


Green Heart of the Valley

Project Report 2009

Produced by the Clean Annapolis River Project

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Clean Annapolis River Project

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Executive Summary

The Green Heart of the Valley Project was developed by the Clean Annapolis River Project as a means to aid the Town of Middleton in reducing greenhouse gas emissions and prepare for potential effects of climate change. This was accomplished through two main focuses: working with the Middleton Town Hall and private business owners within the town to identify ways of increasing energy efficiency and restoring floodplains along the Annapolis River between Middleton and Wilmot.

All Town of Middleton buildings were assessed for energy use and energy efficiency recommendations were made. Participation in an energy conservation seminar and private energy use reviews by business owners was entirely voluntary.

The floodplain restoration completed for Green Heart is part of a longer-term project. Bank stabilization and native species planting will contribute to the overall health of the site and aid in water local quality and quantity issues.

As a result of the Green Heart of the Valley project, the following results were achieved:

- Over 2050 live stakes were installed along the Middleton floodplain
- A total of 72 native plant species were planted at the Middleton site
- Over 16079 m^2 of improved riparian habitat
- A conceptual plan for 6.5 ha of created and restored wetland
- More than 50 ha of land protected by a stewardship agreement
- Creation and protection of suitable habitat for three species at risk: Eastern ribbon snake (*thamnophis sauritus*), wood turtle (*glyptemys insculpta*) and Eastern white cedar (*thuja occidentalis*)
- An energy consumption review, complete with energy efficiency recommendations for the Town of Middleton
- A report on water pricing structures
- Twenty private citizens were educated on energy conservation measures and opportunities
- Five businesses participated in private energy reviews
- More than 25 home energy audits were completed in the Middleton area

Introduction

The Clean Annapolis River Project is a charitable, community-based, non-governmental organization incorporated in 1990 to work with the community and organizations to restore and protect the ecological health of the Annapolis River watershed through science, leadership, and community engagement. The organizational vision and mission are achieved through a series of goals:

- To continually assess the ecological health and environmental stressors of the Annapolis River watershed
- To identify and establish priorities and projects to enhance the ecological integrity of the Annapolis River watershed
- To empower all decision-makers with the knowledge, tools, and research to make ecologically sound decisions with respect to the Annapolis River watershed
- To facilitate collaboration among all stakeholders to address the environmental challenges facing the Annapolis River watershed
- To engage local community members in the restoration and protection of the Annapolis River watershed in ways that are meaningful, relevant, and fun

Green Heart of the Valley

There have been many successful partnerships between CARP and Middleton including riparian habitat stewardship, sustainable agriculture and greenhouse gas reduction on farms. Project Green Heart of the Valley is a continuation of that partnership. The overall goal of the project is to help the Town of Middleton (ToM) develop tools to moderate their contribution and to adapt to the effects of climate change. Specific aims for this project include: improved energy use efficiency, reduced air pollutant emissions, enhanced flood plains and improved terrestrial and aquatic habitats. These goals were achieved through energy use audits and energy efficiency recommendations and riparian restoration work on the Annapolis River.

The first part of the project focused on reducing carbon dioxide (CO_2) emissions. For this project, information on the corporate Town of Middleton's use of electricity, oil, gas, propane and diesel was collected for 2006, 2007 and 2008. This data was analyzed to identify areas where energy use could be used more efficiently to minimize CO_2 emissions (eCO_2) and present opportunities to cut costs. As well, local business owners were invited to learn about energy saving practises and given the opportunity to undergo a free energy efficiency audit.

The second part of the project focused on climate change adaptation. In 2003 CARP and the Meteorological Service of Canada produced a report detailing climate change projections for the Annapolis Valley. This report concluded that there would be an increase in warm and very warm days in the summer. Monthly mean rainfall would remain the same but occur in fewer events, which could result in local flooding events. To mitigate possible floods, CARP began restoration on an Annapolis River floodplain near Middleton. This report includes a summary of riparian work done in the 2008 and 2009 field seasons as well as future plans for the site. A more in-depth report titled *Annapolis Aquatic Habitat Enhancement Project* (Neish, 2008) is available on the CARP website.

As well the Town of Middleton is also building a new sewage treatment plant. This treatment plant will include a tertiary treatment wetland. A conceptual design for this wetland can be found in Appendix G. This wetland will also mitigate the effects of possible flood events.

As the Town is upgrading its wastewater treatment, there was an interest in adopting a new water use pricing structure. The Town approached CARP about exploring pricing structures and a paper is included in Appendix H, which discusses a variety of options but places an emphasis on pricing structures that encourage conservation. This will also contribute to the Town's desire to reduce energy consumption by reducing the volume of water treated by the plant.

Methodology

To assess ToM energy consumption, an excel spreadsheet developed by the Union of Nova Scotia Municipalities (UNSM) was used. This spreadsheet organizes data into five categories: buildings, vehicles, street and area lights, water and sewage and waste. The data collected includes all the buildings and operations to which ToM provides oil, diesel, electricity and/or water services. In this report, three categories were assessed: buildings (electricity and oil), lighting (streets and outdoor lighting) and vehicles. These data are organized by calendar year.

The UNSM spreadsheet does not include number of storeys, building occupants or hours of operation. Therefore the eCO_2 is calculated by determining the emission coefficient, which is essentially the amount of CO_2 produced per unit energy. For example, if 1L of gasoline is burned, 15.95 kg of CO_2 is produced. In this report eCO_2 is always expressed in metric tons. When a building had two electricity meters, the readings from both meters was added together to calculate energy use. As well, ToM did not keep records of annual mileage accumulation on their vehicles so emissions were calculated from the diesel and gasoline purchased by the town each year.

Each building ToM is responsible for providing services for (electricity, oil, etc) was visited to assess current energy use and identify areas where energy might be conserved. The town hall and the library required a more in depth walk through. The town hall and library are broken down into lighting, windows, water, heating and phantom load. For the other buildings visited, observations were recorded and energy saving measures suggested.

Buildings

There were a total of 18 buildings/locations for which ToM is responsible for providing electricity (Table 2), oil (Table 1). With electricity being used more commonly than oil (Table 3). The buildings are listed in Table 2 along with the annual kWh use. The top five electricity users for ToM are (in order) the sewage treatment plant (512000 kWh per year), the water pump station at the hospital (341520 kWh per year), the 101 building booster pump (36730 kWh per year), library (29820 kWh per year) and public works garage (28340 kWh). This is clearly shown in Figure 2. The sewage treatment plant, hospital water pump station and 101 building booster pump are to be expected as high energy users because these locations all contain equipment that essentially runs constantly. The town hall and library are multi-use locations. Whether it is a town council meeting or a visiting author, both of these locations are central to community operations and events.

Table 1. ToM annual use of oil with a three-year average.

	Oil (L)
2006	25060
2007	27600
2008	25480
Average	26050

Table 2. kWh/building/year

Building/location	2006	2007	2008	Three year average (kWh)
Fire department	25030	24140	28780	25980
Public works garage	22840	34110	28080	28340
Town hall	14440	15290	14720	14820
Library	27060	32380	30010	29820
Tourist bureau	2047	3183	2532	2587
Sewer lift station hospital	11580	10530	11940	11350
Water pump station hospital	330500	347600	346500	341520
Lift station	14020	12700	13790	13500
North St lift station	297	371	162	277
School St lift station	8985	6570	5505	7020
Sewer treatment plant lab	516400	493700	526000	512000

Public works storage barn[1]	2540	1	1	800
101 building booster pump[2]	39890	101820	29920	36730
Reservoir	8990	8140	7570	8230
Rotary Raceway Park	3380	5750	3630	4260
T/s street lighting	18020	18160	19000	18000
Commercial St power[1]	1600	1	2300	1000

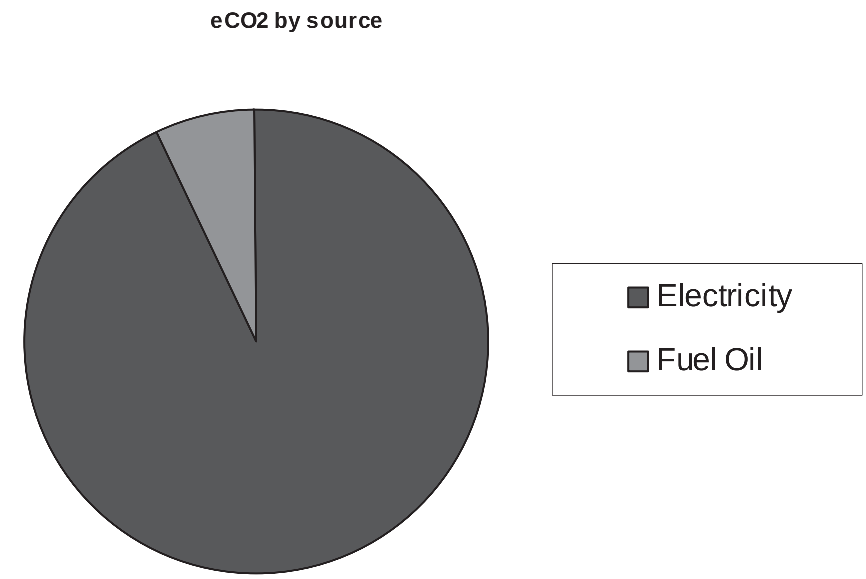


Figure 1. Average eCO_2 for each source for 2006, 2007 and 2008.

Table 3. eCO_2 by source per year.

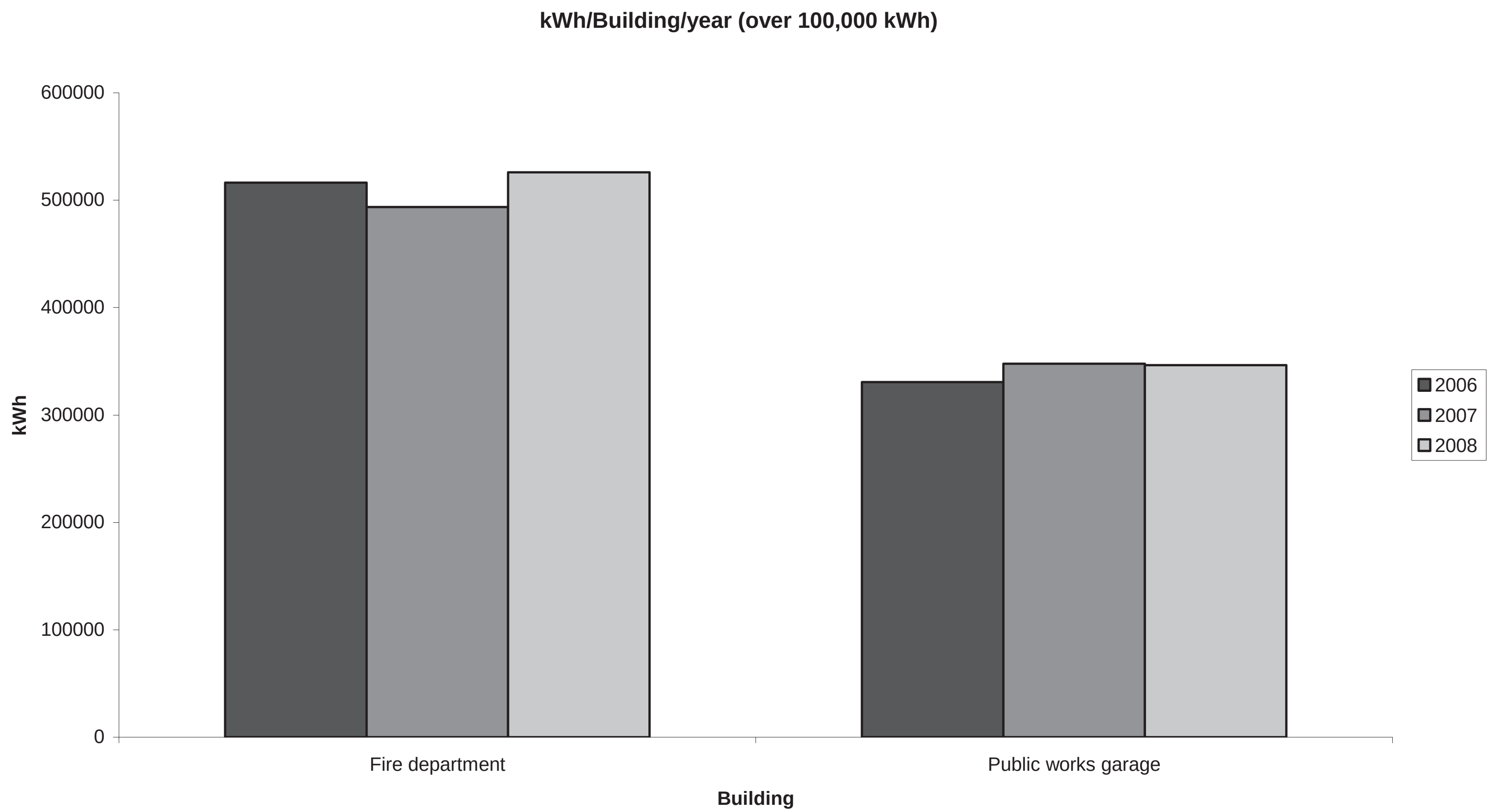
	Electricity	Oil
2006	910	70
2007	970	70
2008	920	70
Average	930	70

The sewage treatment plant will soon be replaced with a newer model and energy conservation measures will be incorporated into the building itself. Booster pumps and water pump stations are housed in very basic buildings (if they are in

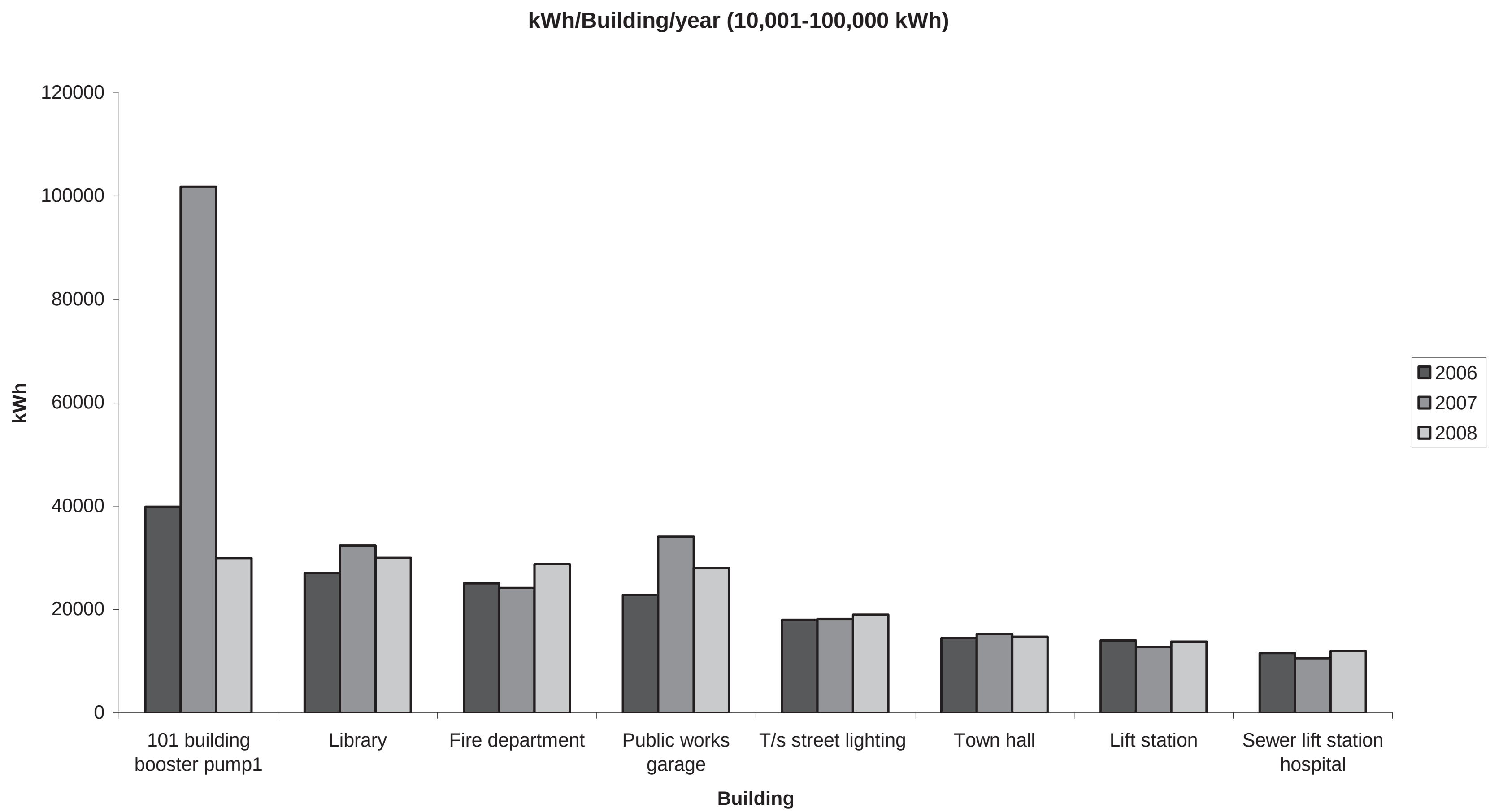
[1] The reason for difference in KWh from year to year for these two buildings is unknown. Attempts were made to understand the differences but are currently unresolved.
[2] The unusual spike in kWh values for this pump station may be a result of a change in the number of phases in the system.

buildings at all). The nature of their energy use is related to the amount of water consumed by the township, which also may be affected by the potential change in the water pricing structure. The ToM is considering adopting a new water use pricing structure, which may encourage water conservation, which in turn will reduce energy use.

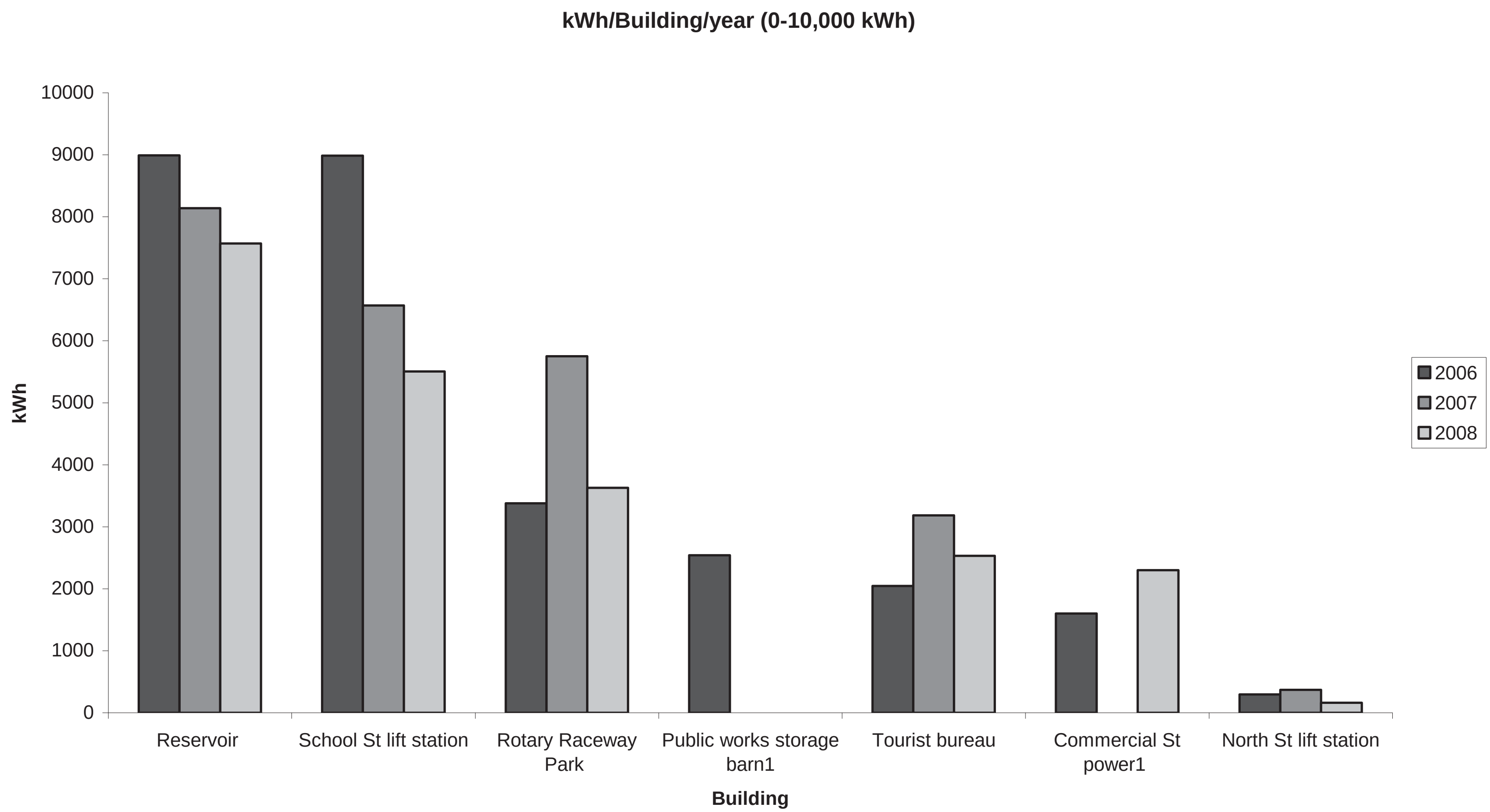
However, Town hall and the library were excellent candidates for reducing energy consumption. As they are both important community buildings they provide a significant opportunity in energy conservation leadership for the rest of the town. A walk through evaluation has been conducted for each site and is included later in the report.


kWh/Building/year (over 100,000 kWh)
600000
500000
400000
300000
200000
100000
0
kWh
Fire department
Public works garage
Building
2006
2007
2008

Histogram A


kWh/Building/year (10,001-100,000 kWh)
kWh
120000
100000
80000
60000
40000
20000
0
101 building booster pump1
Library
Fire department
Public works garage
T/s street lighting
Town hall
Lift station
Sewer lift station hospital
Building
2006
2007
2008

Histogram B



Histogram C

Figure 2. Histograms A, B and C comparing kWh use for each building[1]

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[1] In histogram B, there is one value over 100,000 kWh (101 building booster pump, 2007) but it was included in this graph because kWh use for this building for 2006 and 2008 was below 100,000 kWh

Streetlights

Based on ToM records, the Town is responsible for 260 lights in total, however, in a survey of the town streetlights, the final count was 249[+] (Appendix E). They are identified in Table 4. For an average year, the total eCO_2 for all streetlights is 174 tons. Although a result of quantity, the high-pressure sodium lights are the biggest emitters of CO_2.

Table 4. eCO_2 emissions for each type of light[*].

Light	Number	2006	2007	2008	Average
Mercury vapour	15	13	13	13	13
Fluorescent	2	3	3	3	3
Fluorescent Crosswalk: Continuous burning	1	2	2	2	2
High pressure sodium	242	156	156	156	156

Recently, C-Vision, an electronics manufacturing and design services company in Amherst, Nova Scotia received a 2.1 million dollar grant from Atlantic Canada Opportunities Agency (ACOA) to develop a new Light Emitting Diode (LED) based roadway light. LED street lighting can save 40-70 percent of the electricity a city uses (LEDcity, 2008a). The energy savings are 50% or more and they have a payback period of 3.3 years (LEDcity, 2008b). As well LED bulbs have a ten-year lifetime, whereas the average metal halide is only two (LEDcity, 2008b).

Vehicle Fleet

The eCO_2 for the ToM vehicles was calculated based on the litres of gasoline and diesel purchased by the town within a year. The Town has both on-road and off-road vehicles used primarily by the public works staff. The majority of the town vehicles use diesel, which accounts for greater eCO_2 than gasoline. (Figure 4).

[+] This number does not include cross walk lights.
[*] This table and information are based on Town of Middleton records.

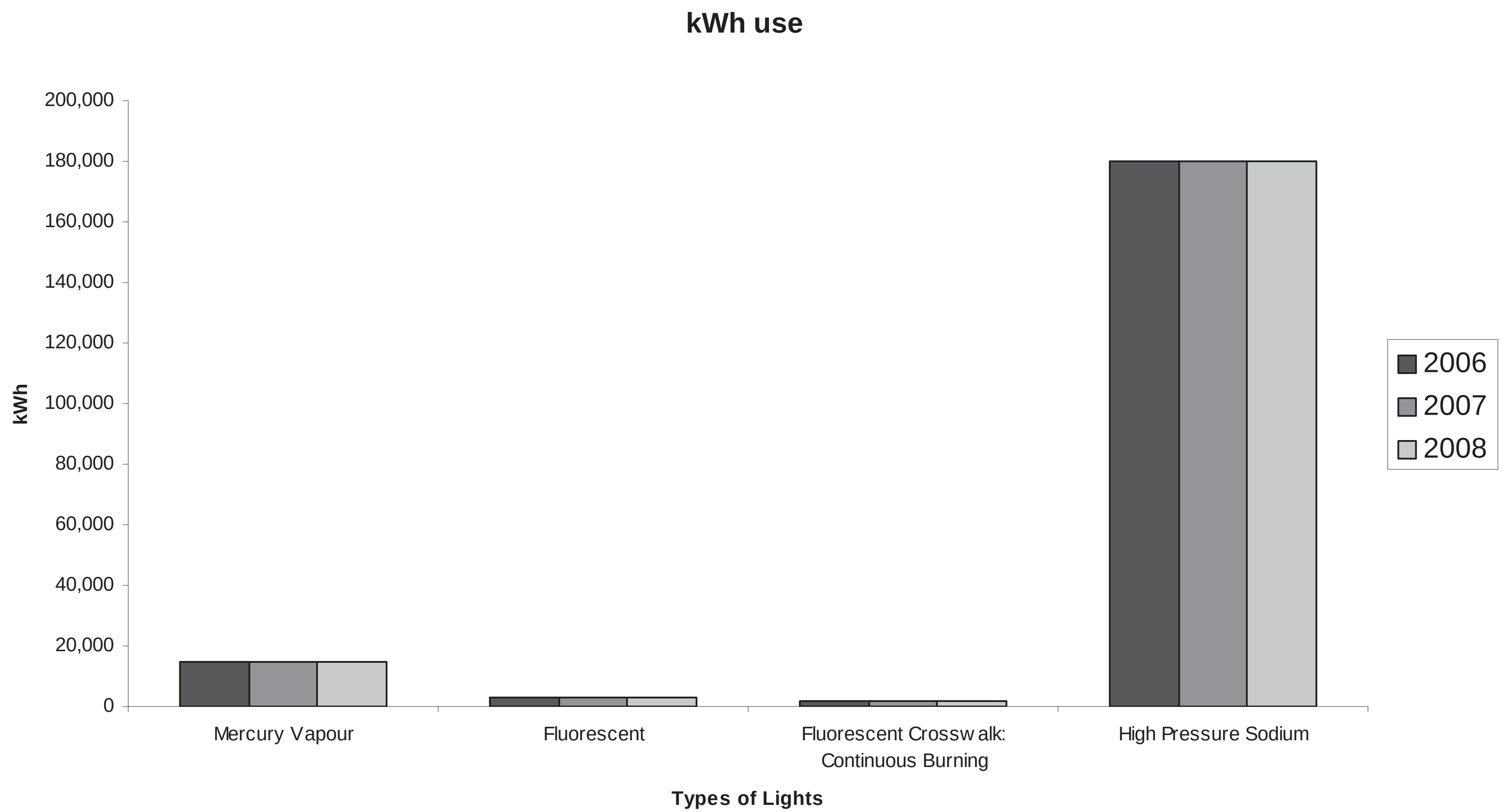

Figure 3. kWh per light type for each year.

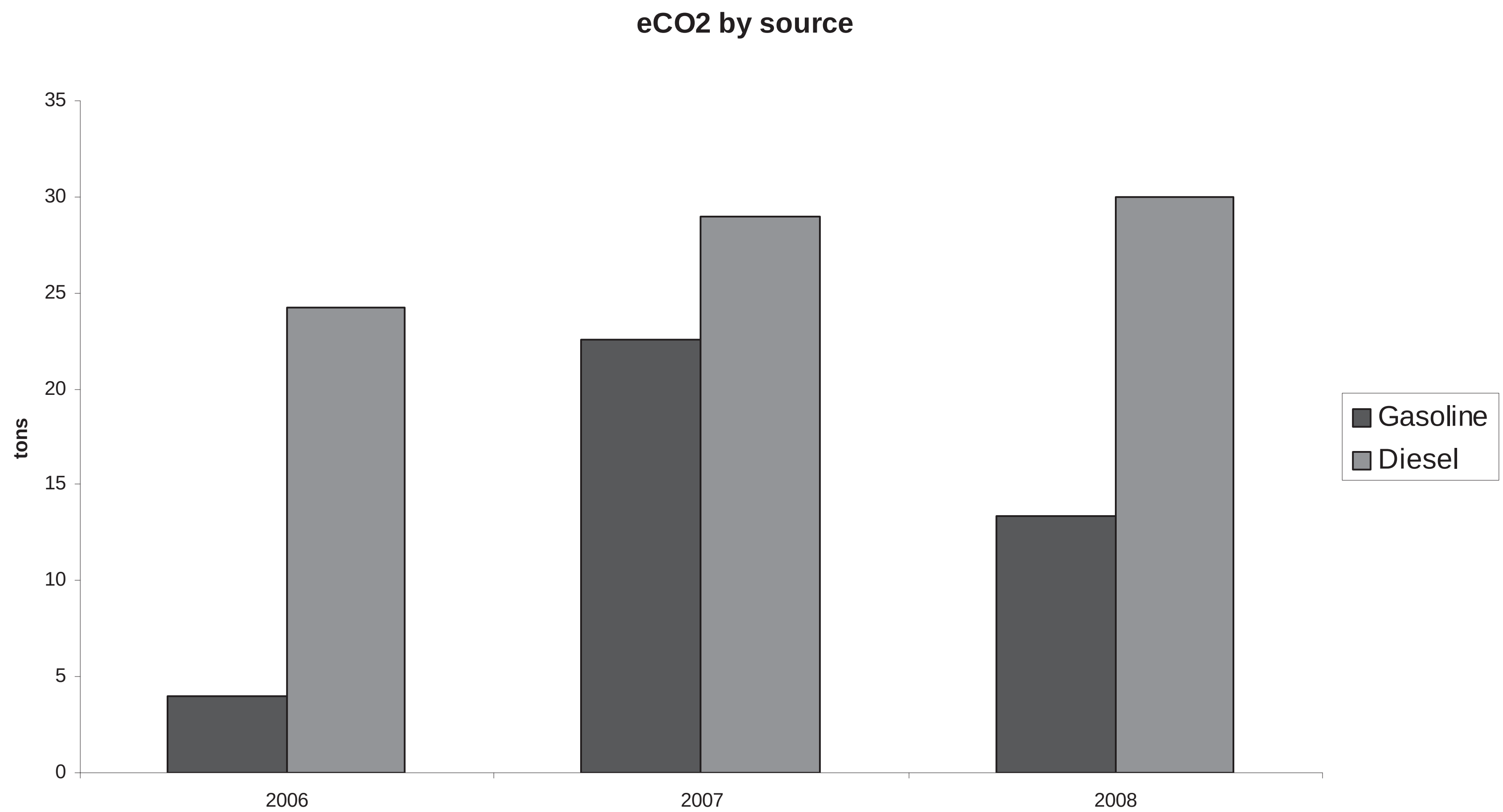

Figure 4. eCO_2 for vehicle fleet by fuel source.

Middleton Town Hall

The Middleton Town Hall is a two-story building with a crawl space basement and an insulated attic. It is an administrative office. There are many good, environmentally-minded practices already in place. A staff that is proactive and conscious is the first step to reducing environmental impact and maximizing energy savings.

Current good practices:

- T-8, open shield lighting
- Unbleached paper towel and Environmental Choice Certified toilet paper
- Thermal pane windows
- Unused rooms are not heated or lit
- Outdoor lights are photo sensitive
- Insulated attic
- Aerators on the faucets

Lighting

The majority of lights within the town office have T-8 bulbs with open shields to allow for maximum lighting. However the stairwell and upstairs hallway had closed shield lighting and there were several small lights which still contained incandescent bulbs. As well, EXIT sign lights had incandescent bulbs. LED bulbs in EXIT signs can save up to $300 per sign in reduced energy, materials and labour for bulb changes (BC Hydro, 2009a).

The following link has a suite of calculators for commercial and institutional organizations for everything from lighting investment paybacks to building energy intensity. It is very useful for determining the potential savings of many energy saving initiatives.
http://oee.nrcan.gc.ca/commercial/technical-info/tools/index.cfm?attr=20

BC Hydro provides many useful tips for energy conserving lighting solutions. This information includes cost, energy savings and financial savings where applicable:
http://www.bchydro.com/buyersguide/Lighting.html

Windows

Although the windows in the office were double paned and at times there was a noticeable draft. Weather stripping and caulking can be relatively inexpensive ways to address this issue. The Natural Resources Canada Office of Energy Efficiency offers many options for increasing the energy efficiency of windows ranging from simple repair to replacement. The link provided describes many methods for improving window energy efficiency.

http://oee.nrcan.gc.ca/residential/personal/window-efficiency.cfm?attr=4

Queen's University is using an incredibly innovative tool to maximize natural light (Queen's University, 2006). They are called light shelves. These shelves reflect sunlight from windows onto the ceiling, which refracts the light into the room. This reduces the need for artificial light and heat. More information about light shelves can be found here: http://livebuilding.queensu.ca/green_features/smart_lighting/light_shelves and here http://www.bchydro.com/buyersguide/Lighting.html.

The Canadian Renewable Energy Network provides many tips on using passive solar energy for heating, cooling and lighting. http://www.canren.gc.ca/tech_appl/index.asp?CaId=5&PgId=303

Water

The toilets in the washrooms had 13L tanks. Now there are many options when it comes to high efficiency toilets: smaller tanks, full and half flush options, those that use vacuums, pressure or gravity in the flushing process. Although initial high efficiency toilets did not perform well, the newer models have been re-engineered and do a more satisfactory job than their 13 L counterparts (Canadian Housing and Mortgage Corporation, 2009b). Toilets with 6L tanks can save more than half of the water of older larger tank models (NRCAN, 2008).

A leaking toilet can waste up to 200 000 L in a year (NRCAN, 2008)! An easy way to test for toilet leaks is to put a few drops of dye in the tank and wait a few minutes. If the dye shows up in the bowl then a leak is present. Another easy but effective way to reduce the amount of water used by toilets is to place a toilet dam or displacement bag in the tank (Figure 5).

The taps in the washrooms were fitted with faucet aerators, an excellent water saving device. Aerators can reduce water use by 25-50% (Environment Canada, 2008a).

Visit the Natural Resources Canada Office of Energy Efficiency website for more water saving ideas: http://oee.nrcan-rncan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4#bathroom

Environment Canada also has some excellent tips. http://www.ec.gc.ca/water/en/info/pubs/brochure/e_iwdww2.htm

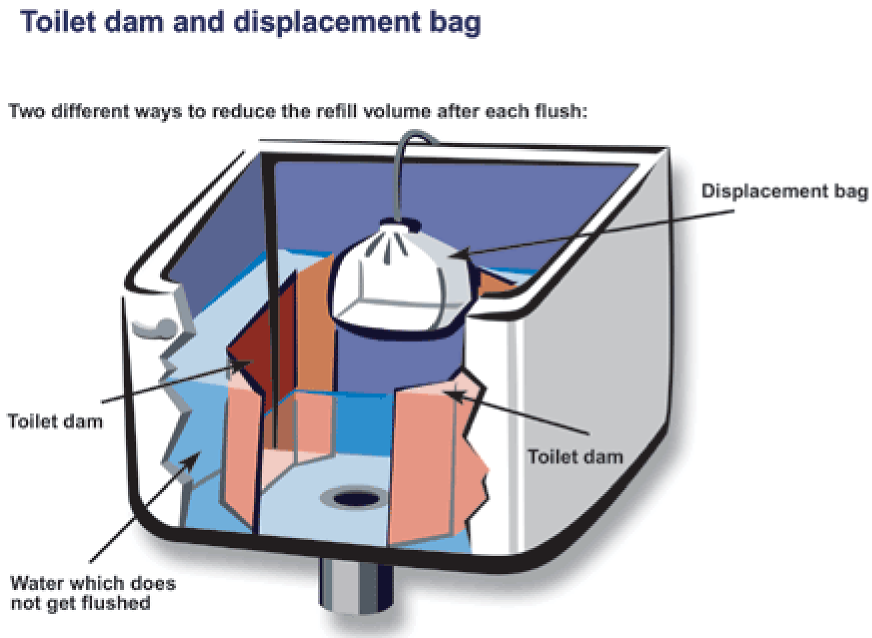

Figure 5. This illustration shows how toilet dams and displacement bags reduce the amount of water used in every flush[#].

Heating

The oil consumed by Town Hall produces on average 78 eCO_2 (tons of CO_2 emitted) per year with an average cost of $21950[*]. As the cost of petroleum is unpredictable, investing in an air source heat pump may be a way to reduce energy costs. Heat pumps use less oil but more electricity. However, in Nova Scotia the majority of electricity is generated by coal, so switching to a heat pump that uses more electricity may actually cause an increase in eCO_2. Heat pumps are also best considered when it is time to replace the current heating unit. Natural Resources Canada estimates that an air source heat pump can save as much as half the fuel cost of an oil furnace and that an air source heat pump pays for itself in 2-4 years (NRCAN, 2008b). However, if a new heating unit is not required, often more energy savings can be realized through sealing heat leaks throughout the building.

Natural Resources Canada has developed a brochure for air source and ground source heat pumps. For more information please follow the link: http://oee.nrcan.gc.ca/publications/infosource/pub/home/heating-heat-pump/contents.cfm

[#] This diagram was retrieved on May 20, 2009 from Water Conservation – Every drop counts! an Environment Canada publication: http://www.ec.gc.ca/water/en/info/pubs/lntwfg/e_chap6.htm
[*] This is an average of oil consumption for 2006, 2007 and 2008. Note this is total oil received both for the Town Hall and the Fire Department as they share a tank.

This link contains a calculator for comparing the costs of your current heating system with the savings offered by newer equipment and other sources of energy. http://oee.rncan.gc.ca/residential/personal/tools/calculators/heatingcalc/index.cfm?attr=0. Although it is a calculator for homes, it can be used to estimate savings for an office building.

Solar energy is an excellent alternative energy option that can reduce greenhouse gas emissions. Some models of solar energy devices can pay for themselves in as little as one year (US Department of Energy, 2004). The following link is for an ecoEnergy incentive program for the industrial/commercial/institutional sector to install active energy-efficient solar air and/or water heating systems. It runs from April 2007 – March 2011.
http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/heat-chauffage/index-eng.cfm

Phantom load

Phantom load refers to the energy consumed by electrical devices when they are shut-off or in standby mode. The Alberta Government, Utilities Consumer Advocate estimates that 10% of the annual electricity uses in Canada is standby power (Alberta Government, 2006). Options for reducing phantom load include: unplug appliances that are not in use, plug appliances into power bars and shut the bars off in the evenings and weekends and choose ENERGY STAR products when replacing appliances.

BC Hydro (2009b) presents these interesting facts about computer phantom load. Screen savers can actually use more energy by displaying complex graphics. Even though a computer may be shut off, it can use over 2 W to maintain local area network connectivity. In hibernate mode, a computer uses approximately 2.3 W and sleep mode uses approximately 3.1 W. Monitors are the only part of your computer that use no energy at all when shut off.

A good estimate of the phantom load produced in a building can be obtained using an electricity use meter, which can be purchased for approximately $25 at a hardware store. In addition, Conserve NS can lend electricity use meters to public and community college libraries. There are useful manuals on the Conserve NS website: http://www.conservens.ca/meter. This website also includes a calculator that can help determine the amount of money being spent on phantom load for various appliances.

ENERGY STAR office equipment is an excellent choice to consider when upgrading office equipment. Energy savings can be in the range of 40-65% by reducing the amount of energy used to perform normal tasks and entering a low power mode when not in use (BC Hydro, 2009c). The following link contained information on the savings that can potentially be realized using EnerGuide and Energy Star products:

http://www.bchydro.com/guides_tips/green_your_business/office_guide/Replace_Worn_Out_Office_Equipment_with_Energy-Saving_Models.html

Green Storage Barn

The public works staff was very proactive about conserving energy. The storage barn is often unoccupied but some equipment stored in the building needs to be protected from the cold. Instead of heating the whole building, the public works staff enclosed an area to be heated and stored the temperature sensitive equipment there. This technique reduced the area that needed to be heated. As well, the staff also fashioned a door brace for the main doors, as they would blow open in high winds. This further ensures that heat loss is reduced.

However, the building is old and there are opportunities to reduce energy loss. Energy savings options include: open fixture lighting and a programmable thermostat. Some potential areas of improvement include: the repair of obvious cracks and holes around garage doors, an upgrade from single paned windows to more efficient models and the replacement of mercury lights with super T-8 CFL bulbs.

Public Works Workshop

The workshop is a building that is more frequently occupied than the storage barn. As mentioned before, the staff is very conscious about turning off lights in areas that are not in use and not heating unused areas. The workshop has some good energy conservative features such as: open fixture lighting, motion sensor outdoor lightings and a programmable thermostat. Like the storage barn, there are cracks and air leaks that could be repaired and the lights contain halogen bulbs and can be updated to super T-8 bulbs.

Lift Stations

These small buildings use electric baseboard heating and have weather stripping around the doors. Compact fluorescent light bulbs are in the fixtures and are only turned on when a worker is in the building. The majority of eCO_2 are related to the pumping equipment.

An important consideration with any motor is to ensure that the size of the motor is suited to its use. Although specialized expertise is required to properly evaluate a motor, the potential savings that can be realized by switching from an oversized to a properly sized motor can be extensive.

Middleton Visitor Information Centre

The Visitor Information Centre (VIC) is only used from May to September. The building has electric baseboards, which are rarely used. A small air conditioning unit is used in the summertime.

The lighting is closed shield with fluorescent lights. There was an older fridge, between thirty and forty years old, which could be updated to a newer more energy efficient model. Older, inefficient models can cost $120 - $150 per year in electricity (Ontario Power Authority, 2009).

The toilets have 13L tanks; switching to newer 6L tanks could potentially save a considerable volume of water. Toilet dams or displacement bags could also provide a cost-effective alternative to new toilets. The sinks do not have faucet aerators, which can also greatly reduce water consumption.

Middleton Library

The Rosa M. Parks Memorial Library is well used by the public. In addition to providing a variety of reading materials for the public, they are also a CAP site and host many workshops, after school clubs and events for the community. The staff is very friendly and positive about reducing their environmental footprint. There are also many good environmentally sound practices in place, such as:

- Using lighting only when necessary
- Not heating unused rooms
- Adjustable thermostats in each room
- Faucet aerators on the washroom taps
- A bike rack outside to encourage active transportation
- Use of natural light
- Thermal pane windows

Lighting

The lights are all T-12 compact fluorescent bulbs with closed shield lighting. There are very few task lights in the building. However, unused spaces are not lit and when possible natural light from windows is used instead of artificial light. The EXIT sign lights are incandescent.

There are many of opportunities for saving energy at the library. An upgrade to super T-8 bulbs could be beneficial, as T-8 bulbs provide lighting that is 40% more efficient than T-12 bulbs (Fetters, 2006). However, T-8 bulbs require electronic ballast, whereas T-12 bulbs require magnetic ballast. Both the T-8 bulbs and their ballasts can be purchased at hardware stores or at any location that sells industrial or commercial style lighting. To further increase lighting efficiency, the existing light shields can be replaced with transparent shields or removed completely.

Windows

There are many windows in the library, all thermal panes. In the main part of the library, the windows provide heat and light, but could not be opened and therefore could not be used for temperature control. However, the library does have two smaller rooms in which the windows could be used for temperature control. There were no obvious drafts from the windows; however choosing insulated windows could go a long way in reducing the library's electricity bill.

Water

The main use of water in the library occurs in the washrooms. Although there are faucet aerators on the taps, the toilets are 13 L tank models and likely flushed frequently throughout the day as the public uses them. There are many options when it comes to high efficiency toilets: smaller tanks, full and half flush options, those that use vacuums, pressure or gravity in the flushing process. Although initial high efficiency toilets did not perform well, the newer models have been re-engineered and do a more satisfactory job than their 13 L counterparts (Canadian Housing and Mortgage Corporation, 2009b). Even though water savings are dependent upon the model being replaced and the new model, basic estimations can be calculated. For example, if the two library 13 L toilets are flushed 10 times a days each (20 total) and are being replaced by 6 L toilets then the estimated water savings would be 140 L each day.

(13 L – 6 L) x 20 flushes/day = 140 L/day

As mentioned previously a shorter term and cheaper water saving alternative is to incorporate the use of water dams or displacement bags in the toilet tank (Figure 5). Once again, the water savings are dependent upon the type of water saving device used.

Heating

The library is heated through electric baseboards. As mentioned previously, each room in the library has an adjustable thermostat so that the rooms do not need to be heated when they are not in use. In addition, the main room in the library has two air conditioning units that are used during the summer.

As previously mentioned, the library is one of the top eCO_2 emitters for the town. There are many opportunities to reduce eCO_2 through innovative heating technology and many options for green heating and cooling systems. GreenHeat Technologies is a good central resource for determining the cost and/or savings or a variety of options including earth, solar and biomass energy. The website is http://greenheat.org/links.html

Phantom load

As the library is a CAP site, there are multiple computers on site. Although they are used frequently throughout the day, there are opportunities for energy savings. Screen savers can actually use more energy by displaying complex graphics (BC Hydro, 2009b). Even though a computer may be shut off, it can use over 2 W to maintain local area network connectivity and in hibernate mode, a computer uses approximately 2.3 W and sleep mode uses approximately 3.1 W (BC Hydro, 2009). Monitors are the only part of the computer that use no energy at all when shut off (BC Hydro, 2009b).

Between appointments, users can be asked to shut off the monitor, or if a computer is not likely to be used for a few hours it can be shut off completely. As well, connecting the computers to power bars entirely stops the loss of energy to phantom use when the power bars are shut off. Any sort of major office appliance, such as a photocopier, can be connected to a power bar and shut off when not in use. When office equipment needs to be replaced, Energy Star and EnerGuide products can be purchased.
http://www.bchydro.com/guides_tips/green_your_business/office_guide/Replace_Worn_Out_Office_Equipment_with_Energy-Saving_Models.html

Summary and Recommendations

The annual average for calculated greenhouse gas emissions in the Town of Middleton is 1300 tons with electricity being the greatest single contributor. Fortunately there are many options available for reducing electrical energy consumption. Below a list of recommendations for the town has been generated. These have been broken into short and long term recommendations, based mostly on the cost of the change. Where applicable, the payback period for a certain measure has been indicated.

Table 5. ToM annual average eCO_2 by source.

Average oil use		Average diesel use		Average gasoline use		Average electricity use*	
Litres	eCO_2	Litres	eCO_2	Litres	eCO_2	kWh	eCO_2
29280	78	7260	19	2460	5.76	1180000	1200
6%		1.5%		0.4%		92%	
Total eCO_2						**1300**	

* This includes an annual average kWh for the streetlights.

Table 6. Short term+ energy efficiency measure

Category	Action	Cost	Payback Period
Lighting	Encourage staff to use natural light when possible	$0	Immediate
	Convert to LED bulbs in Exit lights	$39-$60 (Wisconsin Focus on Energy, 2009)	Payback period: fluorescent to LED 1.43 years; incandescent to LED 0.54 years (Jansson *et al.*, 2006)
	Encourage staff to always shut off lights in areas that are not being used	$0	Immediate
	Clean lights regularly, dust and dirt can reduce light by 30% (BC Hydro, 2009d)	$0	Immediate
Windows	Weather strip, caulk and insulate current windows	Caulking: $3 - $13 Window insulating film: $15 - $25	Payback period for weather-stripping: 3- 5 years, based on estimated cost of $125 (Canadian Mortgage and Housing Corporation, 2009)
Water	Install faucet aerators on all taps	Faucet aerators: $5 - $10	Faucet aerators can save $28/year in hot water costs (BC Hydro, 2009e)
	Use toilet dams, displacement bags or other water efficiency tools in all toilet tanks	Toilet dams: $10 (Environment Canada, 2008b)	
Heating	Turn down the temperature in the office during evenings and weekends	$0	Immediate
	Turn off heat to seldom used areas	$0	Immediate
	Open blinds to allow the sun's energy to add to the heat of a	$0	Immediate

+ Cost and payback period are calculated for one item. Multiple items do not affect payback period, but do affect cost.

	room		
Phantom load	Use power bars on all sockets	Power bar: $7 - $30	
	Turn off power bars or unplug equipment that is not constantly in use (ex. photocopier)	$0	Immediate
	Turn off computer monitor when not in use	$0	Immediate
	Turn off all equipment during evenings and weekends	$0	Immediate

Table 7. Long term+ energy efficiency measures

Category	Action	Cost	Payback Period
Lighting	Convert all lights and lighting fixtures to super T-8's.		Payback period: T-12 to Super T-8 1.57 years; T-8 (700 series) to Super T-8 2.84 years (Newman, 2009)
	Implement light shelves		Payback period: minimum of 10 years (Wulfinghoff, 1999)
	Where possible implement task lighting, instead of lighting a whole room	$0	Immediate
	Replace high intensity sodium streetlights with LED lights.		Pay back period: 3.3 years (LEDcity, 2008b)
Windows	Replace current windows with higher efficiency models	*Dependent upon cost of replacement windows and number of windows replaced	
Water	Replace 13L tank with a low flow option		Less than one year (Alberta Environment, 2009)
Heating	Install an air or ground sourced heat pump		Payback Period*: 1.8 - 2.7 years for a high efficiency air source

+ Cost and payback period are calculated for one item. Multiple items do not affect payback period, but do affect cost.
* This payback period is calculated for a residential building.

			with electric resistance backup and 1.6 -2.4 for a standard efficiency model (Natural Resources Canada, 2008)
	Turn to a solar energy alternative	*Dependent upon model	
Phantom load	Replace current models with higher efficiency models such as EnerGuide or Energy Star	*Dependent upon model	

Riparian Habitat Restoration

The Town of Middleton owns considerable property along the floodplain of the Annapolis River (Figure 7; Appendices A and B). There is about 5000 m of riverbank where significant bank erosion can be seen. In past years, approximately 30 cattle have been pastured at this site. It is likely that the unrestricted access the cattle had to the river has contributed to the fragility of the banks, causing compaction and erosion. An agreement has been reached to remove the cattle to preserve the work that has been done to repair the site. This site is important because it is an area of concern for the protection of the Town of Middleton aquifer, as well as housing a sizeable stand of Eastern white cedar, an endangered species in Nova Scotia.

Water quality and habitat can be degraded when livestock are allowed unrestricted access as described by Hoorman and McCutcheon (2009), Li et al., (1994), Bellows (2003), Trimble and Mendel (1995), Waters (1995) and Fitch and Adams (1998):

Livestock grazing in riparian areas can seriously inhibit natural functions of the site. The livestock can compact the soil by frequenting the same areas this can result in increased erosion and reduced infiltration. This reduces the ability of the land to retain water and nutrients. Soil compaction also makes it more difficult for plants and other organisms to permeate the soil. Aquatic species are also sensitive to sediment load in a waterway. It is not only an abrasive agent, but also it can clog gills.

Riparian vegetation can be reduced through grazing as well as trampling. If there is reduced vegetation this results in less shade, which can increase overall water temperatures. Warmer water holds less dissolved oxygen than colder water. Reduced dissolved oxygen levels can threaten aquatic wildlife. Livestock deposit manure and urine in riparian areas. Not only does this lead to increased nutrient levels but decaying matter in a water body also uses up available oxygen.

To restore this site to a point where it can be called ecologically healthy will be a long-term process. It takes years to alter a forested floodplain to make it suitable for agriculture and conversely takes years for the land to return to a natural state. There are unstable sections of bank along the river at this site. By planting willow stakes at these places the roots can stabilize soil and branches can offer shade for the river. It is hoped that if the site is left untouched by agricultural practices and restoration work completed it will return to a more naturalized habitat. It is hoped that these plants will thrive and contribute to the diversification of the site.

The overall goal of riparian restoration at this site is to create a functioning, diverse riparian zone that is representative of the Annapolis Valley. This would be characterized by:

- Flood retention
- Water filtration
- Soil retention
- Soil management
- Representative species diversity

To ensure the success of the work at this site, a rehabilitation plan has been created. This plan will be following the principles of adaptive management, which is essentially altering practices and policies as more experience or knowledge is gained. Figure 6 illustrates adaptive management. It is a continuous process, as ecosystems are dynamic and can develop or behave in unpredictable ways.

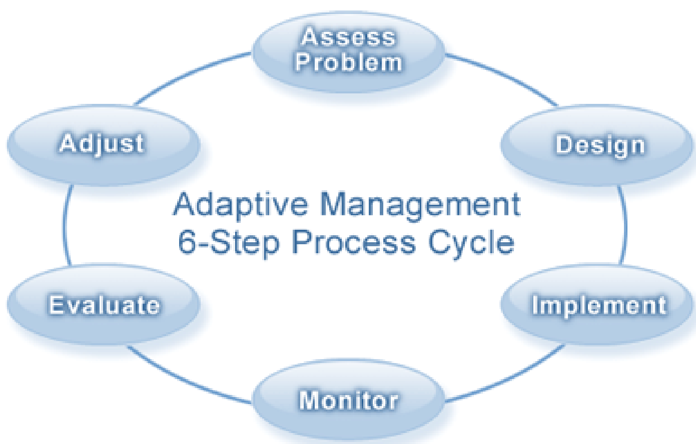

Figure 6. The iterative cycle of adaptive management*.

* This image retrieved on June 19, 2009 from An Introductory Guide to Adaptive Management for Project Leaders and Participants, a Government of British Columbia website: http://www.for.gov.bc.ca/hfp/amhome/Training/am-intro-guide-intro.htm

- Assess and define the problem
- Design
- Implementation
- Monitoring
- Evaluation of results
- Adjustment/ Revision of Hypotheses & Management

A five-year plan for this site has been developed. It will be discussed later in this report.

Methodology

For the Middleton site five actions were implemented to achieve the overall goal of riparian restoration. They are described below, adapted from Neish's 2008 report.

- Planting live stakes and/or native plants
- Fencing livestock out of riparian areas and waterways
- Improving fish and wildlife habitat
- Increasing public awareness of issues that threaten riparian health
- Assisting landowners in environmental stewardship

Live Willow Staking and Tree Planting

Live willow stakes and willow trees were planted approximately 1 meter apart in two or three parallel rows along the banks of waterways within the Annapolis Watershed. The willows stabilize eroding riverbanks, and reduce sedimentation rates in the river. These willows act as nutrient absorbers from surface waters flowing through the riparian area while contributing temperature regulating shade, sediment filtration and habitat for fish and wildlife.

Native nursery stock was planted in an attempt to create a more naturalized habitat (Figure 8). The species were selected based on their suitability to site conditions, as well as food and cover sources for wildlife. These species include: red maple (*acer rubrum*), elderberry (*sambucus nigra*), highbush cranberry (*viburnum trilobium*), yellow birch (*betula alleghenesis*), white pine (*pinus strobus*), eastern hemlock (*tsuga Canadensis*) and red osier dogwood (*cornus sericea*). The site where the native species were planted is adjacent to the proposed wetland. It is hoped that the native nursery stock will create cover, habitat and a food source for wildlife and supplement the compensation wetland.

Fence Installation

The type of fencing at the site was three-strand barbed-wire fence. The barbed wire fence was constructed with untreated spruce posts spaced at approximately 2 meters. These choices in materials were based on longevity of the fence, as well as the need to select materials that would not leach harmful substances into the waterways.

Public Awareness

Through the interaction with the landowner and communications regarding the importance of riparian habitat and agricultural land-use practices, the value of this type of initiative will be imprinted on the community. It has been found, when undertaking similar projects in the past, that word-of-mouth quickly increases awareness and influences local attitudes.

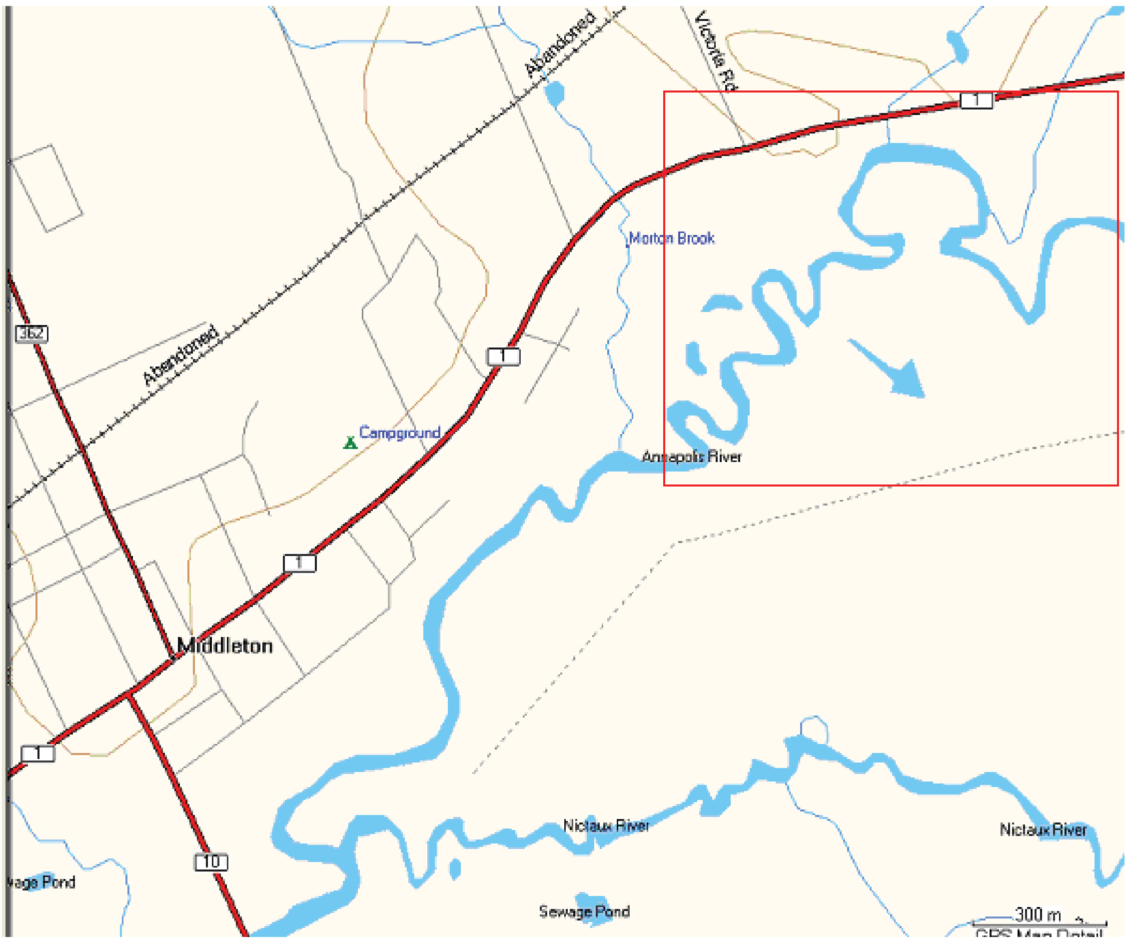

Figure 7. The square indicates the area in which riparian restoration work has been completed during the 2008 and 2009 field seasons (Appendix C includes photographs taken of field work). Note: North points into the top left corner. All the fieldwork that has been completed has happened on the south side of the river.

Photo documentation

A photo documentation protocol has been developed as a means to monitor and catalogue the development and progress of the site as it returns to a naturalized state and as more work is completed. As mentioned above this will be a multi year process, not only in habitat and riparian restoration work but also in natural reclamation for the site to become ecologically healthy. A standardized methodology of photo documentation was created this year and will continue in future years.

The protocol was developed based on “A User Guide to Photopoint Monitoring Techniques for Riparian Areas- Field Tests Edition” produced by Aqua-Tex Scientific Consulting Ltd. and Cooperative Riparian Restoration. First, a GPS unit marked the position the image was taken from and elevation. Second, the height at which the camera was held was recorded. Third, the bearing on the GPS unit was recorded. The pictures were then stitched together using Zoom Browser to create a panoramic view (Appendix D).

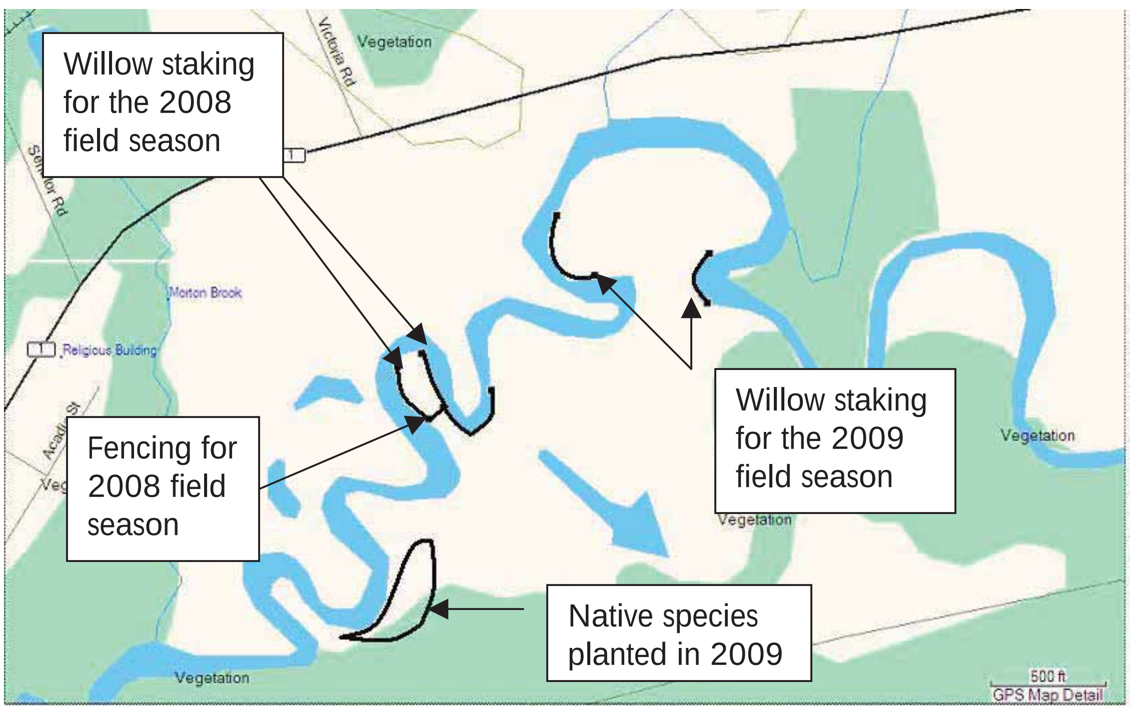

Figure 8. A map of the site for riparian restoration work in Middleton.

Riparian Restoration

Action has already been taken to protect this property. This land was previously leased to a farmer for his cattle to graze. The cattle have been removed from the site for the 2009 season.

In 2008, a peninsula was fenced off to exclude cattle (Figure 8). At that location 1020 live stakes were installed. That work protected 8750m^2 of riparian zone. The 2009 field component a total of 1030 stakes were collected and planted at the Middleton site covering 146 m of riverbank. They were placed at the outside bends of two meanders to stabilize the bank (Figure 8). The banks were eroding quite quickly and prematurely because of previous damage from agricultural operations. The stakes are red osier dogwood (*cornus sericea*) and willow (*salix sp.*) both of which quickly root, binding the soil and leaf out to provide shade for the waterway and cover for wildlife. Additionally, both species are an excellent source of food for mammals.

Although this action will not be completed by the end of this project it is still important to include it as it is likely to have significant impact on the overall health of the Annapolis River in this area. As a result of the construction of a long-term health care facility, 1.7 ha of existing wetland will be filled. Because of this Gem Health Care Group is responsible for constructing a 5.3 ha compensation wetland. This compensation wetland, a marsh-swamp complex, will be developed at the Middleton riparian restoration site (Figure 10). The proposed wetland will be a diverse, self-managing, and resilient ecosystem. Wetland habitats include tall shrub swamp, wet meadow, and shallow marsh (along with upland inclusions). The site will be constructed using as much organic substrate collected from the wetland at the site of the proposed long-term health care facility as possible. Special care is being taken to ensure that a wide range of species will be able to thrive in this new wetland, particularly black ash (*Fraxinus nigra*) and eastern white cedar (*Thuja occidentalis*).

The landowner has signed a stewardship agreement for the riparian enhancement and protection under taken on the property. This agreement ensures maintenance of the fence installed on the site, as well as protection of the native shrubs and trees planted on site (Appendix F).

Flood plain rehabilitation plan

As the site is predominantly pastureland there is plenty of opportunity for planting native species that are representative of a floodplain habitat. At the Middleton site there are sections of bank that could benefit from additional willow staking and areas where native shrubs and trees can be planted (Figure 9).

Year 1 (2008)

- Trialing of live staking technique in areas of most significant erosion
- Exclusion of livestock from selected areas of site

Year 2 (2009)

- Reassess site status
- Expansion of live staking
- 72 native trees and shrubs planted

- Initiation of photo documentation monitoring
- Initiation of constructed wetland
- Exclusion of cattle from entire site

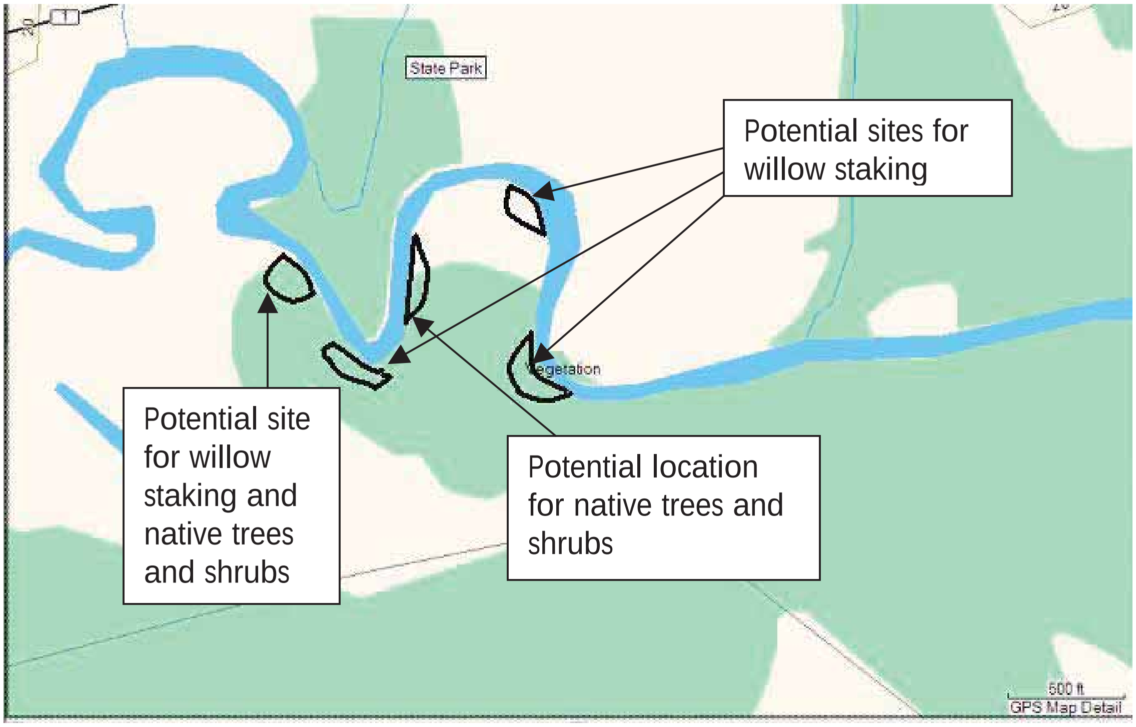

Figure 9. A map of potential future work sites in Middleton.

Year 3 (2010)

- Reassess site status
- Monitoring and control of invasive species
- Continuation of live staking
- Native trees and shrubs planting
- Photo documentation continued

Year 4 (2011)

- Reassess site status
- Continuation of live staking
- Monitoring and control of invasive species
- Native trees and shrubs planting
- Photo documentation continued

Year 5 (2012)

- Reassess site status
- Continuation of live staking
- Monitoring and control of invasive species
- Native trees and shrubs planting

- Photo documentation continued

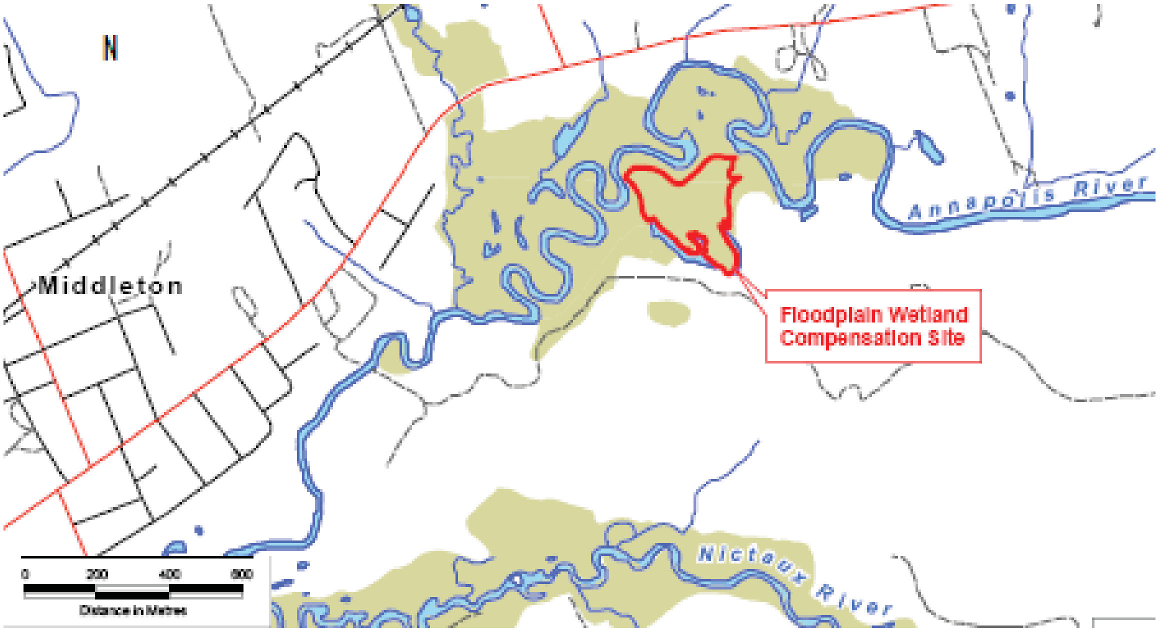

Figure 10. The compensation wetland, as proposed by Jacques Whitford Stantec Limited*.

Conclusion

Already an environmentally focused community, there was a lot of positive receptivity from the Town and businesses to learn how reduce their energy use, as well as support the riparian zone restoration work. Although climate change is often seen as a negative thing, there are many opportunities to create positives out of the changes that can occur. By accepting the reality that change is on the way, the Town of Middleton has begun to prepare itself for possible challenges.

* This image was adapted from: Wetland Compensation Plan Annapolis River Floodplain Site Middleton, Nova Scotia. Prepared by Jacques Whitford Stantec Limited for GEM Health Care Group, April 2009.

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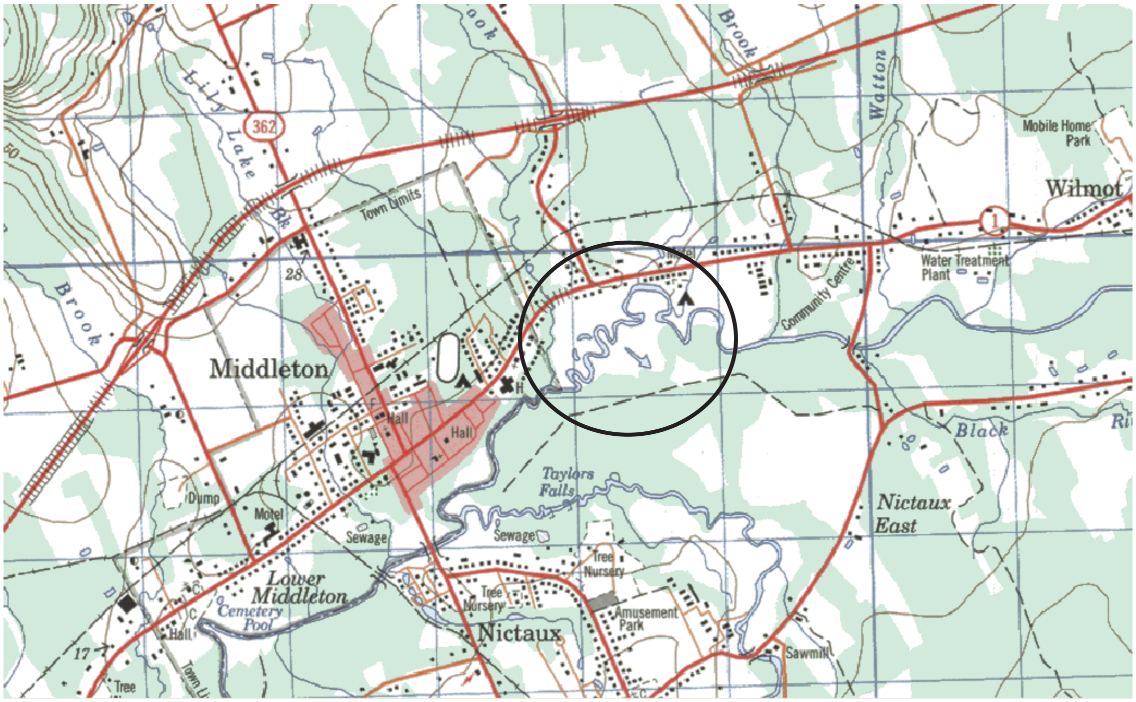
Appendix A – Topographic Map of Work Site



i. Topographic map of the Middleton, with the Middleton site encircled.

Appendix B – Aerial Photographs of Work Site

i. Aerial photograph of Middleton riparian work site.

ii. Riparian work completed in 2008. Number 1 indicates fencing and number 2 indicates willow staking.

Appendix C – Photographs of work and progress

1. Willows staked in the 2008 field season.

2. Growth on willow stake from 2008.

3. Location 1 for 2009 willow staking.

4. Location 1, willow staking completed.

5. The willow staking process.

6. Flourishing *Sambucus nigra* approximately two weeks after planted.

7. *Cornus sericea*, approximately two weeks after planting.

Appendix D - Photo Point Monitoring Images

Table 8. Photo point image descriptions

Way Point #	Coordinates	Estimated Accuracy	Elevation	Height From Ground Level	Photo #'s	Panoramic Title
#008	N44 56.908 W65 03.034	3.2m	12m	1.6m	01, 02, 03	Stitch of WP008
#009	N44 56.906 W65 03.034	3.7m	23m	1.6m	04, 05, 06	Stitch of WP009
#010	N44 56.902 W65 03.049	3.9m	15m	1.0m	07, 08, 09, 10	Stitch of WP010
#011	N44 56.902 W65 03.062	3.3m	12m	1.3m	14, 15, 13	Stitch of WP011
#014	N44 56.904 W65 03.079	5.2m	26m	1.5m	17, 18	Stitch of WP014
#016	N44 56.900 W65 03.086	6.5m	16m	1.5m	19, 20, 21	Stitch of WP016
#018	N44 56.897 W65 03.096	5.3m	17m	1.6m	22, 23, 24	Stitch of WP018
#019	N44 56.889 W65 03.106	6.1m	20m	1.5m	25, 26, 27	Stitch of WP019
#020	N44 57.083 W65 02.770	5.4m	16m	1.7m	53, 54, 55	Stitch of WP020
#021	N44 57.087 W65 02.764	5.7m	10m	1.7m	56, 57, 58	Stitch of WP021
#023	N44 56.986 W65 03.038	4.0m	15m	1.6m	66, 67, 68	Stitch of WP023
#027	N44 56.975 W65 03.038	4.4m	14m	1.6m	69, 70, 71	Stitch of WP027
#026	N44 56.968 W65 03.030	3.7m	15m	1.6m	72, 73, 74. 75	Stitch of WP026
#024	N44 56.966 W65 03.010	5.4m	16m	1.6m	76, 77, 78, 79	Stitch of WP024

Images of area where native trees and shrubs were planted (2009)

WP008

WP009

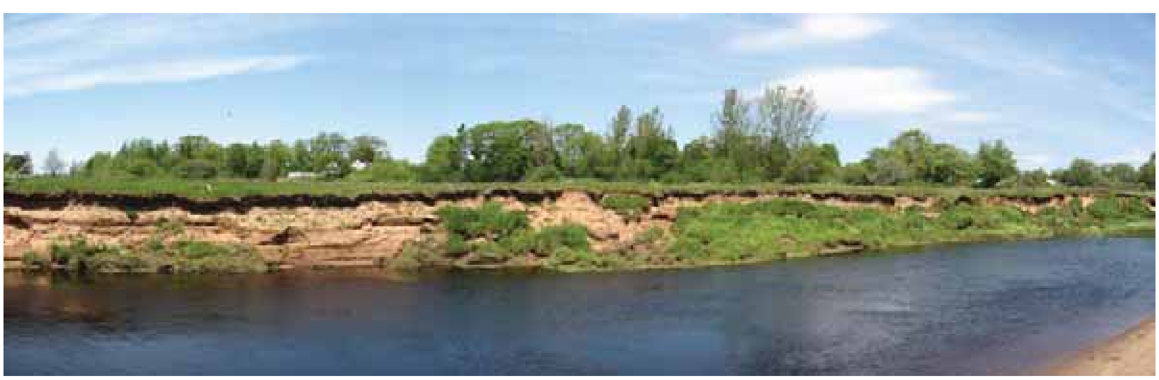
WP010

WP011

WP012

Images of areas where live staking took place (2009)

WP013



WP014

WP015

WP016

WP017

WP018

Appendix E – Town of Middleton Streetlight Survey

Table D1. Streetlight survey for the Town of Middleton*

Street	Number of lights
Commercial	44
Brooklyn	6
Main	56
Duke	2
Acadia	2
Oakland	6
Birch	1
Pinecrest	4
Taylor	4
Jones	1
Goucher	2
Riverside	1
Ross	3
Connaught	9
King	7
Maple	3
Spring Garden	2
Bridge	7
Magee	2
George	3
Mackenzie	2
Marshall	17
Queen	2
North	6
Chapel	1
Mill	1
Meadow	4
Bentley	7
School	17
Freeman	3
Gates	9
Church	3
Centre	2
Victoria	9
Senator	1
Total	**249**

* This table does not include cross walk lights

Appendix F – Stewardship Agreement

Clean Annapolis River Project

151 Victoria Street
P.O. Box 395 Annapolis Royal, NS
B0S 1A0

Toll Free: 1-888-547-4344
Phone. 902-532-7533
Fax. 902-532-3038

Riparian Habitat Stewardship Agreement

I hereby agree to support the riparian habitat enhancement and protection work undertaken on my properties: 05187836 and 05030531 in partnership with Clean Annapolis River Project as Follows.

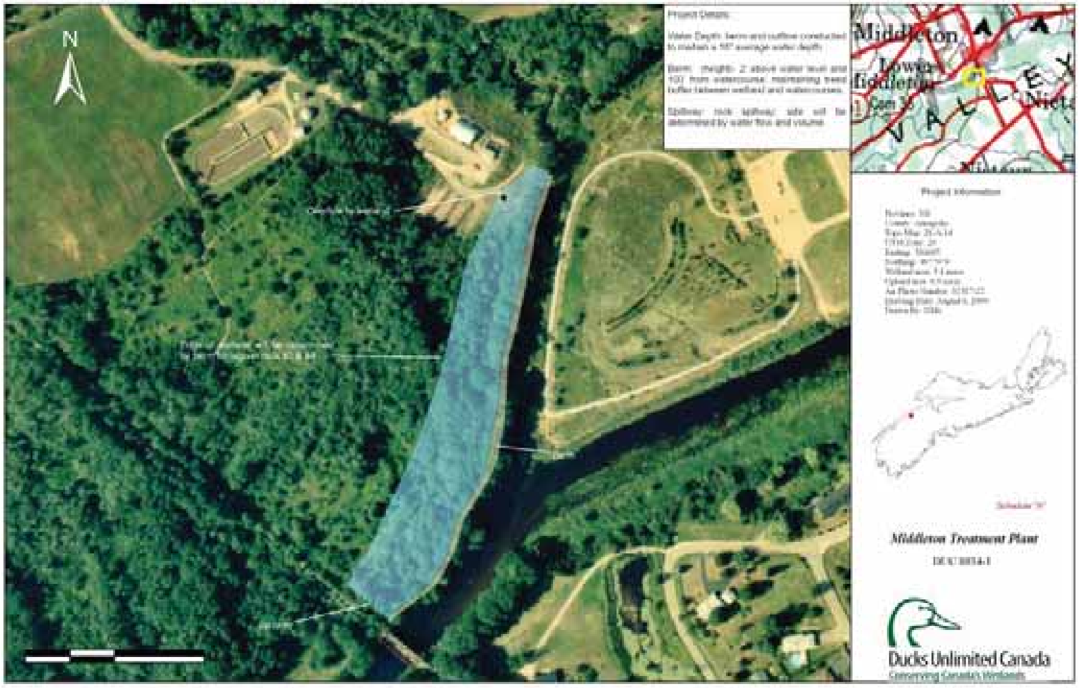
- I agree to use all materials donated by Clean Annapolis River Project for use in the project for the purpose they were intended for, as agreed to with Clean Annapolis River Project.
- I agree to maintain all structures constructed on my property as part of the project for a period of at least ten years, or until, due to land use changes, they are no longer needed to achieve the purpose they were intended for.
- Where reforestation has taken place on my property, I agree to retain a forested riparian buffer zone, and to refrain from removing any trees that were planted there by Clean Annapolis River Project.

Signature of Project Participant: [illegible]
Name of Project Participant: Town of Middleton
Date: June/30/09

Stephen Hawboldt
Executive Director
Clean Annapolis River Project

carp@annapolisriver.ca
www.annapolisriver.ca

Appendix G – Tertiary Treatment Wetland



1. Conceptual design for the Middleton tertiary treatment wetland, submitted by Ducks Unlimited Canada.

Appendix H – Middleton Water Pricing Report

Municipal Water Use Pricing Structure Options

Report prepared for the Town of Middleton, as part of the
Green Heart of the Valley Project

February 2009

Nicole Oliver

Clean Annapolis River Project

Table of Contents

Executive Summary

As part of the Green Heart of the Valley project, the Town of Middleton is planning to replace their current sewage treatment plant and upgrade beyond what is required by government standards. This document is an exploration of water pricing structures, evaluating pros and cons of each, to allow the Town of Middleton to make the best choice possible in financing the upgrade and providing high quality water for human consumption.

There is increasing concern about the quantity and quality of water that we consume (Meakin, 1993). Average Canadian water use is second only to Americans (Jane Goodall Institute of Canada, 2009) with the average Canadian household using more than 300L each day (Real Estate Institute of Canada, 2002). Part of this consumption trend is perpetuated through misconceptions about the true price of water. This is true of municipal water systems. Many pricing structures do not cover the full cost of water, encourage conservation or provide funds for upgrades and repairs of existing infrastructure.

Volume based charges are essentially user pay pricing structures. Pricing structures such as universal monitoring, increasing block rate, sewer surcharge and seasonal peak load are much better conservation tools than flat rate structures. As nearly every human use of water degrades the quality in some aspect, removing less water from the natural environment not only protects the ecosystems it, but also reduces the volume of poorer quality water re-entering the system (Meakin, 1993). There is also the financial benefit on the part of the utility commission. By reducing the volume of water consumed, the amount of water that needs to be treated also reduces. Therefore, if the volume of water treated by a plant decreases by 30% and all else being equal, the life of that treatment plant has also been extended by 30%. As well there are additional savings in terms of substances used in the treatment process such as chloride. This can mean savings in terms of hundreds of thousands of dollars by deferring upgrades or replacements.

Four case studies are included within the report of communities that implemented user pay pricing systems. Savings realized through conservation range from $12,000 to $53,000 each year in reduced costs. One community was able to defer finding a new water supply, which is a $50,000,000 expense. These are significant savings. However as there is a disconnect between the actual cost of water and the price the public is willing to pay there needs to be a reconciliation between the two. Educating the public about the actual cost of providing potable water, as well as making the transition easy and positive should alleviate resistance. As the Town of Middleton has already had great success in working with its citizens to reduce water consumption, an environmental ethic is already present within the community.

Introduction

Freshwater resources are perceived by most Canadians to be in abundant supply (Real Estate Institute of Canada, 2002). It is also considered a renewable source because it is continually moving through the hydrologic cycle. Canadian water usage certainly does not appear to contest this theory of abundance. In 2004 the average Canadian used 329 L per capita (Real Estate Institute of Canada, 2002), in 1999 the average Canadian used 343 L and 335 L in 2001 (Water Governance, 2009b). These figures are significantly higher than many European countries (Figure 1). Despite the fact that Canada holds 20% of the world's freshwater, we possess only 6.5% of the world's renewable supply (Water Governance, 2009a). Over half of the Canadian freshwater supply flows north, away from our most populated regions (Water Governance, 2009a). By 2011 Canadian municipal water use will be double what it was in the early nineties if growth and consumption patterns remain the same (Meakin, 1993). This rapidly escalating water use could mean water shortages for Canada (Meakin, 1993).

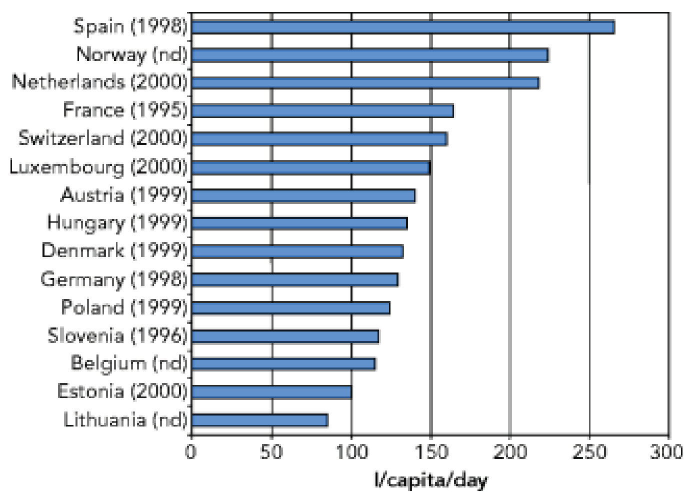


Figure 1. Water consumption in L/capita/day for selected European countries*.

How do Canadians consume such large volumes of water? The answer may be in the value that we assign water. At a conference, a PhD economy student with the University of Chicago stated: "We need to put costs for water and wastewater in context; people are willing to pay far more for soft drinks and other beverages than for tap water." He went on to state that Americans tend to have a greater understanding of global scale problems, such as global warming but knowledge of more local problems, such as producing and providing resources eluded them. As well "people generally also have no sense of how much water costs; even examining local utility bills, it can be difficult to understand. The prices of other resources (e.g., gas) are far more obvious and visible." (Coursey, 2006) Although this is a commentary on the

* Source: European Environment Agency, http://themes.eea.europa.eu/Specific_media/water/indicators/WQ02e,2003.1001/Figure05_11.png/view

American perspective, based on similarities between the countries it is safe to assume that it is also valid for many Canadians.

The price we pay for municipal water and wastewater may be another significant factor. There is a concern among water experts that provincial and municipal water prices rarely reflect the true value of water. This skewed view can result in “over consumption, water use conflicts, deteriorating infrastructure, declining water quality, and stifled innovation in water-conserving technologies” (Water Governance, 2009c). A significant fault to these inaccurate water prices is that insufficient revenue is generated to meet water utility capital and operating costs (Water Governance, 2009c). In addition, water providers must look to other sources of funding to finance repair and replacement of aging water infrastructure. Canadian overuse of water costs billions of dollars in supply and wastewater infrastructure (Meakin, 1993). Although water itself is free, producing potable water is a very costly enterprise.

Aside from social and economic affects of water use, there is a suite of environmental impacts. There are two main types of usage: instream and withdrawal but for the purposes of this paper, withdrawal is the more relevant. Withdrawal use often returns less water than it removed and the water it returns is usually of a lower quality (Meakin, 1993). Meakin (1993) identifies suspended solids (TSS – total suspended solids), organic material (BOD – biochemical oxygen demand), toxic contaminants, and nutrients are the major pollutants affecting water quality.

Suspended solids reduce instream visibility, clog gills and in some instances abrade organisms that live within the water body. Biochemical oxygen demand is essentially a measure of the rate at which organisms use oxygen. The introduction of organic content can increase the BOD. For example, the decomposition of organic material consumes oxygen, reducing the amount available for organisms within the water system. Toxic contaminants can produce a suite of problems for organisms. Examples include reducing oxygen content in the blood, organ deterioration, mutations and/or increase genetic defects in young. Excess nutrients can cause similar effects of increased BOD. Excess nutrients can cause an increase in aquatic populations, which can reach such levels that they cannot be supported within the system. These organisms die and decompose and remove oxygen from the water.

A series of problems arise because Canadians do not really understand the true cost of providing potable water:

1. Our water supply is limited
2. The price charged for water utilities often does not pay for operating and maintenance costs
3. Revenue from providing water utility services does not cover the cost of repairs, upgrades, expansions and replacements to existing water infrastructure
4. Negative environmental impacts of water use

The fact that water is essential to many of our daily activities is undeniable. However, water can be used in a responsible way. The rest of this paper will explore water-pricing options, how water-pricing structures exist in Canada and ways that other communities have found ways to charge accurate prices for water and encourage conservation.

Water Pricing Options

Metering

Using a water metering based pricing system is essentially a 'user pays' system. A user is charged based on the volume of water they use, sometimes with a fix base charge. Water metering can be an effective way to encourage conservation by residential users. Often there is an initial decline in use, with a following rebound period (Loudon, 1994). As long as the pricing structure encourages conservation (or penalizes excessive use) metering will be an effective conservation measure (Loudon, 1994).

Sewer Surcharge

A sewer surcharge is generally a straight percentage add-on to the bill (Loudon, 1994). While this is often used to help recover the cost of treating wastewater it can also be an effective tool in encouraging conservation (Loudon, 1994). A sewer surcharge raises the user's bill by being added on top of the rate the user is charged. If the surcharge is a significant addition users may seek to offset that additional cost by reducing water use.

Increasing Block Rates

This is a 'class-based' charging system. The first block of each class is designed to encompass the average water consumption of a customer in that class (ex. a family). Consumption beyond the initial block is charged at a higher rate. This can be an effective way of encouraging water conservation, as long as the price difference between subsequent blocks is significant (Kitchener, 2007).

Declining Block Rates

A declining block rate is also a 'class-based' model. Often accompanied by constant service or basic fee charge, the cost per unit decreases as consumption increases. The amount of the constant charge is often dependent upon the size of the connection (Kitchener, 2007). Often the initial block rate is based on the expected consumption for a family, the second block rate is designed for the consumption for most middle-sized commercial customers and the third block is based on consumption for larger commercial customers (Kitchener, 2007). This method is thought to discourage water conservation, as cost decreases with increasing volume.

Constant Unit Charge

This is a very simple, volumetric based pricing option. A constant unit rate is constant rate per unit consumed. However, this pricing option is unlikely to cover the cost of providing water because the marginal cost is not constant (Kitchener, 2007). The marginal cost is dependent upon the quantity of water consumed. Kitchener (2007) states that this form of water pricing does not encourage water conservation in that it can conceal the true price of water production.

Flat Rate Charge

A flat rate system charges each user the same amount regardless of volume of water used. This rate system does not give users any real sense of the true value of water. It also does not directly encourage conservation or thoughtful usage. It is easily understood by the users and presents stability for the utility managers in providing a predictable income per user (Source, 2005).

Property Tax (Ad valorem taxes)

In this charging system the costs of operating and maintaining a wastewater plant based on the assessed value of the user's property. The logic behind this system is the higher the value of the property, the greater the ability to pay for services (Myers, 1998). However the relationship between usage and property value is not necessarily strong or even present. To address this disparity some utility providers include a significant fixed charge to moderate the variability in charges due to different property values.

Seasonal Rates

This charging system takes into accountant that water usage varies throughout the year. For the peak season (time of year when water use is at its highest) users are charged at a higher rate. This is implemented to cover the increased cost of providing additional water (Kitchener, 2007). Generally, in Canada, peak season is the summer due to residential lawn watering. The summer rate is applied to all users and based on the user's winter usage patterns. By charging a seasonal rate, the variable capital costs are covered by peak season water use and marginal operating costs are covered by off peak usage (Harris, 1994). This type of pricing mechanism is generally well understood by users and can be effective in encouraging conservation during the peak season.

Peak load Pricing

This pricing system is similar to that of seasonal pricing in that it seeks to charge extra during times of maximum usage. However the theory of peak load pricing recognizes that water demand varies not only seasonally but daily and hourly. This variation in demand influences capital costs of water utilities, in that the infrastructure must be able to support peak demands (Harris, 1994). However daily or hourly peak load rates is not a practical solution because water meters are not read with that sort of frequency.

Water Pricing in Canadian Municipalities

The 2004 Environment Canada Municipal Water and Wastewater Survey report (previously Municipal Water Use and Pricing Survey) presented how municipalities charged for water:

- 37% of Canadian households pay a flat rate for water
- 62% are charged based on the volume of water consumed. Volumetric pricing breaks down into three general categories:
    - 39% are charged at a constant unit price
    - 13% are charged at a declining block rate
    - 10% are charged at an increasing block rate

The results of this survey indicate that users who pay a flat rate use 70% more water than users who are charged on a volume based system. Based on this, it seems correct to assume that volume based charges (essentially user pay) are much better conservation tools than flat rate structures. Aside from the environmental benefits of conservation, there is also the financial benefit on the part of the utility commission. By reducing the volume of water consumed, the amount of water that needs to be treated also reduces. Therefore, if the volume of water treated by a plant decreases by 30% and all else being equal, the life of that treatment plant has also been extended by 30%. This can mean savings in terms of hundreds of thousands of dollars by deferring upgrades or replacements.

By adopting water pricing structures that are more representative of the true cost of water (generally through user pay structures) conservation can be encouraged, as long as there is a financial advantage to consuming less water. There are obvious advantages to infrastructure with water conservation. However, changing and often increasing the price of water to better reflect its true cost can be a struggle for the public. How can the true cost of water be reconciled with the public perception of the cost of water? Below are case studies of towns, cities and municipalities that introduced water-pricing systems that were more representative of the true cost of water and often encouraged water conservation.

Pricing structure	Brief description	Pros	Cons	Examples
Metering	User is charged based on the volume of water they use	- Sufficiently covers cost of producing potable water - May encourage water conservation which can increase the life of water infrastructure - Easily understood by public	- Public opposition to changes in water bill - Cost of meters	Port Alberni, BC Saugeen Shore, ON Vernon, BC Kelowna, BC Savings range from 2 million $50 million
Sewer surcharge	Straight percentage add-on to the bill	- Can be an effective water conservation tool which can increase the life of water infrastructure	- Public opposition to changes in water bill	Sarnia, ON Region of Peel, ON
Increasing block rate	Rate blocks are developed based on volumes of water used. As the amount of water increases, so does the price	- Can encourage conservation which can increase the life of water infrastructure	- May not cover the cost of producing potable water	Cochrane, AB Okanogan Valley, BC
Declining block rate	Rate blocks are developed based on volumes of water used. As the amount of water increases, the price decreases	- Can encourage/support commercial and industrial operations	- Does not represent true cost of water - May encourage wasteful water use which could lead to premature wear on water infrastructure	Winnipeg, MB
Constant unit charge	Constant unit rate is constant rate per unit consumed	- Easily understood by public	- Does not represent true cost of water - May encourage wasteful water use	Niagara, ON Unable to cover costs, therefore had to

				implement volume based structure
Flat rate charge	Each user the same amount regardless of volume of water used	- Easily understood by public - Constant income for water provider	- Does not represent true cost of water - May encourage wasteful water use which could lead to premature wear on water infrastructure	Fort Frances, ON Prince George, BC
Property tax	Fee is based on the assessed value of the user's property	- Easily understood by public	- Does not represent true cost of water - May encourage wasteful water use which could lead to premature wear on water infrastructure - Public opposition to obvious inequalities in individual charges	Corner Brook, NL
Seasonal rate	Users are charged a higher rate during peak season	- Easily understood by public - May encourage water conservation which can increase the life of water infrastructure - Sufficiently cover costs of extra water	- Public opposition to changes in water bill	Windsor, ON Columbia, MO, USA
Peak load pricing	Users are charged a higher rate for weekly/daily peaks	- Represents true cost of water	- Impractical	No examples found

Community Case Studies

The CWWA has a database of water efficiency case studies that is called "Water Efficiency Experiences Database". The case studies described here are examples taken from that database.

Port Alberni, BC: Metering

Population Size: 18468
Timeframe Start: 1/1/1998
Timeframe End: Ongoing

In 1998 the City of Port Alberni installed approximately 6,000 meters as part of a universal metering study and pilot program with the plan to implement a metered rate plan in 1999. The cost of the activities includes: metering study $40,000; installation of residential meters $2.1 million; and installation of commercial and industrial meters $500,000. As a result of the metering and rate structure Port Alberni deferred the cost of finding a new water source, which they estimated to be $50,000,000.

Saugeen Shores, ON: Water Meter Installation and Retrofits to Postpone a Water Plant Expansion

Population Size: 6500
Timeframe Start: 7/1/1991
Timeframe End: 7/31/1992

To avoid a water plant expansion, the Town installed meters and encouraged a voluntary water conservation retrofit program. 2400 residential and commercial meters were installed and paid for by instituting a 2-year levy on taxes. Over 70% of residents voluntarily installed water efficient showers and faucet aerators during meter installation. As a result water and wastewater plant operating costs declined by $12,000 per year and the water plant expansion has been deferred for 8 years. It is apparent that it has been deferred indefinitely.

Vernon, BC: Universal Water Metering

Population Size: 32500
Timeframe Start: 1/6/1992
Timeframe End: 1/31/1993

January 1993 water meters and conservation installed devices for all residential municipal water users. As well a new rate structure was implemented. Based on 6 years of data, the residential savings are 34% as compared to consumption prior to metering.192 million gallons of water are saved per year. This is

34% water savings in a year, and additionally there is a 5% wastewater savings per year. Financially low water users save up to $60 per year. As a result of the project and the lower pumpage that resulted, the utility saved about $50,000 per year in electricity costs and $3,000 per year in chlorine costs.

Kelowna, BC : Meter Installation and Water Conservation Educational

Population Size: 94000
Start: 3/1/1996
Timeframe End: 3/1/2011

A private company was engaged to supply and install 11,200 residential meters and refurbish/replace 1200 commercial meters. This resulted in 100% metering of all user's between April and November 1996. Rates were changed from a flat rate to billing based on metered consumption. Since 1997 when the water meter rates were introduced there has been a 21% increase in water savings. The city calculates that it will save at least $600,000 over a 20-year period in reduced water pumping costs.

Convincing the Public

When it came to convincing the public that implementing a 'user pay' pricing structure there were a variety of methods. In Vernon they paired the installation of meters with water conservation devices and quadrupled flat rates for homeowners who refused to have a water meter installed. Kelowna launched an educational program in conjunction with the metering program to explain new rates and the impact of seasonal water use on the bill.

Education seems to be the key. Citizens need to know the true cost of water and understand that our water supply is not boundless. Also important is providing clean examples of how citizens can reduce their water bills by taking advantage of water saving tools such as toilet dams, faucet aerators and low flow shower heads.

There is a variety of material available on introducing water efficiency to your community. A list of these resources is provided here.

- Canadian Council of Ministers of the Environment, Q&A the Benefits of Water Efficiency http://www.ccme.ca/assets/pdf/pn_1188_e.pdf
- Water Efficiency, Region of Durham Program, http://www.durham.ca/waterefficiency/
- Toronto's WaterSaver Program, http://www.toronto.ca/watereff/index.htm
- City of Prince George, Universal Metering, http://www.cwwa.ca/WEED/Record_e.asp?ID=250

- City of Vernon, Universal Metering, http://www.cwwa.ca/WEED/Record_e.asp?ID=57
- Kelowna, Universal Metering and Water Conservation Education Program, http://www.cwwa.ca/WEED/Record_e.asp?ID=155

Conclusion

“Water management must effect changes in demand, not supply. This approach is necessary as untapped sources of water are becoming rarer, and the depletion and contamination of groundwater sources are further limiting supplies” (Meakin, 1993). Implementing a user pay charging system can reduce water consumption and also more accurately represent the true cost of water.

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