week watering restriction between May 31 and Sept. 30th.

Although highly variable each year, the Region estimates that the water savings related to the one-day-per-week by-law has reduced peak summer water demands by between 8-12%.

The Region also:

- subsidizes the distribution of rain barrels to homeowners as a form of public education,
- delivers water-efficient landscaping seminars,
- provides in-home consultations regarding efficient landscaping, and
- participates in multimedia advertising campaigns focusing on both the conservation by-law and water efficient landscaping.

More information on programs in Waterloo Region can be found by visiting their website: http://www.region.waterloo.on.ca

City of Guelph

Guelph implements various levels of watering restrictions throughout the summer based on the availability of water and the effects of weather. The level of restriction is triggered by low levels in the City's water storage reservoirs and by the Ontario Low Water Response (OLWR). The OLWR team monitors precipitation and stream flow levels at numerous locations throughout Ontario. Low levels of precipitation or steam flows prompt the OLWR to issue either a Level I (voluntary water reduction of 10 percent), Level II (voluntary water reduction of 20 percent), or Level III (maximum water reduction through conservation, restriction, and regulation) restriction. If the OLWR is at a Level I Guelph moves from Blue restrictions to Yellow. If the OLWR is at Level II the City moves to Red (see following).

<u>Blue – Level 0</u>

- Odd/even day and time restrictions (watering only allowed between 7-9 a.m. and 7-9 p.m.)
- Treated lawns may be watered within 48 hours of treatment application.

- A permit is required for watering new lawns outside alternate day/time guidelines. No restrictions on Watering trees, shrubs, flowers, gardens, Filling residential swimming and wading pools, hot tubs, garden ponds or fountains

Yellow – Level 1

- City increases level of public awareness via newspaper ads, radio spots, etc.
- City increases level of enforcement (move from passive response to active response, i.e., more patrolling)
- Odd/even day and time restrictions (watering only allowed between 7-9 a.m. and 7-9 p.m.)
- Treated lawns may be watered within 48 hours of treatment application.
- A permit is required for watering new lawns outside alternate day/time guidelines. No restrictions on Watering trees, shrubs, flowers, gardens, Filling residential swimming and wading pools, hot tubs, garden ponds or fountains

Red – Level 2

- City further increases level of public awareness via newspaper ads, radio spots, etc.
- City further increases level of enforcement
- Lawn watering is not permitted
- Treated lawns may be watered within 48 hours of treatment application
- Permit required for watering new lawns.
- Trees, shrubs, flowers, gardens - odd/even day and time restrictions (watering only allowed between 7-9 a.m. and 7-9 p.m.).
- Residential vehicle washing – hose must have shut-off nozzle. Odd/even day and time restrictions (washing only allowed between 7-9 a.m. and 7-9 p.m.)

The program allows the City to fully enforce all levels of the program. A strong ability to enforce the program is something Guelph customers stated that they wanted. The program is actively enforced through ticketing or the issuance of summons by City by-law enforcement staff. By-law officers issue $130 tickets for program non-compliance, especially in the Yellow and Red levels, but the program is also enforced in the Blue level. Guelph is also especially committed to education in the Blue level. Along with enforcement, the City has implemented a communications strategy to ensure customers are aware of the program and to explain how customers can comply with the program.

More information on programs in the City of Guelph can be found by visiting their website: http://guelph.ca

3.3 Region of Peel

Peel does not engage or enforce water restrictions during the summer months, however, the Region promotes a *Water Wise Wednesday* campaign from June to September (homeowners are asked to avoid using water outdoors on Wednesdays).

During periods of drought the Region conducts an intensive marketing and communication plan to create awareness of wise and conservative water use.

All outdoor programs are promoted through various mediums such as: mobile signs, community newspaper advertisements and news articles, posters in community facilities, website, local television and water bill inserts and messaging. Program handouts are provided through community events. Outdoor program messaging reflects proper water use guidelines.

Peel's Lawn and Garden Consultation Program utilizes trained advisors to consult with residents at their home on sustainable lawn and garden practices. Community-Based Social Marketing (CBSM) focusing on general water efficient messaging is conducted during the summer months and lawn and garden workshops are delivered in partnership with local retailers/garden centres and community groups concentrating on xeriscaping and watershed management.

Three Demonstration Water Wise Gardens exist at Regional facilities. A fourth garden is expected to be constructed in 2009 and maintained in partnership with the area municipality.

Free rain gauges and outdoor water efficiency kits are provided to residents through Region's Community Recycling Centres, municipal facilities, Lawn and Garden Consultations and Workshops, outdoor community events, and by request. A rain barrel subsidy program is available to residents through the Community Recycling Centres and Environment Day events.

More information on programs in Peel Region can be found by visiting their website: http://www.region.peel.on.ca or www.watersmartpeel.ca

3.4 Region of Durham

Odd-even day lawn watering is mandatory May - September (started July 1997).

The Region currently advocates that customers apply a maximum of 1-inch of water (rainfall & irrigation combined) to lawns per week. The Region acknowledges that the impact of the odd/even restriction and the 1-inch per week message is difficult to measure due to seasonal variations and the complexity of the task.

The Region also provides free **Household Water Use Guides** to homeowners and between 15,000 - 20,000 free rain gauges annually to homeowners.

Durham implements voluntary watering restrictions and bans only when required based on weather patterns.

More information on programs in Durham Region can be found by visiting their website: http://www.region.durham.on.ca

3.5 Region of Halton

Currently, Halton implements odd/even watering restrictions during the summer months as well as a voluntary time-of-day restriction. Residents are asked to water their lawns between 6:00 and 9:00 a.m. or 6:00 and 9:00 p.m. Halton expects to introduce a more comprehensive policy regarding outdoor water use restrictions during the Spring/Summer of 2008.

Halton implemented their first full outdoor water ban during the period June 28 to July 9, 2007. Residents were banned from watering lawns and washing cars and driveways. Exemptions from the ban included new sod, and allowed flower and vegetable gardens to be watered by hand. After July 9 a mandatory odd/even water use policy was introduced for the remainder of summer.

Halton offers a Water Efficient Landscape Assessment program for free to residents throughout the summer months and provides free rain gauges and water efficiency information to residents at outreach events throughout the year, and through the Region's and Area Municipalities' offices.

More information on programs in Haton Region can be found by visiting their website: http://www.halton.ca

3.6 Region of York

York Region, in partnership with its local municipalities, promotes the importance of using water wisely during the summer, this includes an advertising campaign highlighting the importance of following the local municipal summer water use by-laws, through posters, newspaper advertisements, media releases and bus shelter ads during the summer months.

The Region offers free water efficient landscape home visits by trained advisors to residents between May and September. Residents who participate in this program receive a free water efficient gardening kit which includes fact sheets, plant lists, sample seed packets, a rain gauge, and a DVD.

York provides free seminars and workshops hosted by gardening experts promoting water efficient lawns and gardens to residents beginning each year in February. Through partnerships with local garden centres, the Region promotes water-efficient landscaping and drought tolerant plants at points of sale.

There are eighteen demonstration gardens located throughout the Region including at Regional buildings, garden centres, public libraries, and conservation and community centres. These gardens offer the community a place to see the beauty of water efficient gardens first hand. York Region also partners with other cities and regions to showcase water efficient gardens at gardening shows like Canada Blooms.

In partnership with a rain barrel vendor, York implements a one day rain barrel sales event in the late spring offering residents the opportunity to purchase a rain barrel at a discounted and subsidized price of $30.

The Region conducts pilot programs in communities with very high outdoor summer water use, for example offering education/certification for landscape contractors, free irrigation system assessments and/or rebates on irrigation sensors. All programs are promoted through Water for Tomorrow bulletins/bill inserts, website, newspaper advertisements, and flyers at point of sale in partnering garden centres and Regional and municipal facilities.

General water efficiency and conservation is promoted during the summer months through the Water for Tomorrow website, information booklets, public displays and via staff presence at community events such as fairs, festivals, environment events, home shows etc. Water for Tomorrow staff are also available for speaking engagements to service and community groups upon request.

More information on programs in York Region can be found by visiting their website: http://www.york.ca

3.7 City of Toronto

City Council approved a *Mandatory Downspout Disconnection Program* in November 20, 2007. Previously, the City offered residents a free rain barrel as an incentive to disconnect their downspouts from the sewer system.

The City encourages homeowners to water their lawns at non-peak hours (7 a.m. to 10 a.m.) to reduce pressure on the municipal water system and to reduce overall water use. Since 2005, the City of Toronto's outdoor water program offers a limited number (2,000) of free lawn and garden audits to educate homeowners on ways to reduce outdoor water use.

The City's website offers seasonal tips for maintaining a healthy lawn and information on how to develop a water-wise garden. Toronto also makes rain gauges available to help residents monitor their lawn watering.

The City does not allow water wastage, i.e., watering practices that result in excessive collecting or flowing of water into any gutter, street, sidewalk, swale, water course or storm drain. The City does not allow the operation of garden fountains or similar devices that do not utilize a water re-circulating system.

The City may, if necessary, implement watering restrictions to restrict the use of water used for lawn and garden irrigation, pool filling, outdoor play, outdoor misting systems, and vehicle washing. Exemptions are typically be made for newly sodded or seeded lawns, newly planted trees, nurseries, turf farms or tree farms, etc.

Since 2005 Toronto has monitored the success of their *Water Efficient Landscape Visits and Residential Outdoor Water Saving Program Services* program.

More information on programs in Toronto can be found by visiting their website: http://www.toronto.ca

Appendix C

Comments Regarding the Effectiveness of Odd/Even Watering Restrictions

Odd / Even Watering – Various Comments

The following are quotations from various people and organizations regarding the effectiveness of odd/even restrictions:

- U.S. Department of Environmental Protection: "Odd/Even Day Outdoor Watering and off peak watering generally does not reduce overall water demand (and may actually increase overall demand)…"
- Mary Ann Dickinson, Executive Director, Alliance for Water Efficiency: "One advance in outdoor water efficiency would be the elimination of the odd-even water restriction. Landscapes, especially in northern areas, don't need to be irrigated every second day yet this is exactly what odd-even restrictions imply. In the best case odd-even restrictions are not effective; in the worse case they may actually promote over-watering."
- Tony Gregg, City of Austin Water Conservation Manager: "Avoid the trap of the odd/even watering schedule, and select an every four- or five-day schedule based on street addresses or (some) other method. Texas cities that implemented the odd/even schedule found no reductions and, in some cases, increases in water use."
- Amy Vickers, Water Use and Conservation Handbook (2001): Communities sometimes establish every-other-day watering schedules…but watering schedules of this frequency are generally discouraged now because experience has shown that they often lead to overwatering. Schedules based on odd/even house numbers may appeal to consumers because they are easy to remember… however, homeowners…sometimes assume that they should water every other day, even though they didn't before."
- Freeman Associates, **"**RESIDENTIAL SUMMER PEAK DEMAND REDUCTION PROGRAM, MARKETING STRATEGY", *January 2006*: The report undertaken in a large Ontario Region identified that just over half of the respondents were even aware of the Region's odd/even watering by-law. When asked to briefly explain how the by-law applied to them, just over 44 percent provided no answer, about 28 percent provided some explanation indicating a general understanding of the by-law, but few could clearly articulate how it applies to them. The majority of the remaining respondents did not provide a description of the by-law, but did identify it as having *something* to do with water conservation.

Although odd/even day watering restrictions are common in Ontario municipalities, there is some question as to how effective they are at reducing outdoor demands. From a practical (and even mathematical) perspective, they offer little in the way of savings – and many people believe that, rather than reducing irrigation demands, the idea of "watering every second day" actually contributes to over-watering. As such, there is a movement in North American communities from odd/even watering restriction to one-day-per-week restrictions.

Appendix D

Community-Based Social Marketing

i) examples of CBSM programs

ii) identifying potential barriers

iii) outlining the steps involved in developing social marketing programs

iv) results of market research studies

v) evaluation of the cost-effectiveness of CBSM programs

Examples of CBSM Programs

Community-Based Social Marketing (CBSM) programs focus on removing barriers that prevent people from adopting certain behaviors while simultaneously enhancing the benefits of those behaviors. CBSM programs are developed by first considering the customer's point of view, and then trying to change as many potential barriers as possible into customer benefits. Many areas have utilized CBSM programs (e.g., Durham Region York Region, Halton Region, City of Glendale, Arizona, Denver Water, etc.) but there are very few scientific studies that have quantified the effectiveness of outreach and education strategies for landscape water conservation. The actual or potential water savings associated with the implementation of CBSM programs are not known (OWWA *Water Efficiency Best Management Practices* manual, September 2005). There are several reasons for this lack of information, including:

- Outreach and education programs are typically only a part of a more comprehensive municipal conservation or efficiency program, making it difficult to isolate savings specifically related to outreach, education, or CBSM.
- Studies have shown that there is an overall lack of information available regarding the implementation of "non-price" conservation programs and a lack of detail and consistency of information necessary to evaluate changes in demand (Renwick and Green, 2000; Michelsen et al., 1998a).

While education, outreach, and CBSM programs usually form at least a part of a water demand management program, not much is known about their direct influence on water conservation beyond the general belief that they are essential to any conservation effort.

Region of Halton - Method of CBSM Delivery Study

A 2003 CBSM study completed in Halton Region had two major objectives:

1. to determine if providing educational materials to homeowners ultimately translates into water savings, and
2. to determine if the level of savings is dependent on the method of delivery.

The three methods of delivery used during this study included:

- Door-to-door drop off of material (no direct contact with homeowner)
- Low level CBSM, i.e., a phone call to alert the homeowner that they would be receiving a copy of the Guide and a subsequent call to answer any questions that the homeowner may have, and
- High level CBSM, i.e., students canvassed the community, completed residential surveys that highlighted the importance of water efficiency, and dropped off the Guide.

The study results support the assertion that the level of savings is related to the level of intervention. Although actual irrigation savings is largely dependent upon weather patterns, lot size, etc., the study concluded that homes that received the highest level of CBSM reduced irrigation demands by about 66 percent more than homes where materials were simply dropped off, and 24 percent more that homes that received only phone contact but no personal contact.

City of Toronto - CBSM Field Study

In 2005 Toronto began a *Water Efficient Landscape Visits and Residential Outdoor Water Saving Program Services* pilot program. As of 2007, 5,250 residential water efficient landscape visits have been completed.

Participant surveys completed at the end of the 2007 program year indicated that 100 percent of participants were either very satisfied or somewhat satisfied with the landscape visit, with 78 percent of the surveyed participants claiming to have implemented recommendations. The survey also noted that 42 percent of respondents signed up for the program to learn how to save water in the garden, 37 percent wanted to learn how to better care for their lawns and gardens, while 33 percent were just 'curious' (note that some people gave multiple answers).

Of those respondents who hadn't implemented water saving measures, 62 percent said they would in the near future and 28 percent claimed that they already had water efficient landscapes.

It is interesting to note that in response to the question, "What parts of the landscape visit did you find most useful?", 26 percent of respondents identified information on "water saving techniques", 30 percent identified "advice on plants and trees", and 23 percent identified "lawn care and maintenance".

While 43 percent of survey respondents stated that they had reduced the amount of water they were applying to their lawns and gardens, 18 percent said they had reduced the number of times per week they irrigate, 11 percent said they applied no more than 1-inch of water per week, and 9 percent said they limited watering to once per week.

Barriers to CBSM Programs

Two separate market research studies involving several Greater Toronto Area municipalities were conducted by Freeman Associates in 2005 and 2006. The studies examined the public views and opinions regarding residential landscapes and the role of the municipalities and stakeholders in the landscaping sector.

The studies identified barriers that may prevent the uptake by homeowners of naturalized or water-efficient landscapes. The first and most significant barrier is a deeply held aesthetic motivation that defines a beautiful landscape as one with:

- a manicured, green, weed-free lawn;
- lots of colour, primarily provided by flowers (principally annuals)
- a neat, tidy appearance; and,
- good design and an organized layout.

This underlying aesthetic motivation leads homeowners to unsustainable behaviours even though many of these behaviours are the result of misinformation or understanding. This means that marketing programs must **first** address the intrinsically held perceptual barrier to water efficient landscapes. Homeowners will not embrace or desire water-efficient landscapes until they perceive them as just as beautiful, tranquil, and colourful as what they perceive their "ideal" landscape to be.

Intrinsic beliefs/values are shared amongst common demographics. This belief system drives everything we do and how we perceive things. Rooted in our intrinsic beliefs is the typical residential landscape. So entrenched is this belief in what a residential landscape should look like that there is little variation in home landscapes across North America. Most residential landscapes are a rectangular plot of land with the house situated in the middle, some foundation planting, a garden or two at the periphery of the property, a focal tree in the front and/or back yard, a driveway in the front, a patio or deck in the back and a large swath of lawn making up the rest of the yard (in some jurisdictions a swimming pool commonly occupies a large portion of the back yard). To maintain the landscape to a standard that "reflects well" as an extension of the property owner requires irrigation, fertilizer and, where not banned, often the use of cosmetic pesticides.

To be effective, social marketing programs must address the deeply held intrinsic perception of the home landscape amongst residents. Research shows that most homeowners hold negative perceptions of naturalized and water-efficient landscapes, yet these are the very types of landscapes that municipalities attempt to market to the homeowner.

It may be largely fruitless to try to inform and educate the homeowner before addressing the perceptual barrier against embracing water-efficient landscapes. Although many Ontario municipalities provide information to their constituents in one form or another regarding outdoor water use it is not clear that this information is being received and understood by the homeowner. In a survey of 60 respondents living in a large Ontario municipality that provides three separate types of printed information regarding lawn and garden maintenance to homeowners, 61 percent said they had never received any information from the municipality. Of the 24 respondents who indicated they had received

printed material, nine remembered receiving a pamphlet, seven remembered receiving the Household Guide to Water Efficiency, four remembered a regional letter, and only four remembered receiving all three publications.

Based on the responses identified in this study, a multi-pronged, integrated marketing program is the preferred approach to reaching residents. Two principle elements of such a program are:

1. Engage the homeowners' "trusted advisors", i.e., nurseries, garden centres, landscape maintenance companies, etc., to help facilitate the homeowners' move from a highly controlled landscape to a more natural and water-efficient landscape.
2. Use a visual campaign to address perceptual barriers (water-efficient landscapes can still be bright and colourful) and market an "incremental change" in residents' approach to their homes' landscape.

Developing a social marketing program

The steps outlined below may be helpful when developing the social marketing component of a comprehensive municipal Water Efficiency Master Plan.

1. Identify the target market (e.g., owner-occupants of single-family residential dwellings) based on a municipal water use profile (programs should target the highest water using sector of the residential market – it is also the sector of the residential market most responsible for peak day demand).
2. Research the target market to identify the potential barriers to securing residents' uptake of sustainable practices and the opportunities within the target market and the broader marketplace.
3. Use the findings from the market research to inform the development of the social marketing program. Depending upon the market research findings and the available budget, a social marketing program may address the following:
    - Messages and positioning – the focus and content of the key messages to be used in your social marketing program (must address barriers and use words that resonate with residents).
    - Strategic partnerships – secure the participation of "trusted advisors", stakeholders (i.e., garden centres, nurseries, landscape professionals, etc.) to help deliver the program.
    - Products and resources – posters, hand-outs (e.g., plant lists, garden/landscape design options, how-to guides, etc.), incentive premiums (e.g., rain gauges), displays, etc.
    - Vehicles – the marketing vehicles that will be used to communicate key messages should be identified; e.g., web sites, electronic and print media, point-of-purchase initiatives, workshops, landscape advisory service, etc.
    - Demonstration sites – these are sites at municipal locations and at participating stakeholder sites that demonstrate transitional landscapes and help address residents' perceptual barriers.
4. Implement the social marketing program on a pilot scale or phase the implementation allowing you to troubleshoot and modify as required
5. Monitor – provide an on-going assessment (both technical-based and market-based monitoring) to determine what water savings are being achieved and what are effective initiatives, and equally important, what are not effective initiatives.

Market Research Studies

Two separate market research studies involving several Greater Toronto Area municipalities were conducted by Freeman Associates in 2005 and 2006. The studies examined the public views and opinions regarding residential landscapes and the role of the municipalities and stakeholders in the landscaping sector.

The market research studies were undertaken to determine the barriers to sustainable landscape practices amongst owner-occupants of single-family dwellings in the GTA, specifically the City of Toronto and the Regions of Durham, Halton, Peel, and York.

Several aspects were evaluated, including:

- Outdoor water use/landscaping
- Single-family residential
- Broader marketplace
- Municipal/Regional operations and practices
- Areas with significant constraints/pressures

For both market research studies, demographic profiles – using Statistics Canada census data – were developed for the study areas. Participants were screened based on their demographic profile, ensuring the research sample matched as closely as possible the demographics of the municipality or study area.

The research sessions (not to be confused with Focus Groups) required respondents to provide written answers to verbally asked questions. Over 180 residents participated in the two studies, answering over 120 closed- and open-ended questions. More than 60,000 responses were received, grouped, and analyzed.

In both studies, a portion of the questions were aimed at determining which intrinsic beliefs were held by the single-family homeowner participants and why they were important to the homeowner. For example, homeowners were asked what their home meant to them (safety, comfort, family, castle, everything) and what their home's landscape meant to them (beauty, reflection of homeowner, pride, relaxing, neat and clean). The following sections highlight the findings of these studies.

Findings

From participant responses it is clear that many people believe that their landscape is an extension of their home. Of 121 responses to the question, "**Rate the importance of your home's landscape out of 10**", the mean response was 8.2, with a range from 3 to 10. Women tended to rate the importance of their landscape slightly higher than men (8.3 vs. 8.0). The main reason given by most respondents was beauty of their landscape (32%), with enjoyment, pleasure, and relaxation rating second (16%). Table 1 below identifies how the question was perceived by participants in different areas.

Table 1: Rate the importance of your home's landscape out of 10

	Overall	Female	Male	Brampton	Markham	North York	Thornhill	Vaughan
n =	121	68	53	26	25	26	22	22
% of n	100%	58%	42%	21%	21%	21%	18%	18%
Mean	8.2	8.3	8.0	8.3	8.4	8.7	7.4	8.0
Range	3 to 10	5 to 10	3 to 10	5 to 10	3 to 10	6 to 10	5 to 10	5 to 10

It is interesting to note that the survey identified watering as the most important lawn maintenance task, with respondents indicating that watering was "necessary for healthy plant growth". A total of 46 percent of respondents stated that they water an average of 1 to 2 times per week, while 32 percent claim to water 3 or 4 times per week for a total of about 90 minutes.

Most important lawn maintenance task -

- Watering 75%
- Weeding by hand 65%
- Cutting, trimming, pruning 37%
- Fertilizing 36%
- Maintaining good soil 25%

Respondents were also asked to provide feedback regarding their feelings and emotions when considering both an "ideal landscape" and a "naturalized landscape". As can be seen in Table 2 and Table 3, it is clear that homeowners do not equate a naturalized landscape with an ideal landscape. A total of 20% of the responses regarding the naturalized landscape were negative whereas only 2% of the responses regarding the ideal landscape were negative.

The public appears to be generally unaware of native plants that can thrive in the Ontario climate with little or no irrigation other than rain. When asked to "*name three plants (not trees, or shrubs) that are native to southern Ontario*", respondents identified:

- 31% Trilliums (Ontario's provincial flower)
- 26% Dandelions
- 22% Mix of other answers
- 21% No answer

Even with terms like Xeriscaping being used for more than 15 years and municipalities building demonstration water-efficient gardens, it appears that homeowners generally have very little idea of what constitues a 'native' plant. Based on study results it may be difficult to persuade homeowners to adopt more naturalized landscapes until their perception of what it means to be 'naturalized' improves.

Table 2 – Positive Feelings and Emotions: Ideal vs. Naturalized Landscape

Positive Feelings and Emotions		
	Ideal Landscape	**Naturalized Landscape**
Calm, relaxed, warm	23%	13%
Peace, tranquility	18%	14%
Beautiful	15%	5%
Happy, content, satisfied	13%	5%
Fun, pleasure, enjoyment	9%	4%
Design, dream, home	7%	0%
Proud	6%	0%
Wonderful, exciting, wow	5%	2%
Colourful, Bright	2%	2%
Natural, healthy, grace	0%	17%
Easy care, freedom, wild	0%	11%
Clean, simple, space	0%	12%
Total Positive Emotions	**98%**	**80%**

Table 3 – Negative Feelings and Emotions: Ideal vs. Naturalized Landscape

Negative Feelings and Emotions		
	Ideal Landscape	**Naturalized Landscape**
Frustrated, angry, upset	2%	6%
Untidy, chaotic, eyesore	0%	5%
Boring, plain, no colour	0%	4%
Ugly, cold, unwanted	0%	8%
Total Negative Emotions	**2%**	**20%**

Participants were also asked to identify their "most trusted advisor" when it came to making decisions about landscapes and gardens. Table 4 clearly identifies that for more than 70% of respondents their most trusted advisor is the Landscape Professional or the Garden Centre / Nursery. It is interesting to note that the municipality was not mentioned by a single respondent as being their most trusted respondent.

Table 4 – Trusted Advisor

Most Trusted Advisor	**Landscape Design & Maintenance**	**Plants, Trees, & Shrubs**
Landscape Professional	49%	27%
Garden Centre / Nursery	23%	46%
Friend or Neighbour	15%	13%
Myself	13%	4%
Family	5%	9%
Books	3%	10%

Respondents were also asked to identify their preferred secondary source for trusted information should they, for some reason, be unable to contact their most trusted advisor. Note that some respondents identified more than one secondary advisor (Table 5). Again, municipalities were not identified by respondents.

Table 5 – Secondary Advisor

Secondary Advisor	Landscape Design & Maintenance
Books (including library books)	33%
Internet/websites	33%
Magazines	28%
Television (like HGTV)	22%
Friends, neighbours and family	16%
Observation, intuition and experience	15%
Nurseries and garden centres	10%

Respondents were also asked where they purchase their lawn care products, and plants, trees, and shrubs (Table 6). This information is valuable since it makes sense for municipalities to provide marketing or educational materials to the public at locations where these materials are most likely to be read and believed. Note that some respondents identified more than one location.

Table 6 – Retail Locations

Where do you purchase…	Lawn Care Products	Plants, Trees, & Shrubs
Home Depot	45%	23%
Canadian Tire	36%	9%
Various Retail	33%	31%
Nurseries	26%	47%
Garden Centres	23%	26%
Rona	15%	5%

Table 7 identifies respondents' positive and negative perceptions of "water efficient" vs. "ideal" landscapes. One-third of respondents view water efficient landscapes as being unattractive and less colourful.

Table 7 – Positives and Negative Regarding Water-Efficient Landscapes

Positives		Negatives	
26%	Less Grass	33%	Unattractive, less colour, cold
26%	Natural water & less watering	20%	More concrete, rocks & deck
18%	More trees, shrubs & shade	15%	Less flowers & trees
18%	Less maintenance	10%	Money & time to do it
12%	Sustainable	10%	No privacy, no fun, no leisure
100%	Total	88%	Total

Cost-Effectiveness of CBSM Programs

There are very few scientific studies that have quantified the effectiveness of outreach and education strategies for landscape water conservation. Data from several sources (e.g., City of Toronto, City of Kitchener, Durham Region, Peel Region, York Region, etc.) indicate that average home is applying much less irrigation than previously anticipated. Data indicates that a small percentage of homeowners are responsible for a large percentage of irrigation demands (in agreement with the Pareto Principle). A CBSM program that involves meeting with homeowners that already irrigate efficiently or that simply love gardening and enjoy talking about their landscapes may result in very little water savings.

While water efficiency is now widely considered a legitimate new "source" of water, it is important that water efficiency measures are cost-effective to implement. For example, it should cost less to supply water through the implementation of an efficiency measure than to supply the same water through infrastructure expansion. A review of the unit costs for water treatment/distribution infrastructure expansion in several Ontario municipalities identified a range from about $0.50 to $2.00 per litre per day of supply. For example, expanding the capacity of a water supply/distribution system by 10,000 m^3/day would be expected to cost between $5 and $20 million.

A municipality should use the unit cost of infrastructure expansion for their own system as a comparison when evaluating how cost-effective their CBSM programs are. For instance, in a municipality where the unit cost of expansion is $1.00 per litre per day, a CBSM program that saves 50 litres per household per day should cost no more than $50 per household to implement.

The cost-effectiveness of CBSM programs aimed at reducing outdoor water use can be enhanced by targeting only those customers that practice excessive irrigation and, therefore, where there is an opportunity for savings. On-site monitoring or customer water billing data can be analyzed to quantify the savings achieved by individual homes participating in a CBSM program.

Appendix E

Worksheet #1

Calculating Outdoor Water Demands, Single-Family Sector, Metered Homes

Worksheet #2

Calculating Outdoor Water Demands, Single-Family Sector, Un-Metered Homes

Worksheet #1 – Avg. Single-Family Irrigation Demands

For Communities that are fully metered

1	Population of Community		
2	Number of Houses		
3	Number of Apartments		
	Information may be available on Canada Post website: http://www.canadapost.ca/cpc2/addrm/hh/current/indexa/taONu-e.asp		
4	Persons per House		
5	Persons per Apartment		
	If unknown, assume 3 persons per House and 2 persons per Apartment		
6	Average annual day water demand		m3
	(total annual water production divided by 365 days per year)		
7	Annual single-family residential (not apartments) water demand from billing data.		m3
8	Avg. daily water demand per house		m3/day
	(divide line 7 by line 2, then multiply by 1000)		
9	Average Summer day water demand per single-family house.		L/day
	Use billing data and demands from Jun., Jul., Aug. Do not include data from apartments. Remember summer demands are often billed in Fall)		
10	Average Winter day demand per single-family house.		m^3/day
	Use billing data and demands from Nov., Dec., Jan., and Feb. Do not included data from apartments. Remember winter demands are often billed in Spring.		
11	Difference between average summer and winter day water demands per house.		m^3/day
	(subtract line 10 from line 9)		
12	Estimated average landscaped area of single-family house (ft^2)		ft^2
	(if unknown assume 2,000 ft^2)		
13	Average landscaped area of single-family house (m^2)		m^2
	(multiply line 12 by 0.093)		
14	Average weekly irrigation demands of single-family home, mm		mm
	(divide line 11by line 13, then multiply by 7000)		
15	Average weekly irrigation demands of single-family home, inches		inches
	(divide line 14 by 25.4)		

Expected Precipitation

Avg. long-term summer (Jun., Jul., Aug.) precipitation in Ontario = 240mm (Environment Canada). Precipitation data Toronto airport 2000 - 2007 indicate avg. of 177mm during summer.

Precipitation of 177mm during Jun., Jul., and Aug. equates to an average of 18.3mm per week (0.72-inches). Precipitation of 240mm during Jun., Jul., and Aug. equates to an average of 13.5mm per week (0.53-inches).

Remember precipitation is not evenly distributed throughout summer. Analysis of 2000-07 data from Toronto airport indicates average of 83% of summer rainfall comes in just 5.8 major events each summer. During most weeks, therefore, almost all irrigation must be provided by homeowner.

Worksheet #2 – Avg. Single-Family Irrigation Demands

For Communities with un-metered single-family homes

1	Population of Community		
2	Number of Houses		
3	Number of Apartments		
	Information may be available on Canada Post website: http://www.canadapost.ca/cpc2/addrm/hh/current/indexa/taONu-e.asp		
4	Persons per House (single-family sector, not including apartments)		
5	Persons per Apartment		
	If unknown, assume 3 persons per House and 2 persons per Apartment		
6	Average annual day water production		m3
	(total annual water production divided by 365 days per year)		
7	Annual multi-family residential water demands from billing data.		m3
8	Annual ICI* water demands from billing data.		m3
9	Estimated municipal & non-revenue water.		m3
	(If unknown, assume 20% of line 6)		
10	Annual single-family residential water demand.		m3
	(subtract lines 7, 8, and 9 from line 6)		
11	Avg. daily water demand per house		m3/day
	(divide line 10 by line 2, then multiply by 1000)		
12	Average **summer day** water production.		m3
	(avg. daily production June - August)		
13	Avg. **summer day** multi-family residential water demands June - August.		m3
14	Avg. **summer day ICI** water demands June - August.		m3
15	Estimated **summer day** municipal demands & non-revenue water.		m3
	(If unknown, assume 20% of line 12)		
16	Avg. **summer day** single-family residential water demand.		m3
	(subtract lines 13, 14, and 15 from line 12)		
17	Avg. **summer day** water demand per single-family house		m3/day
	(divide line 16 by line 2, then multiply by 1000)		
18	Average **winter day** water production.		m3
	(avg. daily production November - February)		
19	Avg. **winter day** multi-family residential water demands November - February.		m3
20	Avg. **winter day** ICI water demands November - February.		m3
21	Estimated **winter day** municipal demands & non-revenue water.		m3
	(If unknown, assume 20% of line 13)		

22	Avg. **winter day** single-family residential water demand. (subtract lines 20, 21, and 22 from line 21)		m3
23	Avg. **winter day** water demand per single-family house (divide line 22 by line 2, then multiply by 1000)		m3/day
25	Difference between average summer and winter day water demands per house. (subtract line 23 from line 17)		m^3/day
26	Estimated average landscaped area of single-family house (ft^2) (if unknown assume 2,000 ft^2)		ft^2
27	Average landscaped area of single-family house (m^2) (multiply line 12 by 0.093)		m^2
28	Average weekly irrigation demands of single-family home, mm (divide line 25by line 27, then multiply by 7000)		mm
29	Average weekly irrigation demands of single-family home, inches (divide line 14 by 25.4)		inches

Expected Precipitation

The average long-term summer (Jun., Jul., Aug.) precipitation in Ontario = 240mm (Environment Canada data). Precipitation data at the Toronto airport from 2000 - 2007 indicate an average of about 177mm during summer.
Precipitation of 177mm during Jun., Jul., and Aug. equates to an average of 18.3mm per week (0.72-inches). Precipitation of 240mm during Jun., Jul., and Aug. equates to an average of 13.5mm per week (0.53-inches).
Remember that precipitation is not evenly distributed throughout the summer. Analysis of 2000-07 data from Toronto airport indicates that an average of 83% of summer rainfall comes in just 5.8 major events each summer. During most weeks, therefore, almost all irrigation must be provided by homeowner.

* industrial/commercial/institutional

Appendix F

Worksheet #3
Billing Structure

Worksheet #3 - Billing Structure

Are all of your customers metered, including single-family residential?

If not, are there plans to become fully metered?

Are there plans to change your current metering strategy (e.g., AMR)? Describe below.

Are there plans within your municipality to change your current billing structure?

What type of billing structure does your municipality currently employ?

Use the following list as a guide.

- ☐ Flat or Fixed Rate
- ☐ Declining Block Rate
- ☐ Rate with base charge or meter charge
- ☐ Uniform Rate
- ☐ Inclining Block Rate
- ☐ Minimum Charge Rate
- ☐ Seasonal Rate
- ☐ Other (describe below)

Are sewer (wastewater) charges included in the water bill?

Are your rates designed for full cost recovery?

Do you have different rate structures for residential vs. non-residential customers?
If yes, describe below.

Appendix G

Worksheet #4
Water Treatment / Distribution System

Worksheet #4 - Water Treatment / Distribution System

System Infrastructure

Briefly describe your water treatment/distribution system.
Use following list as a guide.

Source of water: well-based, lake-based, river-based, purchase water from other entity.

Customer base: primarily residential demands, primarily industrial demands, primarily agricultural, etc.

Metering: are your customers fully metered, including single-family residential?

Age of infrastructure: most elements of system built within last 30 years, most elements of system older than 30 years.

Topography: distribution area relatively flat (one pressure zone), highly variable elevations (multiple pressure zones).

Infrastructure Expansion: Are there long- or short term plans to increase system capacity?

System Losses: Have you calculated the Infrastructure Leakage Index (ILI) for your system?

Unit Cost of Infrastructure Expansion

What is the unit cost of infrastructure expansion for your system?
Use data from recent system expansion if possible. Divide cost by size of expansion.
Example: cost of $1.25 million to expand 1.0 million litres/day = $1.25 per litre per day.

Capacity Expansion:	ML/d	1
Cost of Expansion:	$	2
Unit Cost of Infrastructure Expansion:		(divide line 2 by line 1)

System Growth

- [ ] Is your system experiencing growth in population?
- [ ] Is your system experiencing growth in industrial, commercial, or institutional demands?
- [ ] Is your system experiencing growth in average annual day water demands?
- [ ] Is your system experiencing growth in peak day water demands?
- [ ] Does your municipality have a "Planned Growth" schedule?
- [ ] Do you anticipate capacity problems in future because of growing water demands?

Appendix H

Worksheet #5
Water Efficiency Goals

Worksheet #5 - Water Efficiency Goals

Describe you customer base:

- ☐ Number of residential customers
- ☐ Number of single-family residential customers
- ☐ Number of multi-family residential customers
- ☐ Number of industrial customers
- ☐ Number of commercial customers
- ☐ Number of institutional customers

Is your customer base growing? Residential, ICI? Describe below.

What are your water-efficiency goals and targets? Use the following list as a guide.

- No specific goals have been defined.
- Reduce peak day demands by target (percentage or demand rate) by specific year.
- Reduce average annual day demands by target (percentage or demand rate) by specific year.
- Reduce wastewater flows by target (percentage or demand rate) by specific year.

Does you system currently have problems meeting peak day demands?

Are program water savings goals established based on future demands or best management practice?

What water-efficiency measures are currently implemented in your system? Use the following list as a guide.

- Toilet change-out program (single-family, multi-family, ICI, municipal buildings)
- Pre-rinse spray valve replacement program.
- Landscape audits (residential, ICI, parks, golf courses)
- ICI indoor water audits (capacity buy-back programs)
- Rain barrel subsidy

Do you currently track the costs and savings associated with your water efficiency programs?

Do you currently have a Water Efficiency Master Plan?

Do you post information on water efficiency programs on you municipal web site?

Does your municipality issues watering bans? Describe

Does your municipality implement watering restrictions? When required? All summer? Describe