Green Municipal Funds
Fonds municipaux verts

Note:

This report contains multiple sections. Due to its large file size, only the first section is available in this database.

Should you like to receive an electronic copy of the full report, please contact the Green Municipal Funds at:

(613) 241-5221 or greenfunds@fcm.ca

À Noter:

Ce rapport contient plusieurs sections. Seulement la première section est disponible dans cette base de données à cause du grand volume de fichier.

Si vous aimeriez recevoir une copie électronique du rapport au complet, veuillez svp contacter les Fonds municipaux verts au :

(613) 241-5221 ou greenfunds@fcm.ca

Prepared for

City of Barrie

October 2006

City of Barrie GHG Inventory and Community Energy Plan

Submitted by

CH2MHILL

E102004004TOR

City of Barrie
GHG Inventory and Community Energy Plan

Prepared for

City of Barrie

Prepared by

CH2MHILL

October 2006

CH2M HILL Canada Limited
255 Consumers Road
Toronto, ON M2J 5B6
Tel 416.499.9000
Fax 416.499.4687

CH2MHILL

October 31, 2006

120387.TT.30_E102004004TOR

Mr. Barry Thompson, C.E.T.
Energy & Environmental Officer
70 Collier Street
Barrie, ON L4M 4T5

Subject: City of Barrie Greenhouse Gas Inventory and Community Energy Plan

Dear Mr. Thompson:

CH2M HILL is pleased to provide you with the final version of the above named report. The report was undertaken to meet the milestone commitments of the Partners for Climate Change Program. The Partners for Climate Protection (PCP) program is a network of more than 126 Canadian municipal governments who have committed to reducing greenhouse gases and acting on climate change. PCP is a partnership between the Federation of Canadian Municipalities (FCM) and ICLEI - Local Governments for Sustainability.

The City of Barrie committed to the program in 2001 and has been challenged under the program to meet GHG emissions emission reduction targets by 2011 of 6% in the community and 20% as a corporate entity below 1994 levels.

The report provides an overview of the greenhouse gas emissions for City of Barrie both as a corporate entity and for the greater community. Also identified are the commitment targets under the CPC, and potential opportunities for meeting those reductions. The specific opportunities will require greater analysis in terms of feasibility and economic impact in addition to GHG reductions, which were beyond the scope of this study. The report also provides a Community Energy Plan providing an overview of current initiatives, and defines the challenges and elements in developing a Green Economy in Barrie.

We have greatly appreciated the opportunity to work with the City of Barrie on this study, and look forward to partnering with you on the next steps of implementing the plan and monitoring progress.

Sincerely,

CH2M HILL

Alan Teare, P.Eng.
Project Manager

CNR/Cover Letter 2006-Oct-31.doc

Contents

List of Tables

List of Figures

List of Appendices

1. Introduction

1.1 Purpose

The purpose of the City of Barrie Community Energy Plan is to develop a framework for the City to understand the historical impact of its operations on greenhouse gas (GHG) emissions, and to take action by setting GHG reduction targets.

The first objective of this report was the development of a Community Energy Plan that addressed the facets of energy consumption in the community, for both city corporate and community based assets. This included the development of a GHG emissions inventory; benchmarking the City of Barrie's existing municipal energy intensity performance relative to other jurisdictions; identifying potential energy efficiency projects; and, establishing a GHG emissions reduction target.

The second objective was to complete an environmental accounting audit consisting of a financial review, the identification of cost centres, derivation of performance metrics, and implementation of those metrics into the Operations and Financial Departments. The purpose was to suggest a structure to create a common management tool so that real-time financial decision making and operations control can be achieved.

1.2 Project Background

The City of Barrie historically has demonstrated its commitment to improving overall environmental performance and energy efficiency through various programs such as:

- The ESCO Building retrofit program, implemented in the early 1980s through 1993
- Green Communities Residential Home Tune-up Program
- Water Fixture Replacement Program
- Rebate Program for Water Efficient Washing Machines
- MORE Program for public and ICI recycling
- Master Composter program
- Master Recycling Program
- Plan for bicycle path development to reduce passenger vehicle use

In order to adapt a holistic approach to improved environmental performance and recognize the growing concern of global climate change and Canada's commitment to the Kyoto Protocol, the City of Barrie Council, on February 19, 2001, committed its intent to participate in the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP).

The development of a Community Energy Plan for the City of Barrie was proposed to the FCM in April 2001, the outcome of which will follow in this report.

1.2.1 GHG Emissions

Concern over the increasing trend in global warming and the degradation of air quality in urban areas has resulted in an international focus on the reduction of GHG emissions worldwide. Greenhouse gases include a variety of compounds, including water vapour; however, the Kyoto Protocol has focused on six leading contributors that include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). As sunlight passes through the atmosphere and heats the Earth's surface, some of the energy is reflected back into the atmosphere as thermal radiation. Greenhouse gases trap this energy, which increases the atmospheric temperature creating a "greenhouse" effect.

The concern is that increased atmospheric concentrations of greenhouse gases may gradually increase the atmospheric temperature beyond current levels, which could disrupt natural systems and human activities. Since 1750, atmospheric CO_2 concentrations have increased by approximately 30 percent, believed to be the result of human activities from the industrial revolution to present day.

1.2.2 PCP Campaign

PCP is a partnership between the Federation of Canadian Municipalities (FCM) and the International Council for Local Environmental Initiatives (ICLEI) - the international environmental agency for local governments. FCM is the lead partner on policy development, government relations and funding in Canada, and the ICLEI provides technical support.

By participating in the PCP the City of Barrie committed to five milestones[1]:

- **Milestone One: Take Stock** - Complete a greenhouse gas inventory and forecast. PCP provides free software to measure energy use and emissions for both municipal operations and the community. Use 1994 or the year with the best available data for the base year; forecast energy use and emissions for the next 10 or 20 years for municipal operations and the community.
- **Milestone Two: Set a Reduction Target -**Establish a reduction target. Preferred targets are 20 per cent reduction in greenhouse gas emissions from municipal operations, and a minimum six per cent reduction for the community, both within 10 years of joining PCP.
- **Milestone Three: Develop a Local Action Plan -** Develop and finalize a local action plan that aims to reduce emissions and energy use in municipal operations and the community. This local action plan will incorporate public awareness and education programs.
- **Milestone Four: Implement the Plan -** Create strong collaboration between municipal government and community partners to carry through on commitments and maximize benefits from greenhouse gas reductions.
- **Milestone Five: Measure Progress -** Maintain support by monitoring, verifying and reporting greenhouse gas reductions.

---

[1] FCM Partners for Climate Protection http://www.fcm.ca/scep/support/PCP/pcp_milestones.htm

Each of these milestones was addressed in the purpose of the project.

As of August, 2002, PCP had recruited over 95 local governments into its campaign. As a result of the City of Barrie's participation, they received a grant from the FCM to develop the CEP, which garnered additional financial support from the Province of Ontario Climate Change Secretariat, the Ontario Ministry of the Environment, Enbridge Consumers Gas, and Barrie Hydro.

1.3 Project Approach

The City of Barrie engaged CH2M HILL to develop the Community Energy Plan. This consisted of several phases of data collection and assessment for the following areas:

- GHG emissions inventory
- Benchmarking of Energy Efficiency
- Identification of Energy Reduction Projects
- Identification of Cost Centres

2. GHG Emissions Inventory

2.1 Methodology

An inventory of GHG emissions was developed for the City of Barrie using 1994 as a base year. GHG emissions were estimated by examining energy use information (electricity, natural gas, etc.) and gasoline consumption for fleet vehicles. In some cases, historical data for 1994 was not available, and estimates of emissions were developed based on available information. Specific methodologies and assumptions for these calculations are discussed below. The source data was manipulated for input into the PCP Greenhouse Gas Emissions Microsoft Excel Spreadsheet[2], for calculating emissions in tonnes (Mg) of CO_2 equivalents (CO_2e) per year. The spreadsheet model estimates GHG emissions using USEPA and provincial electricity grid emission factors and data inputs such as:

- Energy consumption data (electricity, natural gas, diesel, etc,)
- Vehicle Kilometers Traveled (VKT verage vehicle fuel economies, and vehicle types;
- Solid waste production and composition; and
- Emissions data for major emitters within the City of Barrie.

Mg of CO_2e is a measurement of the heat-trapping potential of the major greenhouse gases (CO_2, CH_4, N_2O, etc) using CO_2 as a basis for comparison. Each greenhouse gas has a global warming potential (GWP) which is a factor that represents the magnitude of the heat-trapping ability of a gas. Methane (CH_4) has a GWP of 21,[3] thus it traps twenty-one times more heat radiation than CO_2. Therefore, one tonne of CH_4 would be reported as 21 Mg of CO_2e.

The spreadsheet model has two analysis modules. The "Community Analysis" module is used to estimate emissions in the community-at-large, and the "Corporate Analysis" module is used to estimate emissions from City-owned facilities such as buildings, vehicle fleets, and streetlights.

The GHG inventory was developed for the base year of 1994 as recommended by the PCP guidelines. Available data for the year 2000 was used to give an indication of current levels of GHG emissions. Using local planning growth and development data, GHG emissions were forecasted for the target year of 2011 for the interim target of 20% reduction of base year within 10 years of joining the PCP, which the City joined in 2001.

Measures to reduce GHG emissions were identified and analyzed for their ability to meet the reduction target. City programs, policies, or projects planned or ongoing that may have

---

[2] Inventory Spreadsheet Tool KN inventory spreadsheets.xls available athttp:\www. kn.fcm.ca/ev.php|Parteners for Climate Protection|Tools.

[3] The GWP is provided by the UN's Intergovernmental Panel on Climate Change (IPCC) for gases assessed over a 100-year time horizon. The IPCC published its Third Assessment Report (TAR) in 2001ammending the GWPs of several gases including methane. IPCC's Second Assessment report (SAR) in 1996 had previously reported the GWP of CH_4 as 21. As many national inventories have not yet adopted the TAR GWPs, the SAR values were used.

the potential to reduce GHG emissions, were included as reduction measures for this analysis.

2.1.1 Community Analysis Data Collection

The Community modules required information inputs for the following categories:

- Residential
- Commercial
- Industrial
- Transportation
- Solid Waste

Data for the community analysis included natural gas consumption rates, provided by Enbridge; electricity demand data from Barrie Hydro and transportation data was derived from a 1999 transportation study of current and projected traffic patterns.[4] Overall, the available data was used, including data from the years of 1999-2001 to interpolate missing data in the baseline and comparison years. Solid waste data is tracked by the City based on placed tonnage in the landfill.

2.1.2 Corporate Analysis Data Collection

The Corporate modules required information inputs for the following categories:

- Buildings
- Streetlights
- Water/Sewage
- Vehicle Fleet
- Solid Waste

Data for City facilities energy consumption such as electricity and natural gas was collected from Barrie Hydro and Enbridge. Fuel purchases for fleet vehicles were obtained from the Municipal Works Department. Water and sewage data emission was derived from regulatory reports, while waste data was derived from the waste container services tender for contract.

2.2 Community Emissions Inventory

Tables 2-1 to 2-6 contain energy CO_2e estimates from various sectors in the community. The apparent disproportional increase of CO_2e (t) based on electricity usage between the 1994 and 2000 data is due to the increase in the CO_2 coefficient for Ontario energy production between these years. The CO_2 coefficient is based on the combined carbon intensity of the electricity generation sources that produce electricity in Ontario. Between 1994 and 2000 there was a large shift from nuclear power to coal burning power plant sources. This change in energy production from non-carbon emitting sources (nuclear) to carbon-intense emissions (coal) greatly increased the amount of CO_2e emitted in Ontario for every MWh produced. Thus, an equivalent amount of electricity produced in 2000 created more emissions than the same amount of electricity production in 1994.

[4] Read, Voorhees & Associates, *City of Barrie Transportation Study*, 1999

TABLE 2-1
RESIDENTIAL ENERGY CO_2E ESTIMATES

	1994		2000	
	Measure	CO_2e (t)	Measure	CO_2e (t)
Natural Gas	59.1 million m^3	111,052	68.7 million m^3	129,105
Electricity	220 million kWh	26,127	447 million kWh	140,654
Residential Subtotal		**137,179**		**269,759**

TABLE 2-2
COMMERCIAL ENERGY CO_2E ESTIMATES

	1994		2000	
	Measure	CO_2e (t)	Measure	CO_2e (t)
Natural Gas	33.3 million m^3	62,690	38.8 million m^3	72,882
Electricity	425 million kWh	50,472	775 million kWh	243,769
Commercial Subtotal		**113,162**		**316,651**

TABLE 2-3
INDUSTRIAL ENERGY CO_2E ESTIMATES

	1994		2000	
	Measure	CO_2e (t)	Measure	CO_2e (t)
Natural Gas	10.6 million m^3	19,944	12.3 million m^3	23,186
Electricity	40.5 million kWh	4,810	67.4 million kWh	21,191
Industrial Subtotal		**24,754**		**44,377**

TABLE 2-4
TRANSPORTATION CO_2E ESTIMATES[1]

	1994		2000	
	VKT millions	CO_2e (t)	VKT millions	CO_2e (t)
Collectors/Local Roads	146		236	
Limited Access Highway	150		150	
Major Arterial Streets	979		1,455	
Transportation Subtotal	**1,276**	**478,469**	**1,842**	**690,898**

[1]Extrapolated from City of Barrie Transportation Study, April 1999 based on linear interpolation of data from 1997, 2011 and 2021 forecasts

TABLE 2-5
SOLID WASTE CO_2E ESTIMATES

	1994		2000	
	Measure [1]	CO_2e (t)	Measure [2]	CO_2e (t)
Total Waste Landfilled	45,583 t	21,957	37,227 t	17,932 [3]

[1] From Waste Management Business Plan Schedule 'I' - Annual tonnage placed

[2] 2001 Operating Report – Sandy Hollow Landfill, May 30, 2002

3 Golder Associates Sandy Hollow Landfill September 2002 tonnage in place provided as 1,040,000 – this generates an annual amount of 65,423 t CO2e emissions based on cumulative tonnage. The emissions from the tonnes landfilled in one year amount to 17,032.

TABLE 2-6
COMMUNITY EMISSIONS SUMMARY

	1994 CO_2e (t)	2000 CO_2e (t)
Residential	137,179	269,759
Commercial	113,163	316,651
Industrial	24,753	44,377
Transportation	478,469	690,898
Solid Waste	21,957	17,932
Community Total	**0.78 million**	**1.34 million**

2.3 Corporate Emissions Inventory

The corporate emissions inventory is an estimate of GHG emissions from all City-owned facilities, including buildings, vehicles, and water and sewage facilities. For the base year of 1994, the GHG emissions totaled 8,731 tonne of CO_2e for all municipal sources. The corporate inventory is a subset of the community inventory, and thus, City facilities accounted for approximately 1.1 % of all emissions in the City of Barrie during 1994.

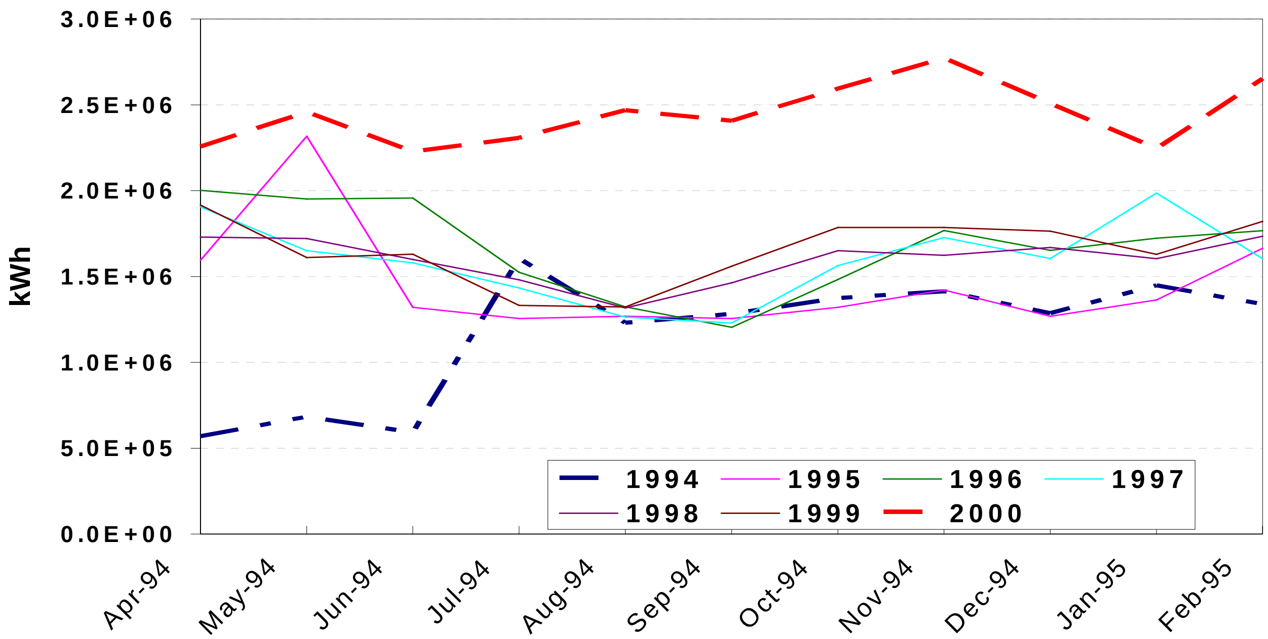
In some cases data gaps were found in the 1994 records, for these circumstances 1995 data was used in place of this missing or incomplete data. It was assumed that the 1995 data represented similar emission rates for the City and therefore substitution for 1994 data has been assumed to be within an acceptable degree of variance. Similarly at the time of the date collection 2001 data was not generally available and a reference year of 2000 was used. Where 2000 data gaps existed, 2001 data was used.

Most of the GHG emissions accounted for were based on seven facilities, representing approximately 15 to 20% of the total corporate emissions. Table 2-7 and Figure 2-1 present the breakdown of GHG emissions by corporate sector. GHG emissions from City facilities with each of these sectors are presented in greater detail in the following sub-sections.

TABLE 2-7
GHG EMISSIONS BY CORPORATE SECTOR

	1994	2000
	CO2e (t)	**CO2e (t)**
Buildings - Nat. Gas	2,229	2,557
Buildings - Electricity	1,311	4,893
Fleet Transportation	800	1,966
Public Transit	2,184	3,345
Streetlights	537	1,883
Water/Sewage	645	4,399
Waste	1,025	414
Corporate Total	**8,731**	**19,457**

FIGURE 2-1
BARRIE CORPORATE ELECTRICITY USE

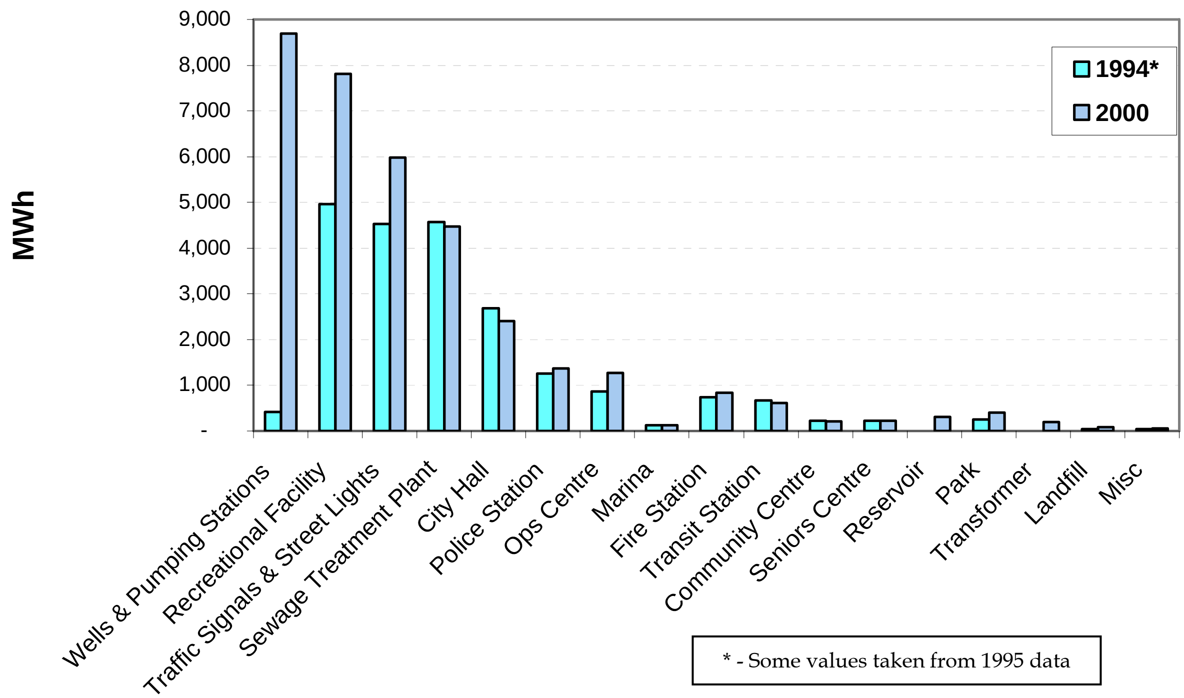


One of the most significant influences on the City emissions was the amalgamation of the City with neighbouring corporations. As a result, there is a significant step increase in the now amalgamated City emissions. The amalgamation took place in 2000, however, to keep meaningful comparison to 1994 values, the amalgamated region data was excluded. This will be useful for determining indicators and efficiency factors for baselining activities. In calculating absolute emissions for both the community and corporate data, the amalgamated data was used, with the understanding that the total emissions under the moniquer "City of Barrie" will be much greater when compared to 1994 data. It should be noted, however, that many of those amalgamated assets existed in 1994, thus the 1994 baseline should also be adjusted upward, so as not to give the impression that the increased CO_2e quantity is all net contribution.

2.4 Corporate Inventory Analysis

Figure 2-2 illustrates the corporate asset electricity use. In some cases 1995 data was used as a replacement for incomplete 1994 data. Thus, the graph is an indication of electricity use based on the most complete data sets available at the time of the data collection for this report.

FIGURE 2-2
CORPORATE ASSET ELECTRICITY USE



Buildings and Facilities

Recreational Facilities represent a significant increase to the City's emissions with the addition of the Barrie Molson Centre in September, 1995 being the most significant factor in addition to the general increased use of the other facilities. The City Hall, Police Station and Operations Centre are also major electricity users amongst the entire asset pool.

Fleet Vehicles

Fleet vehicle emissions have doubled for gasoline powered vehicles and quadrupled for diesel powered vehicles, based on an increased asset ownership. In addition, the City acquired ownership of the marina that it did not own in 1994, which also contributed to the increase of gasoline usage in the 2000 data.

Streetlights

The number of streetlights in the city increases as the city expands, and as vehicle density increases requiring greater traffic control. In 1994, the estimated number of streetlights was approximately 6,000, and in 2004, the number was approximately 9,240.

Water and Sewer Utility

Water pumping stations represent the greatest increase to the City's GHG portfolio since 1994, as prior to 2000 these assets belonged to Barrie PUC. Along with the Sewage Treatment Plant they also represent two of the top three electricity users amongst the asset classes.

3. Emissions Forecasts

3.1 Methodology

The emissions forecasts for each of the Corporate and Community categories were extrapolated from 2001 data based on population growth estimates.

The forecast for future emissions was based on sector growth multipliers based on projected population growth. The residential numbers are affected by the projected increase in the number of households. The commercial projections are based on predicted increases to building floor area. Industrial projections are based on predicted growth in industrial sector employment. Transportation projections are based on forecast VKT growth.

3.2 Community Projections

Table 3-1 summarizes the population growth and projected growth rates for residential, commercial, and industrial sectors.

TABLE 3-1
MEASURES OF GROWTH RATES FOR RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL SECTORS

	1994	2001	2011	2021
Population [1]	74,213	103,710	154,400	204,900
Total Households [4]	26,996	38,855	59,000	81,700
Commercial Floor Space (m^2) [3]	N/A	389,532	N/A	N/A
Industrial Floor Space (m^2) [3]	N/A	348,919	N/A	N/A
Commercial Establishments	1,453	4,000	N/A	N/A
Industrial Establishments	107	250	N/A	N/A
Commercial Employment[7]	9,601[5]	10,427	16,593	21,470
Industrial Employment[7]	16,859[5]	18,442	29,759	39,086
Total Employment [4]	48,333[5]	52,660	84,400	110,100
Transportation VKT [5]	213,920,000	426,384,000	666,225,000	803,277,000
Waste Landfilled (t)[6]	45,583	37,227	53,469	78,784

1,2 – Statistics Canada 2001 Census

3 – Industrial and Commercial Floor space from "400 East and West Property Breakdown.xls"

4 – Population and Employment forecast for the City of Barrie by Hemson Consulting, October 1998

5 – City of Barrie Transportation Study by Read, Voorhees and Associated, April 1999 (Data for year 1996)

6 – City of Barrie Operating Report – Sandy Hollow Landfill

7 – Ratio's (Derived from pg.23 in The City of Barrie Transportation Study, Voorhees and Associated, April 1999) multiplied by Total Employment Data (from Population and Employment forecast for the City of Barrie by Hemson Consulting, October 1998)

N/A – Not Available at time of report

Based on the growth percentages, the equivalent increase in GHG emissions are summarized in Table 3-2.

TABLE 3-2
INCREASE IN GHG EMISSIONS BY SECTOR

Sector	1994	2001	2011	2021
Residential	137,179	269,759	401,608[1]	532,963[1]
Commercial	113,163	316,651	379,981[2]	455,977[2]
Industrial	24,753	44,377	48,815[2]	53,696[2]
Transportation	478,469	690,898	930,436[3]	1,023,840[3]
Solid Waste	21,957	17,932	111,002	163,556
Community Total	**0.78 million**	**1.34 million**	**1.87 million**	**2.23 million**
Emission Target (6% Reduction from 1994)	728,990	728,990	728,990	728,990
Reductions Required to Achieve goal based on status quo	**46,531**	**610,628**	**1,142,852**	**1,501,043**

All quantities expressed in tCO_2e

[1] Assume Constant GHG rate per capita to 2001
[2] Assumed 20% commercial growth and 10% industrial growth per period
[3] Assumed 15% reduction in GHG emission based on Natural Resource Canada, Canada's Energy Outlook, An update, 1999 (assume 5% reduction for 2011)

3.3 Corporate Projections

Table 3-3 contains projections in the growth of corporate measures used to predict corporate asset growth.

TABLE 3-3
MEASURES OF CORPORATE ASSET GROWTH

	1994	2001	2011	2021
Building Floor Space (m^2)	N/A	63,858	N/A	N/A
Fleet size (vehicles)	N/A	210	N/A	N/A
Road Network (km)	N/A	N/A	N/A	N/A
Local Roads	30	37	N/A	N/A
Major Arterial Streets	N/A	13	N/A	N/A
Limited Access Highways	123	140	N/A	N/A
Sewage Flows (ML/d)[1]	31,462	39,964	52,005	64,239
Water Demand (ML/d)	30,323	35,953	46,588	57,393
Waste Landfilled (t) [2]	2,128	N/A	N/A	N/A

[1] Less Molson's contribution to normalize for future flows
[2] City of Barrie Waste Management Business Plan
N/A – Not Available at time of report

Based on the growth percentages, the equivalent increase in GHG emissions are summarized in Table 3-4.

TABLE 3-4
INCREASE IN CORPORATE GHG EMISSIONS BASED ON PROJECTED GROWTH PERCENTAGES[1]

	1994	2001	2011	2021
Buildings	3,540	7,450	8,195	9,015
Fleet Transportation	801	1,966	2,054	1,921
Public Transit	2,183	3,345	4,679	6,209
Streetlights	537	1,883	2,071	2,278
Water/Sewage	645	4,399	5,719	9,150
Waste	1,025	414	455	501
Corporate Total	**8,731**	**19,457**	**23,174**	**29,074**
Emission Target (20% Reduction from 1994)	6,985	6,985	6,985	6,985
Reductions Required to Achieve goal based on status quo	**1,746**	**12,472**	**16,189**	**22,089**

[1] All quantities expressed in t CO_2e

3.4 Target Year Emissions

Based on the PCP commitment goals of a 20% reduction of Corporate emissions and a 6% reduction of Community emissions within a 10 year period, the City of Barrie needs to target annual emission reductions of 16.1 kt CO_2e as a corporation, and 1.14 Mt CO_2e in the community, by 2011.

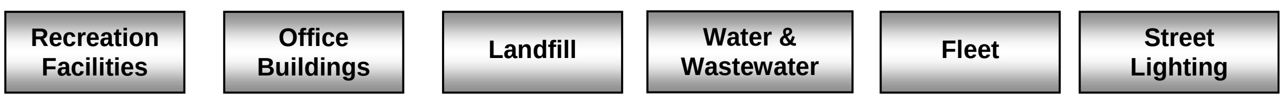
4. Corporate Operations Audit

4.1 Methodology

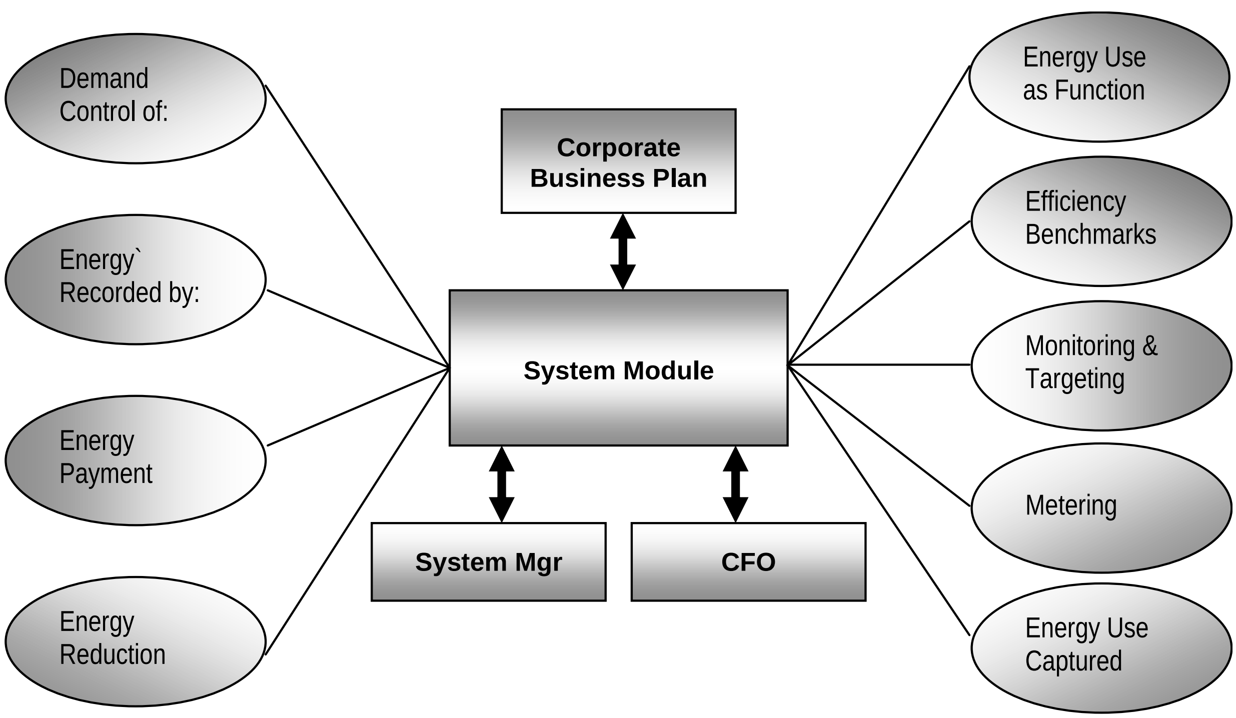
The *Corporate Plan* will evaluate Barrie's municipal operations by looking at the energy efficiency of end-use equipment in our facilities, as well as the potential for improving our operational practices to reduce energy use. Integral to the Corporate Plan will be an Environmental Accounting of how we can improve our energy use monitoring, and provide direct rewards to departments that develop innovative solutions for reducing energy use. Motivating our staff to develop their own innovative ideas will be a key part of the plan.

The major components of the Corporate Plan will include:

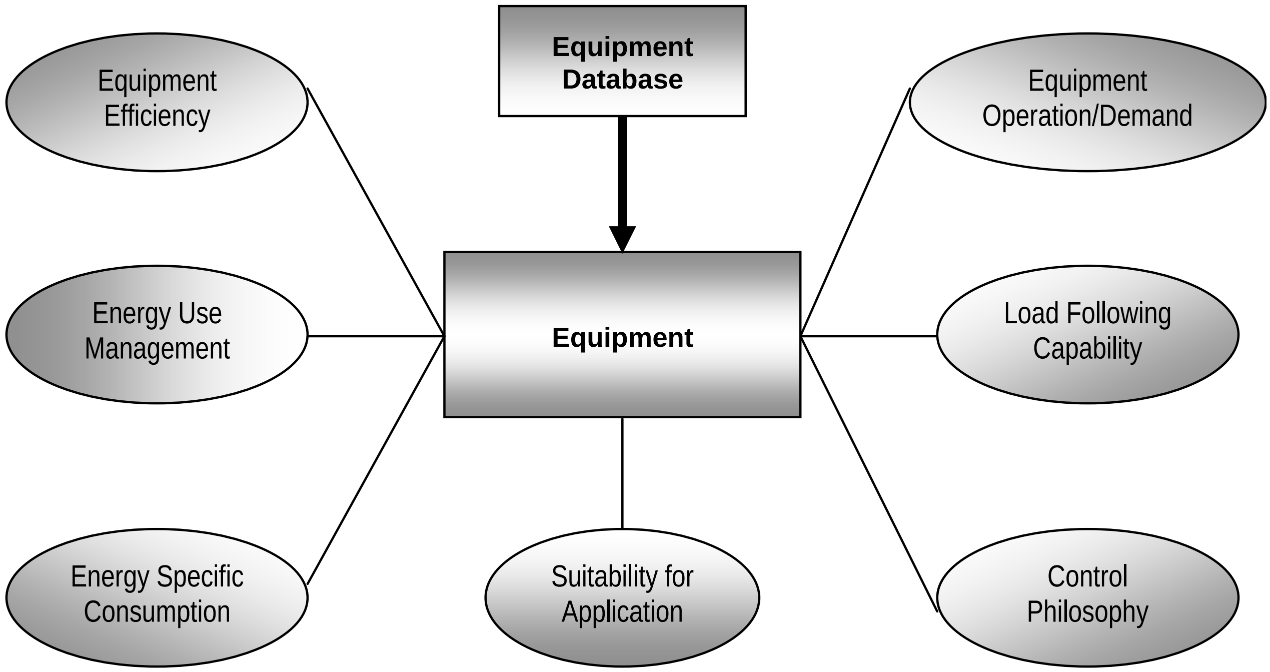
1) Definition and Prioritization of Modules



2) Environmental Accounting for Each Module



3) Inventory City Managed Equipment and Define Efficiency



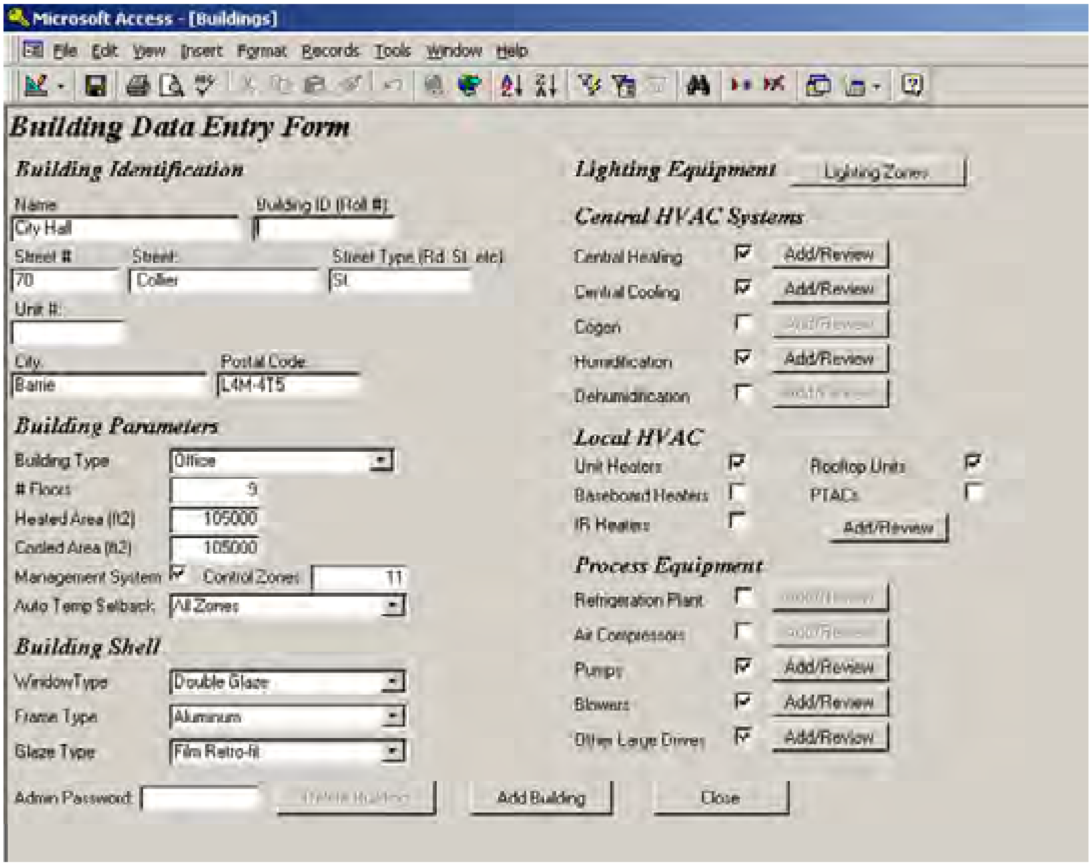
4) Development of a List of Energy Efficiency Measures for the City to Implement

Equipment Based Measures	System Based Measures
► Improved Efficiency	► Reduced System Demand (water conservation, waste minimization)
► Improved Controls	► Implementation System for Inefficiencies to be Reported
► Reduced Operations	► Identify Alternate System to Meet Same Objectives
► Alternative Equipment Technology	► Implement Monitoring & Targeting Programs
	► Establish Energy Use Accountability
	► Create Reward Incentives for Energy Efficiency
	► Integrate EE Targets Into Corporate Business Plan

It is intended that Corporate successes will allow the City to "lead by example" in its efforts to encourage community participation.

The first step in assessing the corporate assets was the development of an equipment database; to log the energy consuming equipment in each of the corporate buildings, to identify the nature and age of equipment, and to assess individual pieces of equipment for their energy efficiency. Figure 4-1 shows a screen-shot from the database and the type of data collected.

FIGURE 4-1
EQUIPMENT DATABASE BUILDING DATA ENTRY SCREEN



The database was developed by CH2M HILL and then turned over to the City for population of the database with the corporate equipment information.

For each of the modules, a meeting was held with staff from the City to review the operations and tour the facilities to gather information on the energy systems and demands for each site. The data and findings were submitted to the City in the form of independent modules, which are appended to this report and are summarized below.

4.2 Corporate Assets

The following tables (Table 4-1 – Table 4-6) summarize the corporate assets pertinent to the GHG emissions based on the six modules developed for the inventory including:

- Recreational Facilities
- Building Facilities
- Water and Wastewater facilities
- Landfill/Solid Waste facilities
- Fleets
- Street Lighting

TABLE 4-1
RECREATIONAL FACILITIES

Facility	Address	Area m²	No. of Rinks	No. of Pools
Eastview Arena	453 Grove Street E	2,216	1	-
Barrie Arena	155 Dunlop Street W.	3,456	1	-
Molson Centre (includes Casey's restaurant)	555 Bayview Drive	8,547	1	-
Allandale Recreation Centre	190 Bayview Drive	12,036	2	1

TABLE 4-2
BUILDING FACILITIES

Facility	Address	Area m² Note 1	Operational Profile
City Hall (incl. Provincial Offences Offices)	70 Collier Street	7,060	Offices, Meeting Rooms, Council Chambers, Administrative functions
Barrie Public Library	60 Worsley Street	3,716	Offices, Public reading areas
Transit Terminal	24 Maple Street	2,323	Offices, Waiting area
Police Station	29 Sperling Drive	4,600	Offices, Garage, Equipment Storage, Holding Cells, Common Areas, Training Rooms
Main Fire Hall	65 Vespra Street	2,230	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Fire Hall #2	11 Bell Farm Road	436	
Fire Hall #3	20 Big Bay Point Road	550	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Fire Hall #4	250 Ardagh Road	604	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Dorian Parker Centre	227 Sunnidale Road	729	Main Hall, Kitchen, Bar and Storage
Lampman Lane Community Centre	59 Lampman Lane	1,198	Main Lobby, Offices, small Kitchen, Change rooms, Classroom, shared Gymnasium and an Outside Pool
Southshore Community Centre	205 Lakeshore Drive	1,815	Main Hall, Tourist Offices Lower levels house equipment storage, workshops and a common area for the local canoe and rowing clubs
Parkview Seniors Centre	189 Blake Street	1,500	Offices, Activity/Banquet rooms, Kitchens, and a Library
Operations Centre	165 Ferndale Drive	6,912	Greenhouses, Park and Recreation offices, Garages, Repair and Maintenance shops, Change Rooms, Administration offices and other common areas

Note:
[1] Building Floor Area excluding cold storage areas

TABLE 4-3
WATER SYSTEM FACILITY NAME, ADDRESS, AND FUNCTION CATEGORY

Facility Name	Address	Function
Barrie Water Pollution Control Centre	249 Bradford	Sewage Treatment Plant
Harvie Road Reservoir	90 Harvie Rd	Reservoir
Mapleview Drive Water Tower	65 Mapleview Dr W	Reservoir
Bayfield Street Water Tower	444 Bayfield St	Reservoir
Bayview Reservoir	157 Dunlop St E	Reservoir
Lismer Blvd. Sewage P.S.	2 Lismer	Pumping Station
Penetanguishene Rd. Sewage P.S.	238 Penetanguishene	Pumping Station
Codrington Street	64 Codrington St	Pumping Station
John Street Well #5	217 John St	Well
Tiffin Street Well #7	44 Sarjeant Dr	Well
Wood Street Well	12 Wood Street	Pumping Station
Huronia Road Well #10	294 Huronia Rd	Well
Big Bay Point Road	20 Big Bay Point Rd	Pumping Station
Centennial Park Well #12	85 Lakeshore Dr	Well
Leacock Drive Booster PS	319 Leacock Dr	Pumping Station
Johnson Street Well #13	168 Johnson St	Well
Huronia Rd. Sewage P.S.	644 Huronia	Pumping Station
Heritage Park Well #14	15 Lakeshore Dr	Well
Marina	55 Lakeshore Dr	Pumping Station
Logan Court P.S.	65 Logan Court Pump Stn	Pumping Station
Anne Street Well #3	54 Anne	Well
Anne Street Booster Pumping Station	164 Anne St N	Pumping Station
Innisfil Street Booster Pumping Station	380 Innisfil St	Pumping Station
Perry Street Well #4	83 Perry	Well
Logan Court Sewage P.S.	65 Logan Ct	Pumping Station
Bayview Dr. Sewage P.S.	799 Bayview	Pumping Station
Duckworth Street Sewage P.S.	510 Duckworth St	Pumping Station
Heritage Park Well #11	5 Lakeshore Drive	Well
Centennial Park Well #15	55 Lakeshore Rd	Well
Bayfield St. Sewage P.S.	509 Bayfield New	Pumping Station
Bayfield St. Sewage P.S.	509 Bayfield	Pumping Station
Brownwood Drive Well #16	101 Brown Wood Dr	Well

TABLE 4-4
LANDFILL / SOLID WASTE FACILITIES EXHIBIT NUMBER

Facility Name	Address	Function Category
Sandy Hollow Landfill	272 Ferndale Drive	Landfill

.

TABLE 4-5
FLEET VEHICLES

Vehicle Type		Function Category
passenger vehicles and pick-up trucks	pick-up trucks and small vans	100 – 1000 Series
off-road tractors	Bobcats, larger lawn mowers, lawn aerators, ski groomer and forklifts	200 – 2000 Series
1 Tonne Trucks	traffic bucket for street light changeout, garbage compactor and sewer inspection/maintenance	300 – 3000 Series
pumper and crane trucks		400 – 4000 Series
5 Tonne Diesel Trucks	fire trucks, snow plows, sanders, snow melter and sewer vactor trucks	500 – 5000 Series
city transit buses		600 – 6000 Series
street sweepers and other antique vehicles		700 – 7000 Series
heavy diesel equipment	road graders, back hoes, bulldozers and compactors	800 – 8000 Series
small gasoline engines	push mowers, weed whackers, small pumps	900 -9000 Series

TABLE 4-6
STREET LIGHTING

Lamp Type	Wattage (Excluding Control Circuit)	Number of Lamps	Function Category
High Pressure Sodium	70W	288	Street Lights
	100W	4,150	
	150W	3,193	
	200W	409	

TABLE 4-6
STREET LIGHTING

Lamp Type	Wattage (Excluding Control Circuit)	Number of Lamps	Function Category
	250W	896	
	400W	217	
Mercury Vapour	150W	16	Street Lights
	250W	15	
Metal Halide	100W	56	Street Lights
Totals		**9,240**	

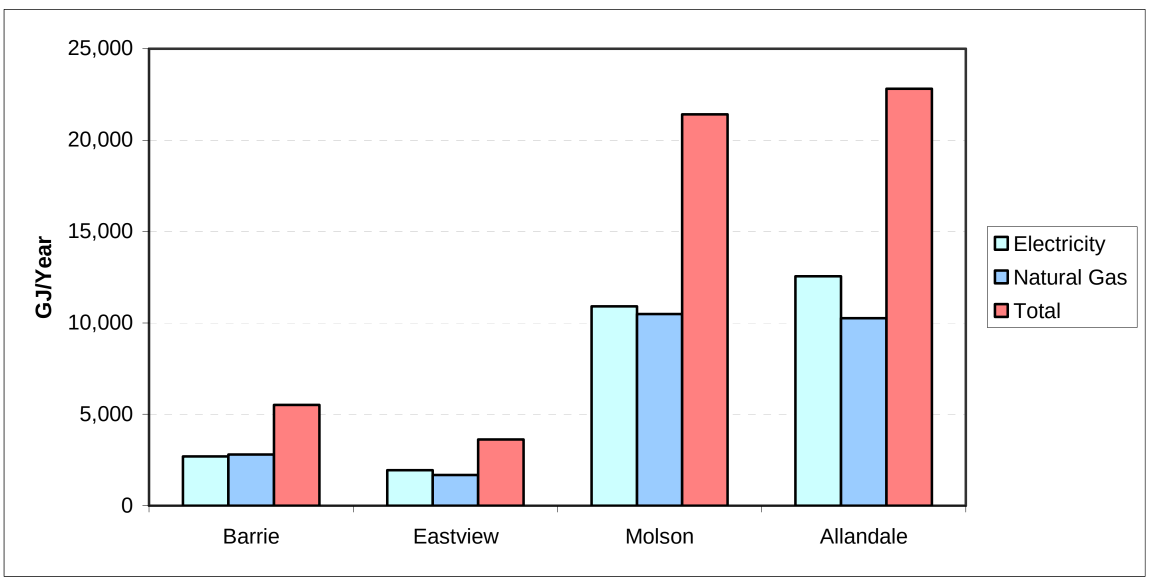
4.3 Corporate System Modules Summaries

The following sections highlight the findings of the module analysis of the Corporate assets. Each of the modules is appended to this report.

4.3.1 Recreation Facilities Summary

In 2000, the City's recreation facilities consumed 7,649 MWh (27,536GJ) of electricity, 693,511 m^3 (26,353GJ) of natural gas, and 130,000 m^3 of water. This equates to a total energy consumption of 53,889 GJ/year (assuming 38MJ/m^3 of gas) and an overall utility cost of approximately one million dollars.

FIGURE 4-2
TOTAL ENERGY CONSUMPTION (GJ)



To meet the 20% PCP reduction target for this sector, a total reduction of 2,673 tonnes CO_2e from 2000 levels must be achieved.

TABLE 4-7
Summary of Recreational Facilities

2000 Energy Use	53,889GJ
GHG Emissions	3,710 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	**1,078 tonnes CO_2e**

While this target represents a significant quantity of energy, it is attainable based on the potential opportunities identified in the facilities audit. The following table provides a high level summary of the energy savings measured identified. The potential GHG reduction potential is estimated based on operating rules-of-thumb, since no sub-metering data is available to validate savings potential.

TABLE 4-8
POSSIBLE ENERGY SAVINGS MEASURES AT RECREATIONAL FACILITIES

Energy Savings Measure	Estimated GHG Reduction Potential
Establish Monitoring & Targeting Program This is a broad-based measure that would include establishing sub-metering at all major load centres, benchmarking efficiency, and establishing energy efficiency improvement targets. It is generally accepted that the implementation of an energy monitoring system will generate 10-15% energy savings, based on improved operational practices. As identified in the Facilities Module, there is a grouping of equipment that could benefit from tighter operational control.	350 tonnes CO_2e
Conduct Building MUA Balance at Molson Centre and Allandale Building make-up air represents a larger energy load than the refrigeration plants at the Molson Centre and Allandale. For example, Molson Centre has two MUA units with a total rated capacity of 80,000 cfm. On a 27^{o}C day with a RH of 70%, the MUA system could be consuming over 1,200 kWh per hour, with intake dampers taking 50% outside air. Better control over MUA will provide both heating and cooling energy savings.	100 tonnes CO_2e
Update and Integrate Major Equipment in Energy Management System The existing EMS at Allandale does not have a control interface at the facility and Operations staff is not fully aware of its full function. A review of how equipment is being controlled and the addition of a control interface at Allandale would enable control over equipment operation. Another example is at the Molson Centre, where 38 tonnesof roof top cooling are not integrated into the EMS and are end-user controlled. It is likely that no set back control is being utilized in this case.	10 tonnes CO_2e
Upgrade Outdated Atmospheric Water Heating to High Efficiency Boilers Domestic water heating and ice flood water is largely heated with lower efficiency atmospheric boilers that would range in efficiency from 50-70 percent. Upgrades to high efficiency sealed combustion boilers would yield efficiencies from 80-92%.	50 tonnes CO_2e
Verify and Eliminate Once-Through Cooling Water at Allandale Allandale has 30,000 m3 water spikes in the summer months that are potentially due to once-through cooling of the refrigeration plant condensers. If verified, elimination of this load would avert large water wastage, along with the associated treatment and pumping costs.	0.1 tonnes CO_2e

TABLE 4-8
POSSIBLE ENERGY SAVINGS MEASURES AT RECREATIONAL FACILITIES

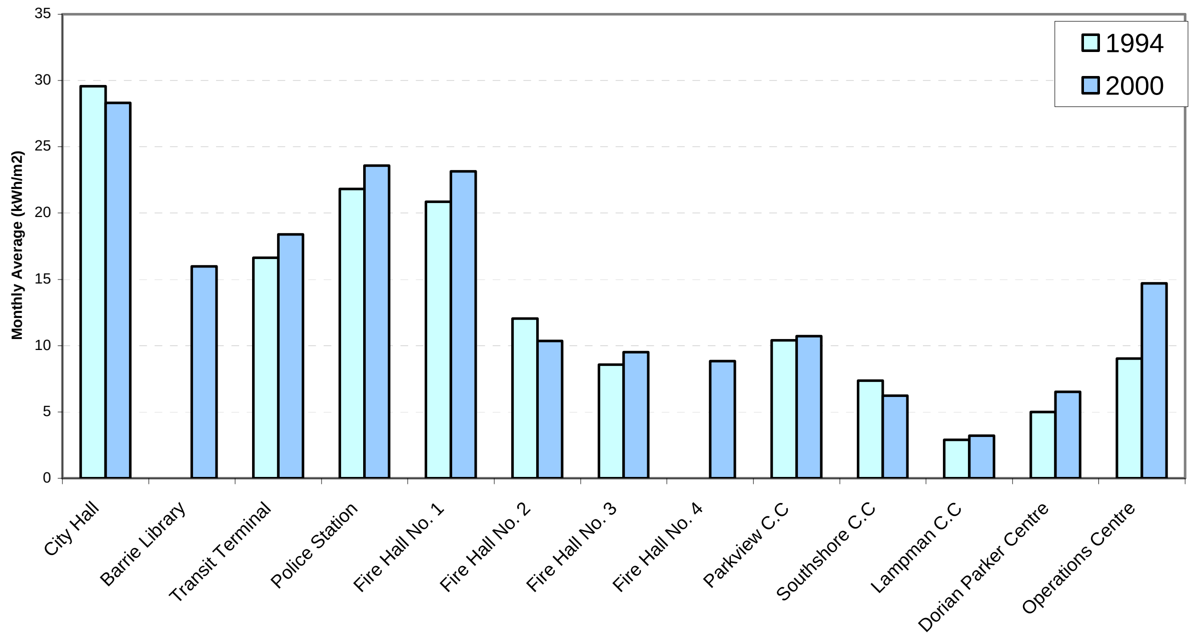
Energy Savings Measure	Estimated GHG Reduction Potential
Review Controls in Refrigeration Plants There are several opportunities to save energy in the operation of the refrigeration plants by adjusting operations. For example, during cold winter months and unoccupied night time operation, the load on the compressor plants is relatively low. Through these periods it may be possible to reset the minimum brine temperature set point to increase the operational efficiency of the compressors. An approximate 2 percent reduction in electricity usage can be seen for every 1 degree increase in minimum brine temperature. Also, Molson Centre only runs the brine pumps when the refrigeration plant is operating; however, all other facilities run their brine pumps continuously. Shutting off the brine pumps reduces pumping energy and the sensible heat load generated by the pump itself.	25 tonnes CO_2e
Add Dimmer Controls to Metal Halide Lighting Frequent on/off cycling of HID lamps will shorten their life; however, dimmer control can be employed to reduce energy consumption during unoccupied hours.	1 tonne CO_2e
Future Capital Projects for Equipment Replacement This category includes capital based projects that are identified through monitoring and targeting programs, as well as general efficiency upgrades during the retrofit of retired equipment. An example would be the efficiency gain achieved when the pool dehumidification system was retrofitted in fall 2003.	137 tonnes CO_2e
Lighting Replacement Program There is only one recreational facility being assessed for lighting replacement opportunities. These considerations are taking place at the Allendale Recreational Center. If the replacement program was implemented there would be an estimated savings of 150,000kWh/year at this facility alone.	48 tonnes CO_2e
Total Potential Reductions	720 tonnes CO_2e

Additional specific opportunities and details are provided in the Recreational Facilities Module in Appendix A.

4.3.2 Office Building Facilities Summary

City Hall stands as the most populated and largest building, as well as the highest energy, at just over 27 kWh/m^2. The Police Station and Fire Hall #1 fall in the 20-25 MWh/m^2 range, and the Library, Transit Terminal, and Operations Centre, fall into the next category of approximately 15-20 MWh/m^2. The remaining Fire Halls and community centres generally consume less than 10 MWh/m^2 annually.

FIGURE 4-3
ELECTRICAL USE INTENSITY BY BUILDING FLOOR AREA



Note:
For Barrie Library no electricity data available for 1994 or 2000, 2001 data presented instead.

To meet the 20% PCP reduction target for the corporate assets, a total reduction of 1,843 tonnes CO_2e must be achieved below 2000 emission levels.

TABLE 4-9
Summary of Corporate BuILDINGs

2000 Energy Use*	27,260 GJ
GHG Emissions	3,573 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	**1,730 tonnes CO_2e**

*Excluding Recreational Facilities and Marina

The following table provides a high level summary of the energy savings measured identified. The potential GHG reduction potential is estimated based on operating rules-of-thumb since no sub-metering data is available to validate savings potential.

TABLE 4-10
POSSIBLE ENERGY SAVINGS MEASURES

Energy Savings Measure	Estimated GHG Reduction Potential
Establish Monitoring & Targeting Program This is a broad-based measure that would include establishing sub-metering at all major load centres, benchmarking efficiency, and establishing energy efficiency improvement targets. It is generally accepted that the implementation of an energy monitoring system will generate 10-	240 tonnes CO_2e

TABLE 4-10
POSSIBLE ENERGY SAVINGS MEASURES

Energy Savings Measure	Estimated GHG Reduction Potential
15% energy savings, based on improved operational practices. As identified in the Buildings Module there is a grouping of equipment that could benefit from tighter operational control.	
Lighting replacement program There are currently three City buildings being assessed for lighting replacement opportunities. Included in the assessment are the Operations Center, City Hall and the Police Station. Collectively the lighting replacement program is estimated to save 640,000 kWh/year.	156 tonnes CO_2e
Update and Integrate Major Equipment in Energy Management System The existing EMS at City Hall has a control interface at the facility and Operations staff is not fully aware of its full function. A review of how equipment is being controlled however would enable control over equipment operation.	10 tonnes CO_2e
Add Dimmer Controls and Motion Sensors Current practice relies on building staff or maintenance staff to turn off lights. Use of motion sensors and dimmer controls can be employed to reduce energy consumption during unoccupied hours.	5 tonne CO_2e
Total Potential Reductions	411 tonne CO_2e

Additional specific opportunities and details are provided in the Building Facilities Module in Appendix B.

4.3.3 Landfill/Solid Waste Summary

For the GHG emissions inventory, the emissions are determined from the total waste landfilled in a year. As can be seen by the Figure, the GHG emissions for waste management decreased from 1994 to 2000 due to the decrease in quantity of waste landfilled. The City of Barrie has steadily increased the amount of recyclables that have been diverted from disposal in the landfill. Further GHG reductions can be obtained by increasing the waste diversion rate, which currently stands at 32%. On its own the landfill has met the 6% reduction target for its own emissions from 1994 levels.

Similarly for the corporate waste, the GHG emissions generated from the waste produced in 2000 are below the 20% reduction target emissions at 820 tCO_2e.

FIGURE 4-4
BARRIE WASTE AND GHG TREND

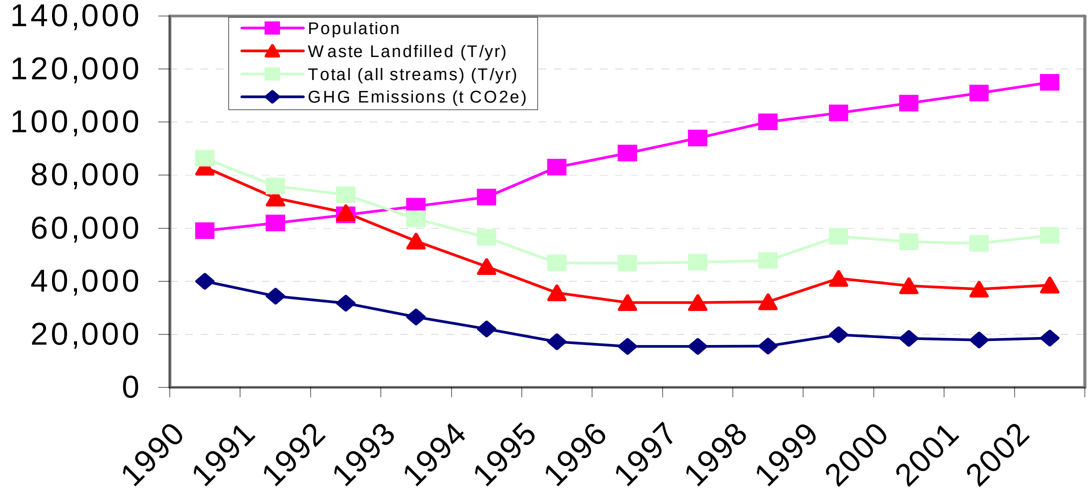


TABLE 4-11
Summary of Landfill and Solid Waste (Community Emissions)

2000 GHG Emissions (Landfill)	17,932 tonnes CO_2e
6% Reduction PCP Emissions Target	**20,460 tonnes CO_2e**
2000 GHG Emissions (Corporate Solid Waste)	414 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	820 tonnes CO_2e

The following measures are recommended for reducing GHG from waste management:

Table 4-12 shows the potential reductions in GHG based on waste diversion and landfill gas flaring. The annual reduction of 51,000 t CO_2e from flaring differs from the emissions produced from waste placed in 2000 of 17,932 as a result of methodology. The emissions from the tonne of waste placed in 2000 will be released over the lifecycle of the decomposition of the waste. The actual emissions generated in a particular year will be based on the cumulative waste-in-place decomposition. Based on waste in place calculations for 2000 the annual emissions in 2000 would have been 65,432 t CO2e.

TABLE 4-12
EMISSIONS REDUCTIONS ACTIVITIES

Measure	Estimated GHG Reduction Potential
Increase Waste Diversion	0.48 tonnes CO_2e per tonne waste diverted from landfill
Landfill Gas Flaring	51,000 tonnes CO_2e

4.3.4 Water/Wastewater Summary

To meet the 20% PCP reduction target for this sector, a total reduction of 516 tonnes CO_2e from 2000 level must be achieved by 2011.

TABLE 4-13
Summary of Water/Wastewater Facilities

2000 Energy Use	13,467,640 kWh
2000 GHG Emissions	4,399 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	**3,883 tonnes CO_2e**

*Natural Gas usage marginal when compared to electricity use

Additional specific opportunities and details are provided in the Water/Wastewater Facilities Module in Appendix D.

4.3.5 Fleets Main Summary

The City of Barrie operates and maintains approximately 210 fleet vehicles, ranging in size from passenger, and light duty trucks to heavy diesel equipment. The Fleet department also carries small motors and police vehicles as part of their asset inventory. The Barrie Transit system is operated and maintained by PMCL therefore, fuel consumption and energy efficiency opportunities are evaluated separately. To meet the 20% reduction target for the corporate assets within the fleets a reduction of 2,387 tonnes CO_2e would be required from 2000 emission levels.

TABLE 4-14
Summary of Fleet Emissions

2000 GHG Emissions	5,311 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	**2,387 tonnes CO_2e**

TABLE 4-15
Energy Savings Measures for Fleets

	Fleet Services Measures	Estimated GHG Reduction Potential
Fleet Services Behavioural Factors		
1.	Smart Driver Training Program This measure encompasses all aspects of Smart Driver training, including minimization of idling, trip optimization, and better fuel use accountability. Current experience from this program has demonstrated that 8-10% fuel reduction is achievable if awards recognition programs are in place. This measure is applicable to all fuel usage.	197 tonnes
Fleet Services Equipment and Fuel Use Factors		
2.	Conversion of 50 Percent of Series 100 Vehicles From Gasoline to Natural Gas CNG offers an 84% reduction in GHG emissions as compared to an equivalent amount of gasoline. Conversion to CNG offers the highest percentage reduction option currently available to Fleet Services.	321 tonnes
3.	Use Ethanol Blended Gasoline for Remaining 50% of Series 100 Vehicles Running of Gasoline Ethanol blended gasoline can reduce GHG emissions by approximately 4%.	23 tonnes
4.	Switch to Blended Biodiesel Significant test data is now available on the operation of biodiesel in various types of vehicles, ranging from pick-up trucks to garbage collection vehicles and transit buses. Suppliers indicated a confidence level in converting fleets to a 20% summer blend and 5% winter blend of biodiesel. The GHG emission reduction presented in this measure assumes a yearly blended average of 12.5% biodiesel.	118 tonnes
5.	Retrofit Fleet Service Bay Doors at Ferndale Assume a 5 percent reduction in building heating fuel is possible.	27 tonnes
Subtotal of GHG Reduction Potential for Fleet Services		**686 tonnes**
Barrie Transit Behavioural and Equipment Factors		
6.	Smart Driver Training Program FleetSmart will be implementing a specialized Smart Driver training program for transit bus operators starting fall 2004. Preliminary results from this program have demonstrated that 10% reduction in fuel consumption is readily attainable.	334.5 tonnes
7.	Switch Transit Buses to Biodiesel Comprehensive test data is now available from testing completed by Société de Transport de Montréal (STM) and the Canadian Renewable Fuels Association. As noted in the fleet section, a blended fuel average of 12.5% annually provides the opportunity to reduce equivalent diesel emissions by approximately 10%	334.5 tonnes
Subtotal of GHG Reduction Potential for Fleet Services		**669 tonnes**
Grand Total CO_2e Emission Reduction Potential for Fleet Services		**1,300 tonnes**

4.3.6 Street Lighting Main Summary

In 2000, the City's street lights and traffic control signals consumed approximately 6,800,000 kWhs of electricity. This equates to a total energy consumption of 24,480 GJ/year and an overall utility cost of approximately $476,000 dollars.

To meet the 20% PCP reduction target for this sector, a total reduction of 428 tonnes CO2e from 2000 energy use must be achieved.

TABLE 4-16
Summary of STreet Lighting

2000 Energy Use	24,480 GJ
2000 GHG Emissions	1,883 tonnes CO_2e
PCP 20% Reduction Target of 1994 Emissions	**428 tonnes CO_2e**

In the street lighting sector, new technologies, such as electronic photocells and LED traffic control signals, make the PCP target easily attained and exceeded. The GHG reduction potential is estimated based on forecasted operating hours, since street lights are not individually metered.

TABLE 4-17
ENERGY SAVINGS MEASURES FOR STREETLIGHTING

Energy Savings Measure	Annual kWh Saved	Estimated GHG Reduction Potential
Change to More Efficient Lamp Types Changeout existing mercury vapour lamps to pulse start metal halide, and convert probe start metal halide to pulse start metal halide. Convert all incandescent traffic control signals to LED.	1,431,498 kWh	450 tonnes CO2e
Changeout all Cadmium Sulphide Photocells to Electronic Photocells Replacing the existing photocells with newer, more reliable electronic types could reduce lamp operating time by up to 30 minutes per day, by improving shut-off sensitivity. Newer photocells also consume less power.	394,186 kWh	124 tonnes CO2e
Total Potential Reductions	**1,825,684 kWh**	**574 tonnes CO2e**

5. Summary of Corporate Operations

5.1 Analysis of Potential Reduction Targets

A draft analysis was performed for the modules and summarized in section 4.3 to demonstrate the types of reduction activities that could be undertaken and how they would individually contribute toward the overall reduction target of 20% below 1994 emission levels for corporate assets. Table 5-1 summarizes the total GHG emission reduction measures and identifies the remaining gap.

TABLE 5-1
SUMMARY OF GHG EMISSION REDUCTION MEASURES

Corporate Asset Class	Required Reductions from 2000 to Meet Target	Potential CO_2e Reductions	Total 2011 % of Reduction Target
Recreational Facilities	2,632	720 tonnes	4.4%
Office Buildings	1,843	410 tonnes	2.5%
Waste/Landfill	NA	51,000 tonnes	315%
Water / Wastewater	516	20 tonnes	0.12%
Fleet Vehicles	2,924	1,300 tonnes	8.0%
Street Lighting	1,453	570 tonnes	3.5%
Grand Total CO2e Emission Reduction Potential	**9,368**	**54,000 tonnes**	**333%**
Target for 2011	**16,189**	**16,200 tonnes**	**100%**
Surplus from Target Reductions		**37,800 tonnes**	

The reductions necessary to achieve the PCP 20% reduction target were presented in Section 4 within each asset class; however, Table 5-1 clearly demonstrates that the 20% reduction could be achieved for all asset classes by addressing the landfill gas emissions.

Barrie's landfill does not currently have a landfill gas collection system in place. Landfill gas is composed primarily of methane, carbon dioxide, and trace organic compounds. It is produced by the decomposition of waste and is estimated to contribute up to three per cent of Canada's GHG emissions. Flaring destroys the methane in landfill gas, and therefore, reduces the GHGs. Utilization, instead of flaring, provides additional benefits, including generating revenue at sites where landfill gas utilization is economically viable. The capture of landfill gas provides a source of renewable energy, primarily for heating and generating electricity, but also for new uses such as vehicle fuel.

There are safety and environmental considerations associated with landfill methane as it is a potent greenhouse gas and can form explosive mixtures when mixed with air. Flaring contributes primarily to emissions of carbon dioxide as a greenhouse gases while venting contributes to emissions of methane, also a greenhouse gas. The following assessment is provided by the U.S. Agency for Toxic Substances and Disease Registry:

> "Some passive gas collection systems simply vent landfill gas to the atmosphere without any treatment before release. This may be appropriate if only a small quantity of gas is produced and no people live or work nearby. More commonly, however, the collected landfill gas is controlled and treated to reduce potential safety and health hazards.
>
> Combustion is the most common technique for controlling and treating landfill gas. Combustion technologies such as flares, incinerators, boilers, gas turbines, and internal combustion engines thermally destroy the compounds in landfill gas. Over 98% destruction of organic compounds is typically achieved. Methane is converted to carbon dioxide, resulting in a large greenhouse gas impact reduction. Combustion or flaring is most efficient when the landfill gas contains at least 20% methane by volume. At this methane concentration, the landfill gas will readily form a combustible mixture with ambient air, so that only an ignition source is needed for operation. At landfills with less than 20% methane by volume, supplemental fuel (e. g., natural gas) is required to operate flares, greatly increasing operating costs.
>
> Some public concerns have been raised about whether the combustion of landfill gas may create toxic chemicals. Combustion can create acid gases such as SO_2 and NO_X . The generation of dioxins has also been questioned. [The US]EPA investigated the issue of dioxin formation and concluded that the existing data from several landfills did not provide evidence showing significant dioxin formation during landfill gas combustion. Because of the potential imminent health threat from other components of landfill gas, landfill gas destruction in a properly designed and operated control device, such as a flare or energy recovery unit, is preferable to uncontrolled release of landfill gas." [5]

5 Agency for Toxic Substances and Disease Registry "Landfill Gas Primer An Overview for Environmental Health Professionals" found at http://www.atsdr.cdc.gov/HAC/landfill/html/ch5.html

6. Environmental and Activity Based Cost Accounting

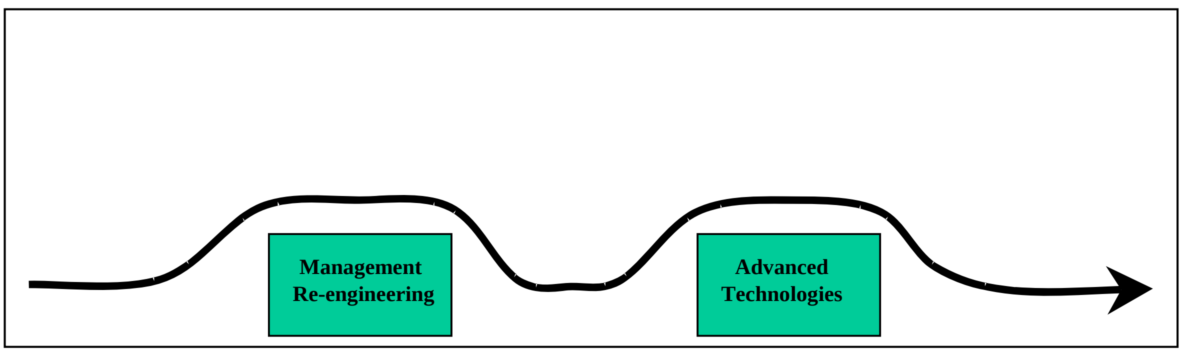
6.1 Background

The seven technical modules of this report primarily focus on the current ***Operational Status*** of facilities and ***Equipment*** based opportunities to reduce energy consumption. This module focuses on over-arching ***Management*** and ***Cultural*** issues that are key to achieving long term GHG reduction goals.

The City of Barrie has implemented many energy efficiency initiatives in the past which have met with varying degrees of success in terms of their long term ability to sustain energy savings. While there are successes, there are also instances where energy efficiency practices have been lost due to changing management, or a perception by staff that a measure provides little benefit and makes facility operation even more cumbersome.

Long term energy efficiency goals need to be achieved through a culture of ***Continuous Process Improvements*** throughout all departments within the City. In the long run, it is not necessarily that the large infrastructure projects yield the greatest GHG reductions; but rather, it may be the collective result of many smaller projects conceived and initiated by individual employees. Figure 6-1.

FIGURE 6-1
THE PATH TO SUSTAINABLE GHG EMISSION REDUCTIONS



This section discusses an "Environmental Accounting" approach to systematically evaluate how the City's current management practices support continuous energy efficiency improvement.

6.2 Overview of Environmental and Activity Based Cost Accounting Process

The Environmental Accounting Audit was designed to evaluate the existing degree of synergy between the ***Operations*** and ***Financial*** departments in controlling management decisions that result in the lowest overall environmental life cycle cost. Starting with a financial review, a City-wide analysis was made to identify major energy cost centres. This information was used to identify major areas that were most likely to yield tangible opportunities for environmental and operational cost savings.

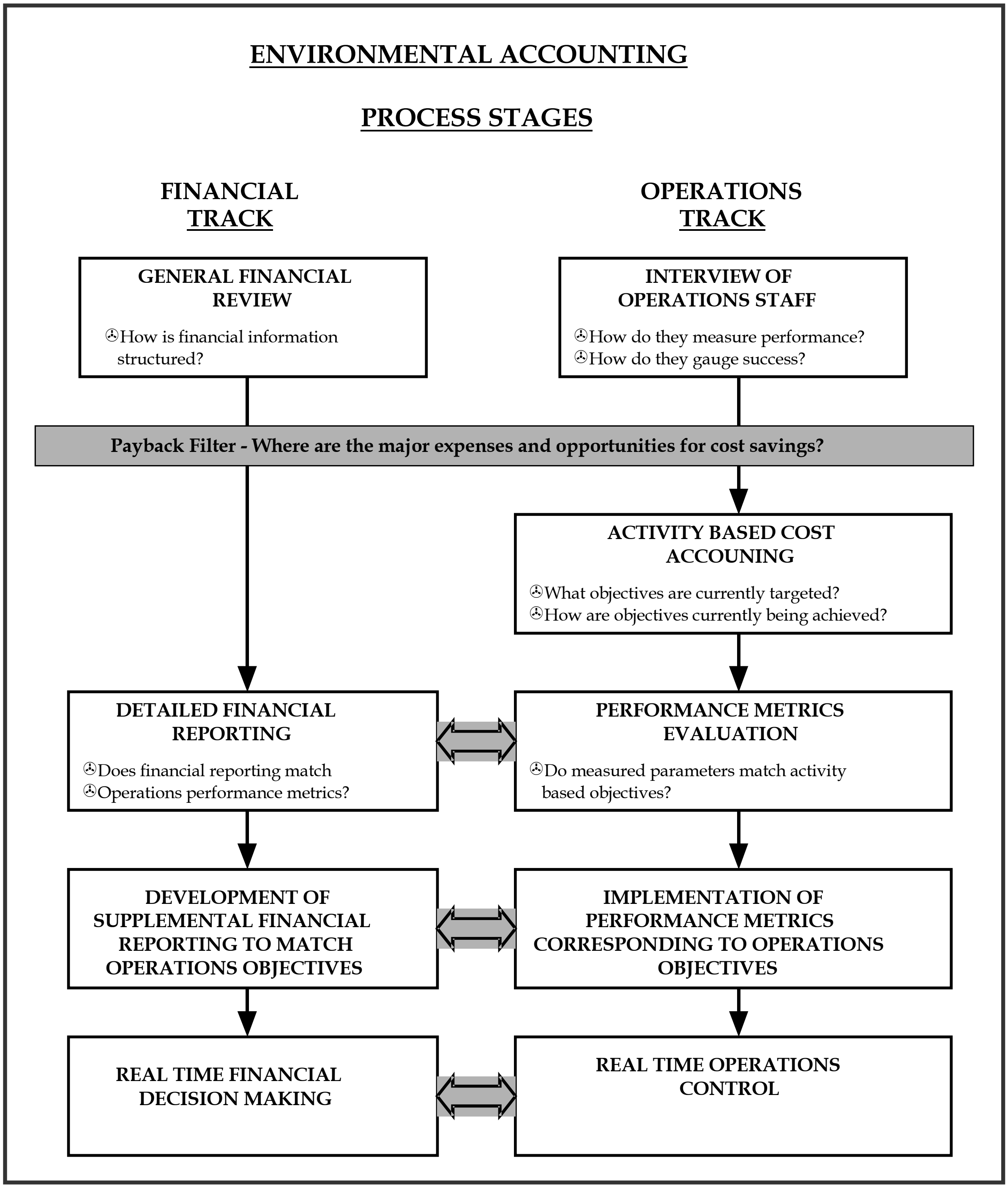
Figure 6-2 illustrates the basic approach of how Environmental Accounting was applied to the City of Barrie. Through the process, two parallel tracks were followed to evaluate performance from both a Financial and Operations perspective. The end objective being the creation of a management tool, which will identify and guide actions that can be taken to improve financial and operational performance.

Stage One – Financial Review and Operations Staff Accountability

In the first stage, a general financial review is conducted to determine how the City's financial information is structured, with specific focus on the detailing around major cost centres. On the Operations side, operations staff personnel were interviewed to determine how they measure their own performance and how they gauge success. This stage provided the following information:

1. The ease with which the financial cost center information can be applied to individual staff activities and processes at various facilities.
2. The relationship between current financial reporting practices and how Operations gauges performance of their staff.

FIGURE 6-2
ENVIRONMENTAL ACCOUNTING



Stage Two – Activity Definition

In evaluating key cost centres, the actual activities and processes being conducted at facilities were identified. In this stage, the overall business objectives of specific departments were identified and then contrasted to the current activities being conducted to reach these objectives. This activity provided the following information:

1. The degree to which each department or facility measures its performance with regard to energy efficiency and/or environmental performance.
2. Potential areas where current best practices may not be employed due to the continued use of "status quo" methods. This stage will identify where newer technologies or management processes could improve overall operations.

Stage Three – Performance Metrics

In stage three, detailed parameters by which the Financial and Operations Department measure performance were evaluated. The performance metrics are reviewed in the following context:

1. Are individual performance metrics easily measured?
2. Do the performance metrics measured account for "end-of-pipe" costs or do they encourage performance improvement at the source? For example, an end-of-pipe metric might be: total gasoline use for vehicle transportation. Whereas, an associated source metric might be: vehicle travel avoided.
3. Do existing performance metrics support the identification of hidden costs?

Stage Four – New Performance Metrics

In Stage Four the new performance metrics are implemented into the Operations and Financial Departments. The objective of this stage is to enhance existing management tools by providing supplemental measurement and reporting documents.

Stage Five – Decision Making Tool

Ultimately this process will create a common management tool for the Financial and Operations Departments within the City of Barrie. By having a measurement and reporting structure that linked objectives, real time financial decision making and operations control can be achieved.

6.3 Environmental Accounting Audit Findings

The findings in this section are reported as general recommendations for all facilities. For specific facility recommendations please refer to the appropriate Module in the appendices.

Stage One – Financial Review and Operations Staff Accountability

The most significant observation of the Environmental Accounting Audit is that continuous process improvement appears to be currently focused on administrative simplification. In the Financial Department, all energy billing (natural gas, propane, and electricity) has been consolidated on one general ledger account, and it is maintained on an Excel spreadsheet that is not readily attainable by Operations staff. Historically, energy use billing was forwarded to facility managers by photocopying and forwarding energy bills, however, this was cumbersome, so the practice has been discontinued.

City managed transportation fuel consumption is provided to the Fleet Services manager through the independent billing of Mayes Martin. However, this billing can only be considered on an aggregate basis since the current card lock system is unreliable for monitoring individual vehicle fuel usage.

Transportation fuels used by third party operators (e.g., garbage collection and transit) are not seen by City staff, as the fuel use is lumped into general service contracts with the respective operators.

On the Operations side of the equation, individual employees are somewhat aware of efficiency issues but they have no job performance metrics associated with energy use reduction. There is currently no incentive based system to acknowledge/reward staff for reducing energy consumption in their daily operations.

With the exception of locations with energy management systems, Operations staff is generally not aware of energy use levels since nearly every facility only has central metering and no provisions for internal readout stations. Staff currently has no means to evaluate the impact of their operating practices on energy consumption.

In most cases, there is a specific disconnect between the personnel in the Financial Department paying the energy bill, and the Operations staff responsible for running the energy consuming equipment.

Operations staff currently gauges their success in terms of operating equipment reliably and meeting the requirements of the tenant(s) of the facility. (Examples include temperature and humidity targets for office buildings and ice hardness and temperature for ice arenas). In some cases, energy end use is largely affected by staff operating equipment in a manner to avoid tenant complaints.

Stage Two – Activity Definition

With respect to capital planning, energy efficiency is always a strong consideration for equipment purchases in new facilities and retrofit applications. However, the focus on energy efficiency does not seem to be carried forward from capital planning to daily operations, as facilities do not have energy end-use targets or objectives. In general, energy use budgeting is based on the previous year's consumption plus an energy price index. No formal programs exist for staff to identify non-capital based energy efficiency opportunities or areas of energy wastage.

Stage Three – Performance Metrics

With respect to facility specific energy consumption, neither the Financial Department nor the Operations Department currently has any formal performance metrics.

Except where energy management systems exist, there is no method of energy use trending to identify long term increases in energy use. (Long term increases can represent a slow reduction in equipment efficiency or deviation from standard operating practices).

Most facilities only have central metering with no remote terminal readout for daily or hourly monitoring. With minimal exception, there is no submetering in any facility. The lack of sub-metering is impeding the City from establishing daily efficiency targets and uncovering hidden energy wastage. Some examples of energy wastage uncovered during this audit included:

- Tens of thousand of gallons of water being used for once through cooling
- Building occupants leaving windows open to reduce heat where a thermostat was broken
- Very large air handlers being left on during unoccupied building periods

6.4 Recommendations

Ultimately, senior City officials should have direct performance metrics of the City's energy consumption from both an aggregate and individual facility basis. To foster a culture of Continuous Process Improvement, the metrics should be based on specific energy usage as well as the implementation of management programs to reward employees for identifying methods of reducing energy usage.

Improve Current Energy Use Metering

As a starting point, it is necessary to be able to directly measure current performance and future improvement. All central meters at each facility should be equipped with remote communication modules so that City staff can see real time energy use. With deregulation, the gas and electric utilities will likely have already converted larger meters to be able to provide digital readouts. For a nominal charge, the City can get a direct feed of this information into the respective facility. For smaller loads, meters can be retrofitted by the utility to be able to provide digital outputs – this may involve a slightly higher cost. During the process of obtaining digital signals from central meters, consideration should also be given to installing sub-metering on large energy consuming equipment.

Adopt Metering Data Acquisition Software

Obtaining digital consumption information will yield a large volume of data that will need to be processed to generate interval consumption information (hourly, daily, monthly) as well as historical trending. The utilities will have the greatest experience with this software and would be able to make recommendations to the City based on a needs analysis. This software would allow reconciliation with utility bills as well as help to reduce overall energy charges by:

- Assisting facility operators in maintaining target energy consumption
- Identifying periods when peak demand charges could be reduced
- Identifying equipment efficiency reduction trends that signal required maintenance (e.g., heat exchanger fouling)

- Identifying trends of increased energy use which may be the result of a deviation from traditional operating practices.

Benchmarking and Performance Metrics of Energy Use

A benchmarking program should be established at each facility. The benchmarking program should initially consist of basic energy indices such as volume of natural gas and/or electricity consumed per area of office floor space (m^3 natural gas/m^2 and/or kWh electricity/m^2). Benchmark indices can then be compared to other similar type facilities in the City and with other buildings in Ontario. Current benchmarks are being developed by Ontario Recreation Facilities Association and the Canadian Building Energy End-Use Data and Analysis Centre (see www.ualberta.ca/~cbeedac for references).
As a second phase to benchmarking, other parameters may be evaluated to help improve energy performance. These would be more operational based and might include control of brine temperature in arenas during different ice usage requirements (e.g., figure skating and ice hockey) or timing of setback controls in office buildings.

The third phase of benchmarking metrics would be to establish a correlation of parameters that drive energy usage in a facility. Level of occupancy and number of heating or cooling degrees days would be prime examples. Ultimately, these benchmarking indices could be integrated with energy monitoring software and be used to forecast energy consumption in a facility. Deviations from forecasted energy use could be highlighted enabling operators to investigate abnormal energy use. This level of sophistication may only prove cost effective for larger facilities that operate year round such as City Hall or the Molson Centre.

The benchmarks chosen by the City will also be important for the long term monitoring of energy savings in support of the PCP program GHG reduction commitment. The International Performance Measurement and Verification Protocol (IPMVP) define general procedures to achieve reliable and cost effective determination of savings. The protocol is free to download at www.ipmvp.org .

Management Performance Metrics

Ultimately, to achieve the goal of "Continous Energy Efficiency Improvement" it will be necessary to implement energy based performance metrics for Operations Staff. As noted previously, implementing a physical means of measuring energy use will be of prime importance. The other key factor will be communication so that everyone understands the "big picture".

> *"…When people only understand the procedural aspects of their job as opposed to the whole process there is a reluctance to change….To gain acceptance of new practices and to foster innovation, people need to understand the whole process." – Enbridge Management*

Eliminating hidden energy wastage and changes to operational practices will likely yield the lowest cost options to meeting Barrie's PCP GHG reduction targets. Creating a culture where these changes are fostered by City staff is crucial to long term success.

Another important aspect to management metrics will be communication of energy efficiency goals to end-users of various facilities. Promotion of energy efficiency will improve the image of the City and also help to mitigate circumstances where clients request operational practices that are overly energy intensive. For example, running unit heaters in the ice arena to keep air temperature warm for skaters.

Integration with Financial Measurement and Rewards System

Reducing energy consumption within a facility can often mean a smaller energy budget next year if a formal reward program is not implemented. This can be a major disincentive to innovation. Senior staff through the Finance Department should have performance metrics whereby Facilities staff is rewarded for meeting and exceeding energy use performance targets. Since the City is growing, overall energy budgets may continually increase, however, proper benchmarking indices will allow Senior Staff to gauge performance in a dynamic environment.

Finally, the Finance Department, in cooperation with Operations Department, should develop a new financial tracking system that is networked based and allows retime access to billing and performance metric information by multiple departments.

7. The Community Energy Plan

This section of the report is meant to be the initiative to develop a Community Energy Plan. The following text will outline key issues and strategies for developing the plan.

The ***Community Plan*** would lay out a strategy for engaging all citizens and business sectors to participate in improving their energy use requirements. This section of the plan will explore new alternatives, to not only encourage local businesses to become more energy efficient, but also to become our "champions" in providing economically desirable green product options to the community. The underlying premise of the Community Plan is that sustainable improvements must be founded in natural market economics as opposed to solely relying on incentive and public awareness programs. By fostering increased trade and manufacture in the growing world green economy, the City will prosper through a cleaner environment and stronger economy.

The Green Economy is just starting to gain strong momentum across the country as municipalities set green purchasing policies. Failing to assist the local businesses in supplying this market demand will suggest a significant missed market opportunity.

The major components of the Community Plan will include:

1. Identification of local companies providing green products and services.
2. Understanding the Green Product Economy and how we can assist local businesses to utilize this emerging market
3. Develop Government/Industry stakeholder groups and suggest strategies to work cooperatively to synergistically meet business and environmental objectives.
4. Gain full engagement of the Community through sector based Stakeholder Groups

7.1 Overview of Current Initiatives and Lessons Learned

The City has been highly proactive over the past 10 years in adopting programs and partnering with energy utilities to bring energy efficiency programs to our community. The success of these programs has been dramatically affected by the relatively low cost of energy in Ontario – which makes for long payback periods when investing in energy efficiency. Historically, governments and local utilities have tried to overcome these hurdles by providing incentive programs to encourage the purchase of higher efficiency products.

Barrie has implemented several community based incentive programs that have had notable success, but the major problem is that they are not self sustainable. Once the subsidies are removed, consumer buying practices revert back to original patterns. A vivid example of this effect was the creation of Be Green Barrie, which was established to promote home energy efficiency through subsidized audits. Once the initial cash infusion was exhausted, the program lost viability in the marketplace.

Community Energy Efficiency

The Programs

- Energuide
- Be Green Barrie
- Washing Machine Rebate
- Low Flow Toilet Rebate
- Low Flow Shower Heads
- Rainbarrel Program
- ESCO Building Retrofits
- Recycling Programs
- Education / Awareness

The Challenges

- Require Financial Incentives
- Limited Uptake
- Artificially Changing Market Dynamics
- Not Sustainable without Government Support
- Limited Ability to Leverage Community Partners
- Lack of Regulatory Support to Enforce

While incentive programs do have value in raising public awareness of energy efficiency, it is clear that a sustainable long-term strategy must be non-incentive based and consumer driven.

7.2 Defining the Challenges

In general, there are three mechanisms to encourage non-incentive based energy efficiency within the community:

1. Improve Energy Efficiency of Equipment Sold in Marketplace (New & Retrofit)
2. Education – Change Behavioral Factors Influencing Direct/Indirect Energy Use
3. Regulate energy efficiency/ energy use

To develop new strategies, many municipalities have focused on education/awareness and, in some instances, regulations, to encourage energy efficiency. To evaluate the potential success of any new energy efficiency strategy, it must be considered in the context of technical, economic, societal, and political challenges.

Analyzing the Success of Energy Efficiency Measures

Energy Efficiency Strategy	Technical	Economic	Societal	Political
Education/ Awareness	Manageable	**Difficult**	Good	Good
Regulation Command & Control	Manageable	Manageable	**Difficult**	**Difficult**
Consumer/ Market Driven	Manageable	Good	Good	Good

For example, a strong education/awareness program of energy efficient technologies would likely receive strong societal and political support because everyone wants to feel green, but this may not always actively influence purchase decisions where higher efficiency translates into higher capital cost. On the other hand, regulations can definitely overcome economic hurdles, but often there is a lack of political will to impose unpopular regulations.

Strategies that can positively affect market demand usually have the highest success rate and greatest sustainability. When consumer demand for a green product exists, there is likely a lack of societal or political hurdles, and competition in the marketplace will usually overcome any technical or economic hurdles. The challenge then, becomes fostering a business environment in Barrie where green industry can flourish meeting new market demands.

Public Appeal to Reduce Energy Useage **VS.** **Encourage Business Opportunities**

Public Appeal to Reduce Energy Useage

- Education /Awareness
- Foster Environmental Conscience

Encourage Business Opportunities

- Foster Environmental Economy in Barrie
- Foster Job Creation
- Increase Tax Base
- Influence GHG Emission by Influencing Energy Efficient Product Demand

7.2.1 Sample Energy Efficiency Initiatives

Here are some sample initiatives that the City might look to, which fall under the different types of mechanisms discussed previously:

Education/Awareness Sample Initiatives

Decrease Motor Vehicle Traffic

According to the 2001 Transportation Tomorrow Survey, [6] trips made by the residents of the City of Barrie are ranked 88% by auto (71% drivers, 17% passengers), with Transit consisting of 2%, and walking/cycling consisting of 6%, during a 24 hour period.

Encourage Bicycling/Walking

The City of Barrie could develop more trails, lanes, paths, and walkways throughout the community to provide additional transportation options. This could include secure and weather-protected bicycled racks at major travel destinations, and an extensive sidewalk system in urban corridors and compact neighborhoods that are pedestrian-friendly, with amenities such as shaded areas, benches, water fountains, and landscaped walkways. The City of Barrie could also allow for the accommodation of bicycles on transit buses and shuttles with the use of bicycle racks. The City could also encourage businesses to provide showers to enhance "commuter bicycling."

Bicycling and walking are pollution-free and should be promoted as an alternative to other forms of transportation.

Carpooling and Vanpooling

The City of Barrie should encourage the public to carpool and vanpool. The City could petition the Ontario MOT for the development of HOV on major highways and arteries, serving to encourage car/vanpooling as an efficient transportation alternative. The City could encourage employers to provide preferential parking for carpool and vanpooling employees. The City could provide free parking for car/vanpools in the downtown area.

Telecommuting

The City of Barrie should encourage the business community to utilize alternative work schedules and reduce the number of commuter trips. With advances in computers and telecommunications, employees could telecommute from their homes (i.e. work from their home using home computer or laptop), or from regional telecommute centers.

Promotion of Energy Efficiency Programs

The City of Barrie should promote increasing the energy efficiency of existing and newly constructed buildings using other models, such as the "Green Buildings" program. The "Green Buildings" program focuses on sustainable building techniques which aim to minimize need for, and reliance on, energy and water supplies. There are many approaches that have been used to accomplish this, including but not limited to:

- Setting local building energy standards by modifying or developing City ordinances
- Requiring building permit applicants to outline energy efficiency measures, or document an energy efficiency plan
- Provide tax incentives to businesses, industries, and institutions that utilize energy-efficient appliances and technologies in new construction, or in upgrades

[6] http://www.jpint.utoronto.ca/tts01/Barrie.html

Promotion of renewable energy systems can also be made through a different program.

Regulation Command and Control Sample Initiative

Decrease Idling of Motor Vehicles

Traffic congestion causes excessive vehicle idling in traffic jams and at stoplights. Drive-through windows at restaurants and banks also encourage excessive vehicle idling, since this "convenience" does not often save time. The average passenger vehicle emits 1 kg of GHG per minute during summer conditions. This number is higher in cold weather and among poorly maintained vehicles. Excessive vehicle idling can be reduced by improving the existing road system, thereby encouraging efficient traffic flow patterns. This will tend to decrease travel times, reduce driver frustration, increase worker productivity, and potentially reduce traffic accidents caused by anxious and careless drivers.

Intelligent Traffic System

Another option for potentially reducing vehicle idling times is to install an Intelligent Traffic System (ITS) to improve traffic flow on the major roads and arteries, especially after traffic incidents. If the average idling time per vehicle could be reduced by at least 1 minute per day on major roads and arteries, then GHG emissions could be significantly reduced during the 20 year commitment period.

Staggered Work Hours

Traffic congestion during peak rush hour traffic contributes much of the GHG emissions from motor vehicles. With increasing growth and the common use of single-occupancy vehicles, travel times are increasing every year, especially as congestion worsens. One option for reducing peak congestion is to encourage employers to utilize staggered work schedules to minimize peak hour traffic. Employers could stagger work schedules such that half of its work force (1st shift) would work from 7:00am to 4:00pm and the other half would work 9:00am to 6:00pm. To some extent, this has been implemented by many industrial companies, but there is the potential to expand this program further throughout the City.

Assuming that average travel times could be reduced by 1 minute per day, per vehicle by expanding the use of staggered work schedules, then, the potential GHG emissions reduction would be similar to reductions from minimizing idling.

Landscape Control

The City should strengthen its landscaping ordinance to encourage well-designed landscaping and tree planting, helping to reduce the amount of reflective heat from parking lots and to shade structures, which should also help to reduce cooling costs. The City could encourage existing developments and require new developments to consider the "Heat Island" effect during design, to leave more trees undisturbed and plan new landscaping to maximize the benefits of plants. Plants act as carbon sinks and can reduce building cooling costs through direct shading and through evapotranspiration, which tends to lower nearby air temperatures. Permeable geotextiles provide an alternative to paved areas. These materials provide the structural stability needed for vehicle access or parking, while reducing solar absorption. Using these permeable ground surfaces, interplanted with ground cover could enhance stormwater drainage and reduce atmospheric heating associated w/paved surfaces.

Consumer/Market Driven Sample Initiatives

Industrial Biodiesel Plant

Fostering the potential location of this type of facility in Barrie would have local economic and environmental benefits through the generation of lower GHG fuels.

Encourage Use of Alternative Fuel Vehicles

The City of Barrie should encourage the use of alternative fuel vehicles by providing refueling stations or encouraging the private sector to invest in alternative fueling stations. Vehicles powered by compressed natural gas (CNG) or electric vehicles have 50 to 80% fewer GHG emissions per mile than conventional gasoline-powered vehicles. Presently, this is a major hurdle as private industry partners are not favouring the supply of alternative fuel vehicles. The goal of this general measure is to reduce GHG emissions from vehicles by encouraging businesses, industries, and the general public to switch to alternative fuels that emit less GHG. It is difficult to project how market conditions, regulatory actions, and consumer response will affect the type of alternative fuel used in the future. Therefore, GHG emissions reductions based on the use of several alternative fuels is given below for comparison. Actual implementation of an alternative fuel program may result in one fuel being selected or a combination of fuels being selected.

Although the Provincial and Federal governments have typically been responsible for legislating and regulating the transportation sector, there are several options that the City can use for promoting the increased use of alternative fuels. The City of Barrie could encourage the use of alternative fuel vehicles by subsidizing the development of refueling stations throughout the City. Refueling stations should be owned by the private sector, but the City could provide grants for the construction of CNG refueling and electric recharging stations throughout the City. The City could also provide electric recharging stations at the City's parking facilities. The City could promote the use of alternative fuel vehicles through public education and advertising campaigns. Another potential strategy would be to officially lobby or encourage the Province to enact requirements for businesses to purchase alternative fuel vehicles.

Residential Fuel Switching

The City of Barrie should encourage residents and builders to utilize cleaner fuels for home heating. The City could amend the local building code to restrict the use of heating oil. By 2021, many of the existing heating systems fueled by heating oil will reach the end of their useful life. The City could offer financial incentives, such as grants and low-interest loans, to encourage existing homes using heating oil to convert to a more efficient fuel. Many of these homes may be low-income households.

Improve Home Energy Efficiency

Improving the energy efficiency of homes as potential for large reductions in GHG emissions by reducing the demand for electricity generated by coal-fired power plants. There are many ways to increase energy efficiency and reduce waste during the design and construction phases of residential units, as well as after construction. Energy efficiency upgrades range from inexpensive retrofits, such as fluorescent lighting, to upgrades of existing HVAC systems. Also, solar technology has advanced in recent years and the cost of these systems continues to drop.

Energy Efficiency Improvements

Energy efficiency improvements can reduce energy demand by approximately 40%, compared to the average home. The following is a list of energy efficiency measures that could be implemented. The following section discusses energy efficiency measures that can be implemented in residential units.

Lighting

Lighting accounts for 15% of residential energy demand. The typical household spends $110 per year on lighting. Installing compact fluorescent lights (CFL) that utilize 50% less energy than incandescent lights can reduce energy costs. CFLs cost much more than incandescent lights, initially ($20-30). However, CFLs can last 10 times longer than incandescent bulbs and save approximately $45 in energy costs over the life of a 75 watt bulb.

Heating/Cooling

Proper design and installation of HVAC systems can reduce energy costs by 10 to 30% by ensuring properly sized equipment, reducing air leaks, and purchasing efficient systems. Improving the R-value of the insulation will also reduce energy demand. Purchasing or specifying high R-value windows will reduce drafts and condensation.

Appliances

The efficiency of major home appliances has increased considerably in recent years. The typical clothes washer consumes 40% more energy than models with newer technology. The EnerGuide program identifies appliances that meet certain energy efficiency guidelines.

Passive Solar Design

Utilizing passive solar design techniques in home construction can reduce energy costs up to 25% by ensuring proper window orientation. Roof overhangs and awnings can be used to minimize direct sunlight entering the home during the summer months. Most of the windows should face south to maximize home heating during the winter months. Proper design of landscaping can also reduce energy costs by shading the home and preventing direct sunlight to heat the home during the warmer months, but also allowing the winter sun to provide secondary heating. Light-colored roofs and attic vents can help reflect heat and cool the attic, which reduces cooling costs during the summer months. Also, designs to increase natural lighting in the home will reduce daytime demand for lighting.

Residential energy efficiency can be encouraged by the City through various strategies including:

- Amending local Building Codes for single-family and multi-family residential units to strengthen guidelines regarding insulation, HVAC systems, and appliances
- Encourage lenders to provide discount mortgage rates for energy efficient homes
- Time of sale energy efficiency requirement
- Offer rebates, low-interest loans, or other financing to retrofit existing low-income homes.
- Penalties, such as local tax, for less efficient equipment and appliances
- Expand Green Building program

Residential Use of Renewable Energy

Renewable energy systems provide the cleanest form of energy. Currently, photovoltaic (PV) or solar systems have high initial costs, but they typically last for 20 to 30 years and require no energy or fuels.

With advances in technology and programs, solar systems may become a more attractive option in the future for meeting residential energy demands. Power can be diverted from coal-fired power plants to a renewable energy with no GHG emissions.

Corporate Sample Initiatives

Expand Mass Transit System

This general reduction strategy is intended to reduce traffic congestion and GHG emissions by reducing the number of miles driven by single-occupancy, gasoline-powered vehicles. Two specific measures identified to meet this goal include the development of a Regional Rail System and the expansion of the existing Bus Transit System in Barrie, to complement the Regional Rail and expand ridership. The goal of this general reduction strategy is to reduce GHG emissions from the transportation sector.

Regional Rail System

The GO Transit Authority is the lead agency for the planning and implementation of a Regional Rail System. Plans call for extending the Bradford line train service to the Barrie area, using the track corridor owned by the City of Barrie. The Regional Rail will use self-propelled, diesel-powered, bi-directional transits. The reduction in kilometres travelled by gasoline and diesel-powered motor vehicles results in a reduction of greenhouse gas emissions.

Expand Mass Transit Bus System

The City of Barrie should expand its mass transit busing system to complement the planned Regional Rail System. The objective of this specific measure is to increase ridership on the Regional Rail by extending transit bus service to the Regional Rail stations in the City, and to increase bus service within the City to provide additional transit opportunities.

Land Use Planning to Reduce VKTs

One of the most effective options for reducing GHG emissions from the transportation sector is to reduce trip times through effective land use planning. The City Planning Department's Official Plan (1994) includes policies to encourage high-density and mixed-use developments. The Plan also encourages infill development, especially in the downtown area, where the older industrial complexes are being converted to mixed-use developments with apartments and condominiums as well as retail stores.

High-density and mixed-use development can reduce GHG emissions by reducing the need for in-town driving. The purpose of these developments is to place residential areas closer to the commercial centers and reduce the number and length of trips for shopping and other errands. By some estimates, new development that improves accessibility by mixing land uses and clustering development generates about half as much VKT as does urban sprawl (Calthorpe, 1993: 43,64; Ewing, 1997:11).

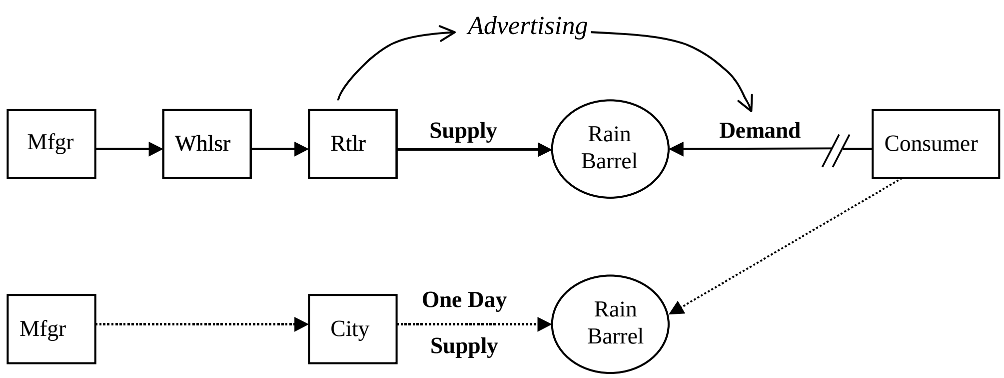
While education and regulation can provide some success, by and large market driven strategies through partnering are the most successful and sustainable.

7.3 Fostering a Green Economy in Barrie

Considering the Supply Chain – The Rainbarrel Example

Barrie presently has a well received Rainbarrel Program, when the city has an annual event day where rainbarrels are sold to the public at significantly discounted rates, encouraging water conservation. While this program is very successful, it targets the end consumer by facilitating a temporary supply chain through the city. This creates consumer awareness and temporary market demand, but it does not ensure sustainability since the traditional supply chain is bypassed.

Considering The Supply Chain

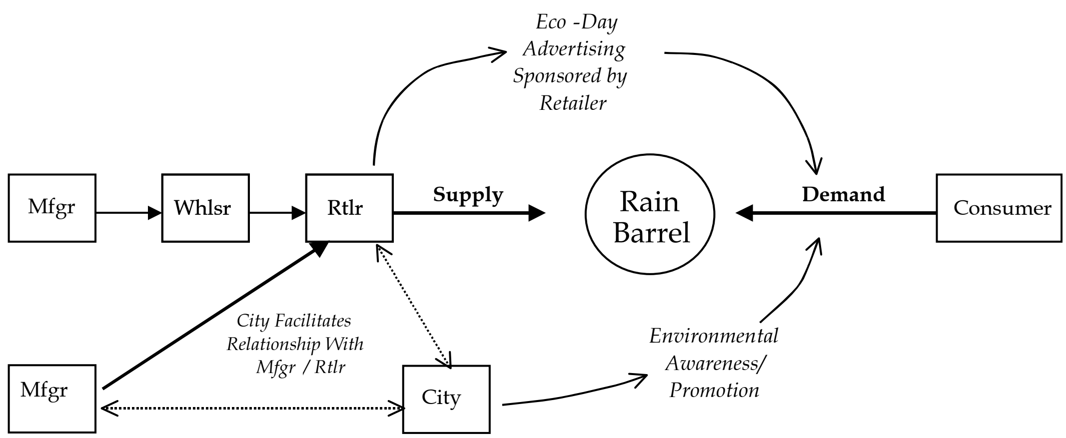


The planned new approach will look for ways to engage retailers during our rainbarrel day, so we can encourage existing supply chains to continuously promote green products that will benefit the city. Retailers would benefit from enhanced corporate image and increased customer traffic in their stores. The city could benefit through promotional partnerships whereby the retailers advertising dollars are used to promote special event days. Leveraging limited departmental budgets would enable the city to reach a wider audience and increase the number of community promotion days.

Examples of activities that this might include:

- *City endorsement of eco days – city could leverage retailers advertising budgets*
- *encourage local retailers to have Barrie Eco-Products Section in their stores*
- *introducing our manufacturing supply source to local retailers*
- *working with retailers to establish price points where rainbarrels and be sold*

The Supply Chain – New Approach



It would be the long term goal of this type of joint promotion, that retailers would see the benefit of these types of green product days and begin to search out new products on their own.

7.4 Sphere of Influence – Evaluating the Different Market Sectors

To pursue this type of market based approach, it will be necessary to determine the factors and organizations that influence the purchase decision of energy consuming property and equipment. The following table gives an illustrative example, from various sectors.

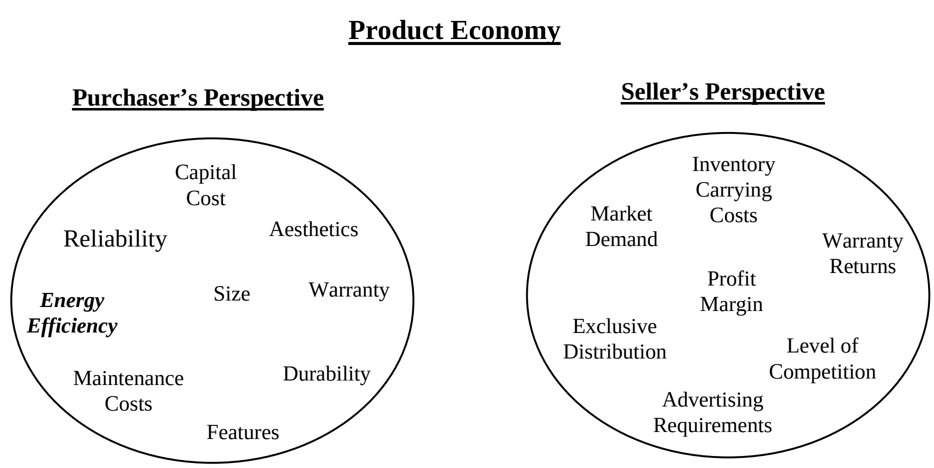
TABLE 7-1
MARKET SECTORS EVALUATION

Market Sector	Example Product	Influencing Organizations	Example Issues
Residential	New Homes Home Renovations	New Home Builders Contractors Retailers	Building Codes Market Demand for R2000 Homes
	Residential Appliances	Retailers Contractors	Ontario's Low Energy Cost Higher Capital Cost for EE Products Longer Payback for Seasonal Use Appliances Profit Margin for Seller
Commercial	Commercial Office Buildings	Developers Contractors	Building Codes Immediate Profit Motive for Developer –

TABLE 7-1
MARKET SECTORS EVALUATION

Market Sector	Example Product	Influencing Organizations	Example Issues
			Developer Generally Not End-User Tenant Paying Energy Bills
Industrial	Heating/Cooling	Contractors Internal Staff	Major focus is placed on process operations Heating costs are often hidden
	Process Equipment	Process Equipment Manufactures Internal Staff	Product Quality / Productivity Dominates Decision Making Process Reliability Capital Investment Focused on Productivity Improvements that yield higher ROR

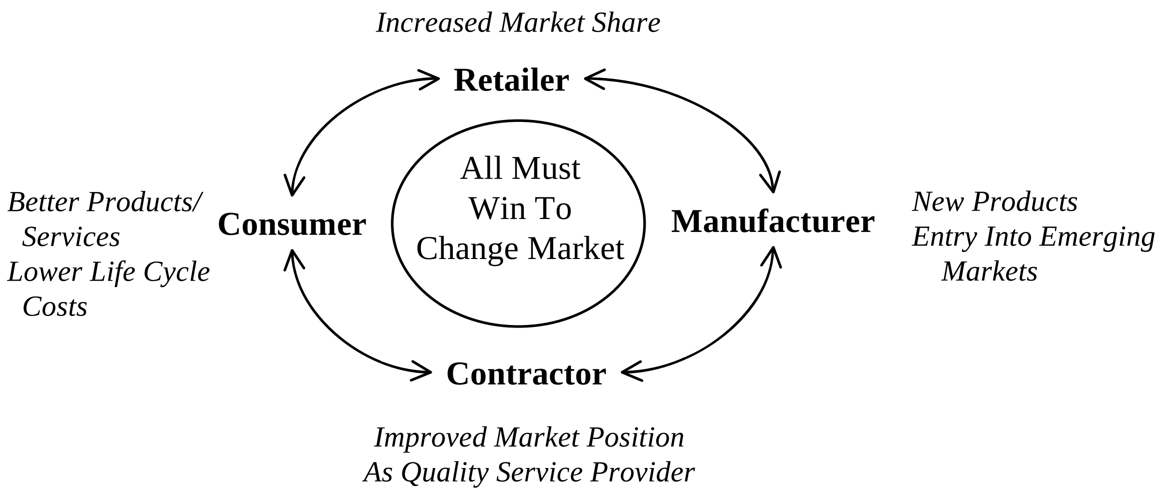
There is a product economy associated with each purchase decision and it will be important to understand the psychographics from both the seller's and purchaser's perspective.



Energy Efficiency Will Always Be A Subset of the Product Economy

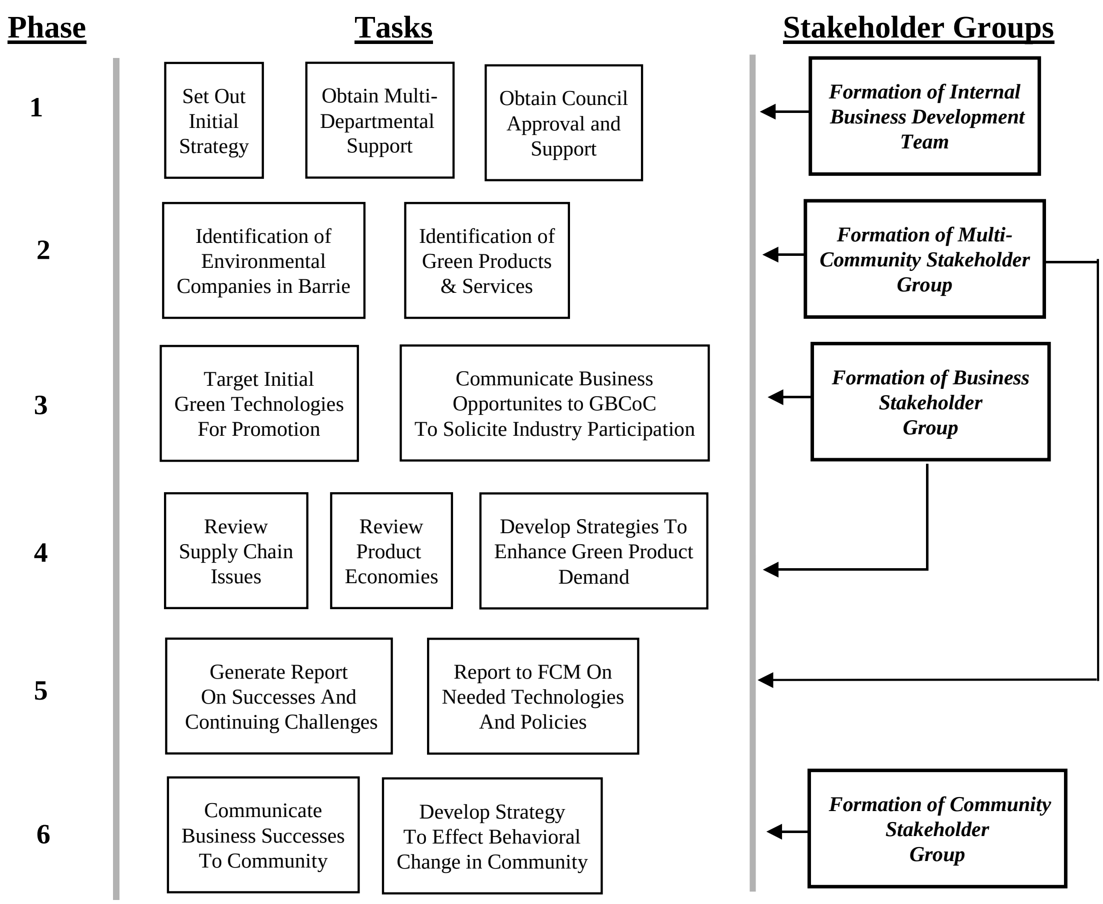
A seller may be reluctant to promote an energy efficient product if it reduces market share or if it provides a lower profit margin. For example, in the commercial building market, the developer is rarely the end-user tenant responsible for paying the energy bills. Therefore, a lack of incentive is created for the developer to install energy efficient equipment and reduce profit margin.

These types of market issues require long-term strategies and their understanding is crucial to developing a sustainable green economy. All participants in the product sales cycle must win.



7.4.1 Economic Development – Strategies for Enhancing Green Industry

The following chart and text provides an overview of our preliminary strategies to enhance Green industry in Barrie.



Phase 1 – Establishing an Internal Business Development Team

Phase One will involve approval of the green business development strategy, as laid out in this document. Council approval and appropriate internal resource allocation will be critical, as management of the Stakeholder Groups will require team members from various City departments. As defined in subsequent sections, these will initially include, Engineering, Economic Development, Legal, and Public Relations.

Phase 1 Deliverables

1. Council Adoption of the Community Energy Plan Strategy
2. Initial Budget and Resource Allocation Given to Project
3. Creation of Internal Green Business Development Team

Phase 2 – Identification of Green Businesses in Barrie and Green Product Opportunities

To develop long term strategies and to create a foster green industry in Barrie, it will be necessary to identify the local companies that are currently providing green services and gain their feedback in identifying market hurdles that need to be overcome to foster greater success. Identification of companies could be managed through the Economic Development Office, in cooperation with the Greater Barrie Chamber of Commerce. These organizations are already proactive in lobbying member concerns relating to business development opportunities, so there would likely be strong interest in pursuing green initiatives.

Integral to this phase will also be the identification of green products that can help the city meet targeted environmental objectives. This task is a large undertaking and would be difficult for the city to undertake independently. Fortunately, the identification of economically viable green products is being pursued by other municipalities, under their Local Action Plan Initiatives and emerging Green Municipal Purchasing Policies. It will be our strategy to seek out these communities, through FCM, and create a Multi-Community Stakeholder Group for the purpose of identifying existing green products which will assist in community energy reduction.

Phase 2 Deliverables

1. Identification of environmentally focused businesses in Barrie.
2. Identification, through FCM, of municipalities fostering green product alliances.
3. Formation of Multi-Community Business Development Stakeholder Group
4. Creation of List Green of Business Opportunities to Communicate to Greater Barrie Chamber of Commerce.

Phase 3 – Engage Local Business to Create Joint Green Business Development Strategies

The list of Green Business Opportunities developed in Phase 2 is intended to be the "carrot" to entice local businesses to join a Barrie Business Stakeholder Group. The second carrot will be the size of the market base represented by the communities comprising the Multi-Community Business Development Stakeholder Group formed in Phase 2.

The main purpose of this Phase will be to communicate the type of products, business potential, and market dynamics, of the emerging Green industry to local businesses. In addition, the potential impact of emerging market risks will also be conveyed. (Market risks would include factors, such as no longer qualifying as municipal supplier under Green purchasing policies being adopted by many jurisdictions.)

Phase 3 Deliverables

1. Formation of Barrie Green Business Development Stakeholder Group.
2. Presentations to local industry on the risks and opportunities presented by the Green Economy.
3. Develop list of target technologies to test business development model.

Phase 4 – Review of Selected Product Economies and Develop Marketing Strategies

Under this Phase, the Business Development Group will evaluate the product economies of key technologies that present opportunities for new business development and reduced energy consumption in Barrie. The information gained from evaluating product economies will be used to create cooperative strategies for the City of Barrie and local businesses to enhance market demand.

Phase 4 Deliverables

1. Report on How City and Local Businesses Can Enhance Market Demand for Key Technologies, Selected in Phase 3.
2. Implementation of Marketing Strategies

Phase 5 – Report Successes and Address Products That Have Significant Market Hurdles

It is likely that technologies will be identified in prior phases that would have a very positive impact on the environment, but currently they have significant market hurdles to achieve economic viability. It will be the objective of this phase to report on these technologies to FCM, and, through the stakeholder groups, provide recommendations that should be carried out a federal level to overcome the challenges.

Phase 5 Deliverables

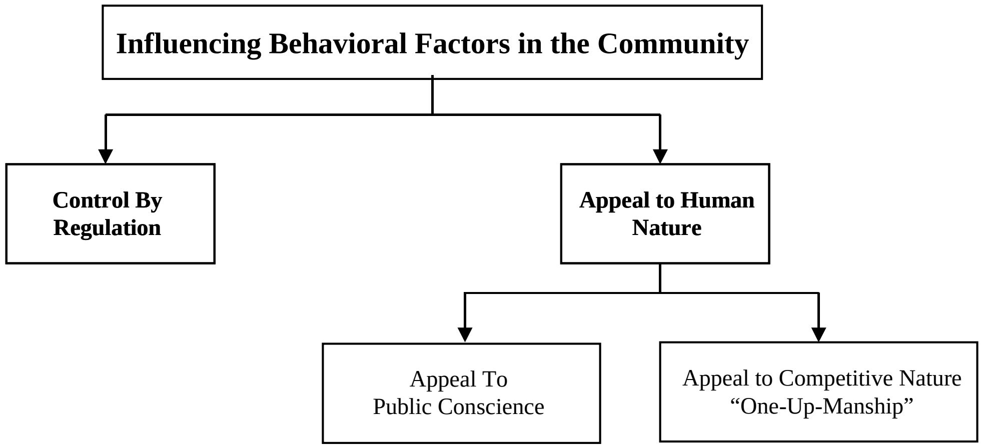
1. Report to FCM on Successes and Products that need broader based support to overcome market hurdles.

Phase 6 – Changing Behavioural Factors That Influence Energy Usage

Phase 6 is a departure from the business approach of the previous phases, and focuses more on influencing behavioural change within our community to reduce energy usage. This phase focuses more on the traditional approaches of education and outreach to communicate ways that individual citizens and organizations can reduce their environmental footprint.

The strategies developed under this task would be created by Community Based Stakeholder Group(s). A single group or multiple groups could be formed, representing each community sector. For example, residential, institutional, commercial, industrial.

The stakeholder groups would be tasked with identifying measures in each sector to improve overall energy efficiency and greening of the community. Each group would be asked to consider the use of regulations or an appeal to human nature. In the area of human nature, we would ask the group try to develop innovative approaches, leveraging more than just the environmental conscience. For example, energy benchmarking residential homes might suggest to wasteful homeowners that they are losing money.



Phase 6 Deliverables

1. Creation of Community Based Stakeholder Group(s)
2. Establishment of Communications Programs for Activities of Community Energy Plan
3. Development of community sector based strategies for encouraging energy use reduction.

8. Acknowledgements

CH2M HILL would like to acknowledge the following participants who contributed funding or resources to the baseline inventory and community energy plan:

- Federation of Canadian Municipalities
- Barrie Hydro
- Enbridge Gas
- Ontario Ministry of the Environment

9. References

Read, Voorhees & Associates Limited, City of Barrie Transportation Study, April 1999. Report 97036

StatsCan Census 2001 Population Data for City of Barrie at www.statscan.ca

Statistics Canada Census 1996 Income and Work Statistics for Barrie (City), Ontario at www.statscan.ca

The Centre for Spatial Economics, Preliminary Final Report, City of Barrie, Ontario Population, Household and Employment Projections Employment Lands Projections, May 21, 2003.

Hemson Consulting Ltd. Population, Households and Employment Forcast Update, Phase II and III Working Document 1 and 2, January 2004.

APPENDIX A

MODULE 1
RECREATIONAL FACILITIES

City of Barrie Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module 1:
Recreation Facilities

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Figures

List of Tables

PART ONE

Review and Profile of Energy Consumption in Facilities

Background

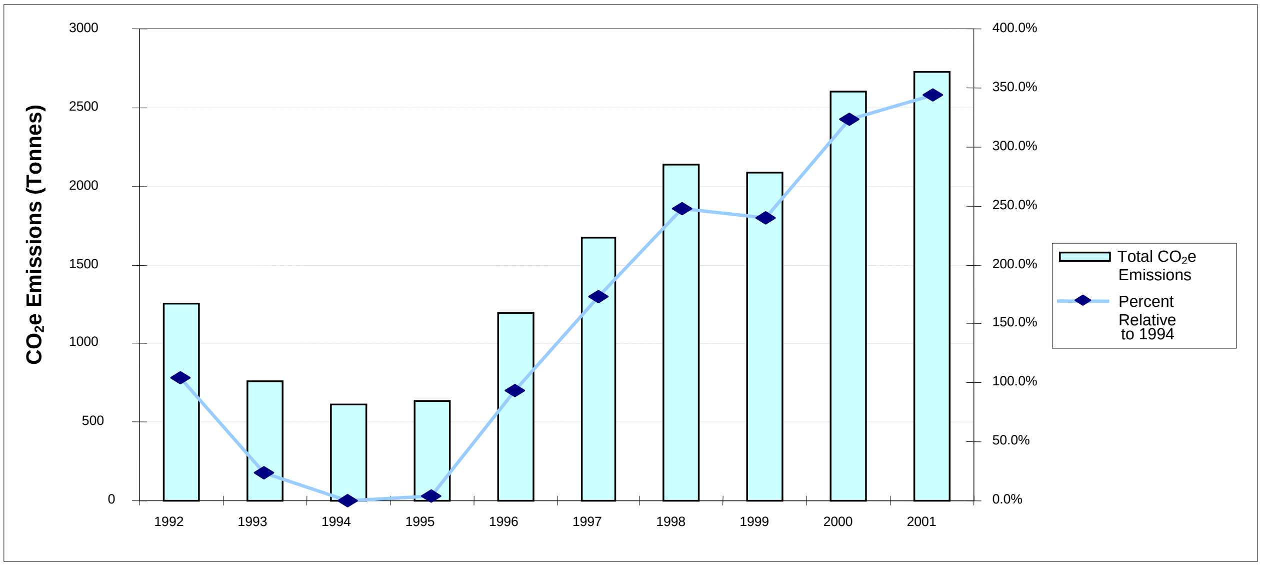
This audit document is intended as a sub component to Barrie's overall Community Energy Action Plan (CEP) which sets out the City's strategy to meet its commitment to the Federal Government's Partners for Climate Protection Program (PCP program). The recommended Green House Gas reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% in the greater community 6% below 1994 energy use levels, by the year 2011.

The objective of this audit is to provide a high level review of recreation facility energy use and identify target areas where opportunities for improved energy use may exist. The facilities covered in this report include: Barrie Arena, Eastview Arena, Molson Centre and Allandale Recreation Centre.

Overall Energy Consumption and Barrie's Commitment to PCP Program

The chart below provides a historical trend of overall energy use in Barrie's recreation facilities. As indicated in Figure A1-1, the recreation sector has seen a 350 percent increase in overall energy usage since 1994. The dramatic jump in energy consumption is the result of the new Molson Centre which came online in 1996. When the new East Bayfield Community Centre is in full operation it is likely that the overall energy consumption increase in this sector will exceed 400 percent. This poses a monumental task to achieve the recommended guidelines as proposed in the PCP program in absolute terms.

FIGURE A1-1
RECREATION FACILITIES – OVERALL CO_2E EMISSIONS (TONNES)



Since the reduction targets are guidelines, it is proposed our goal should be to reduce Green House Gas (GHG) emissions in buildings that existed in 1994 by 20% and that all new facilities be designed to emit 20% less than the Ontario baseline standard for that type of facility. It is recommended the Molson centre be considered a new facility and benchmark its performance with comparable facilities.

Barrie's recreation facilities experienced a significant drop in energy consumption between 1985 and 1992. This drop was the result of the program conducted with an Energy Services Company (ESCO) that was implemented around 1984. The City may want to consider "grandfathering" credit for these energy efficiency measures given the significant load addition of the Molson Centre.

FIGURE A1-2
TOTAL CO_2 EMISSIONS (WITHOUT MOLSON CENTER)

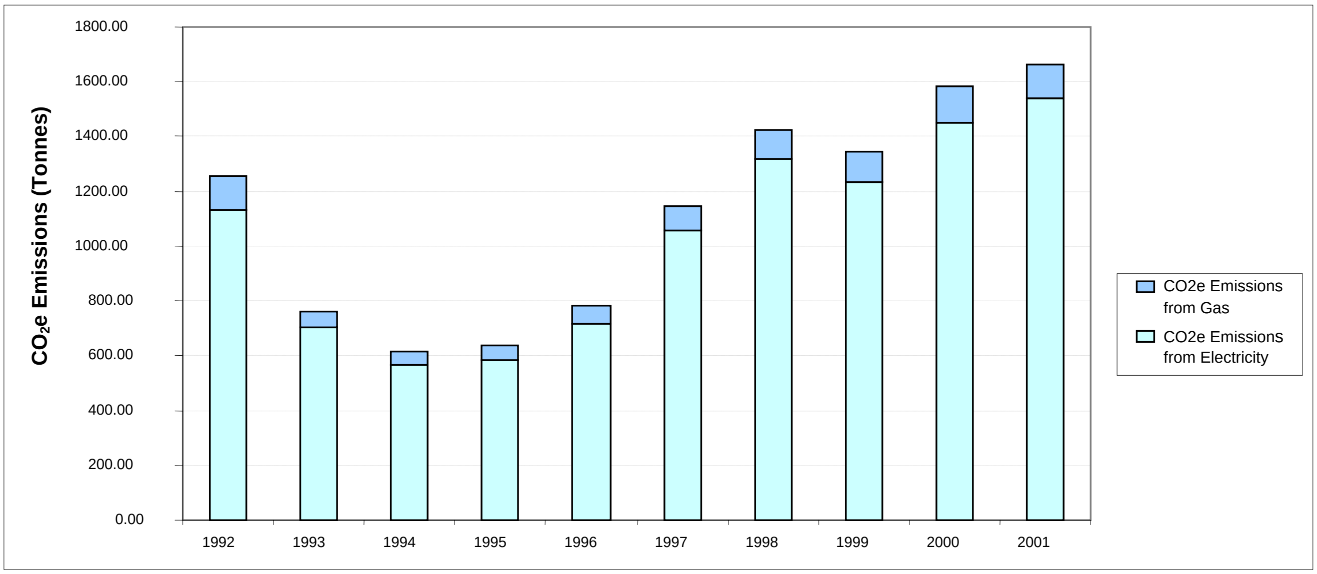


FIGURE A1-3
CO_2 EMISSIONS (WITHOUT MOLSON CENTER)

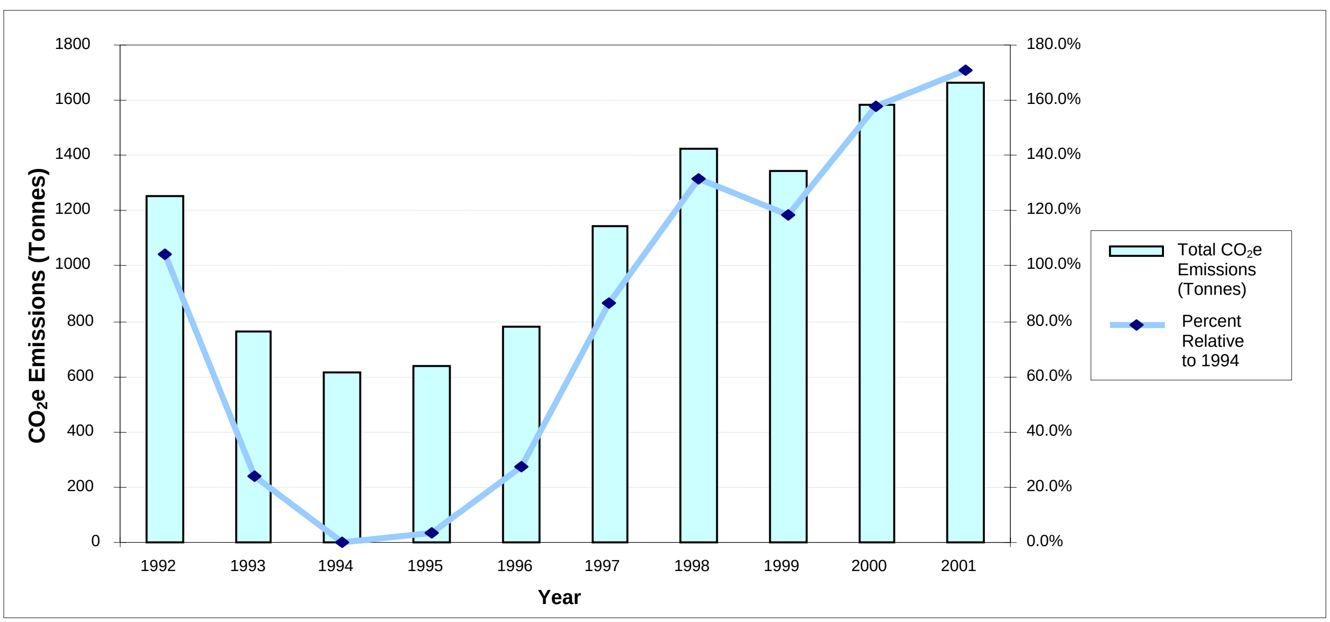


Table A1-1 sets out the PCP CO_2e emission reduction targets on an individual and collective basis for Barrie's recreation facilities. Note that 1996 was selected as the base year for the Molson Centre since it was the first year with a full set of consumption data. Since the Molson Centre has seen a dramatic increase in energy consumption during the first four years of operation the City may wish to adjust the base year.

TABLE A1-1
INDIVIDUAL AND COLLECTIVE CO_2E REDUCTION TARGETS

Facility	1994 CO_2e (tonnes)	1996 CO_2e (tonnes)	2000 CO_2e (tonnes)	Required Reduction (tonnes)	Equivalence
Eastview	144	N/A	227	112	356,175 kWh 59,572 m^3 NG
Barrie	210	N/A	389	221	702,800 kWh 117,550 m^3 NG
Allandale	994	N/A	1,616	821	2,610,900 kWh 436,700 m^3 NG
Molson	N/A	394.35	1,478	1,163	3,698,500 kWh 618,600 m^3 NG
Totals	1,348	394.35	3,710	2,632	8,370,100 kWh 1,400,00 m^3 NG

N/A – Not available at time of report

Energy Use Trending and Benchmarking Performance

As a starting point for the audit it is useful to review historical energy use trends and benchmark the energy efficiency of each facility to its counterparts. Table A1-2 provides a facility and operation profile so that similarly run facilities can be compared.

TABLE A1-2
FACILITY COMPARISON

Facility	m^2	Hours of Operation	No. of Rinks	No. of Pools
Eastview	2,216	September to March 6:30 AM to midnight daily	1	-
Barrie	3,456	September to March 6:30 AM to midnight daily	1	-
Molson (includes Casey's restaurant)	8,547	Winter: September to April – 6:00 am to 1:00 am daily Spring Shutdown: May to June 6 week shutdown for maintenance Summer Season: June - September – 8:00 am to 10:00 pm, 5 days/wk	1	-
Allandale	12,063	Pool – 5:30 am to 10 pm daily Winter: September to April – 6:00 am to 1:00 am, daily Summer: June - September – 8:00 am to 10:00 pm, 5 days/wk	2	1

As the table indicated Eastview and Barrie Arena are both single pad arenas with seasonal operation. Molson Centre and Allandale are both year round operations; however, Allandale has no summer shutdown and also operates a pool. Based on these profiles it would be expected that Eastview and Barrie will have similar consumption and load profiles and Molson and Allandale would have similar load profiles but Allandale being a larger facility with two ice pads and a pool should have a higher consumption pattern.

Historical Energy Use Patterns

A review of the historical energy use patterns can shed light on any changing operational patterns or significant load additions at each facility. As can be seen on Figures A1-4 and A1-5 the historical gas and electricity consumption for Allandale, Eastview and Barrie Arena are relatively stable which tends to suggest these facilities are being run according to a consistent operating protocol. Molson Centre, however, does have a trend toward increasing gas and electricity consumption. This trend will be further evaluated in the detailed Molson section.

The historical energy use patterns support using Eastview and Barrie Arena as comparative benchmarks. The Allandale Facility and Molson Centre do not share the same level of similarity as Eastview and Barrie, however, contrasting these facilities does highlight possible areas for improved energy efficiency – as discussed in subsequent sections.

FIGURE A1-4
HISTORICAL ELECTRICITY CONSUMPTION

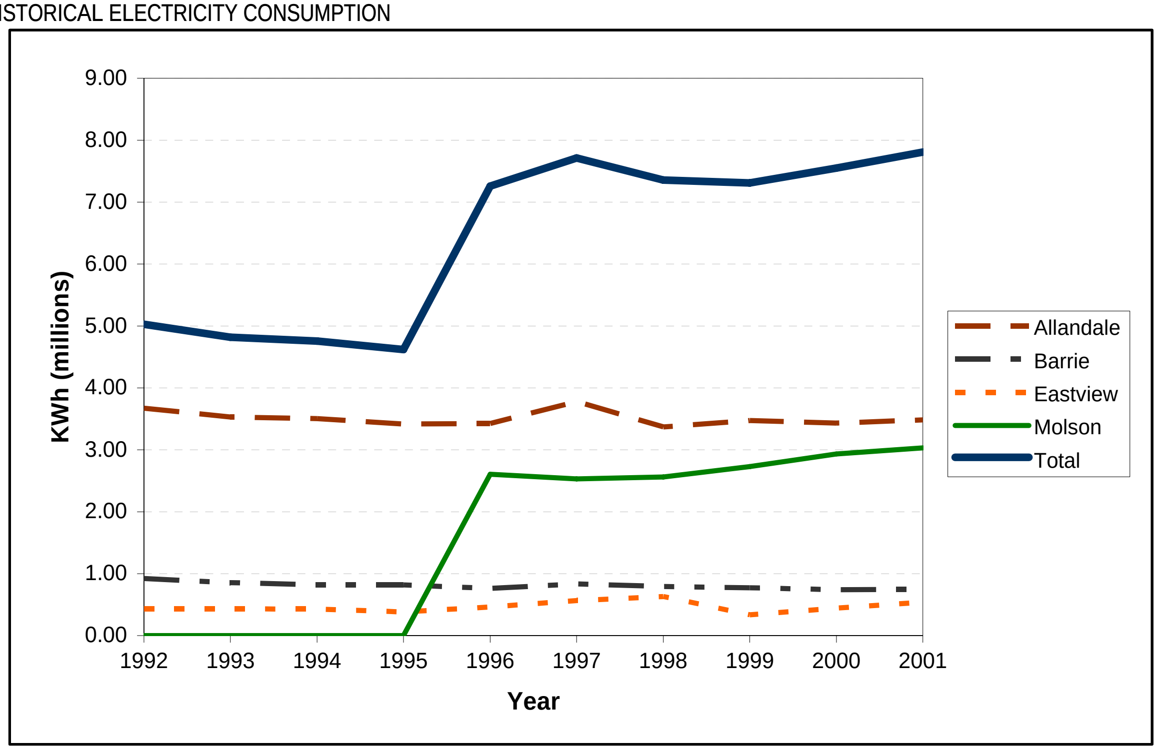
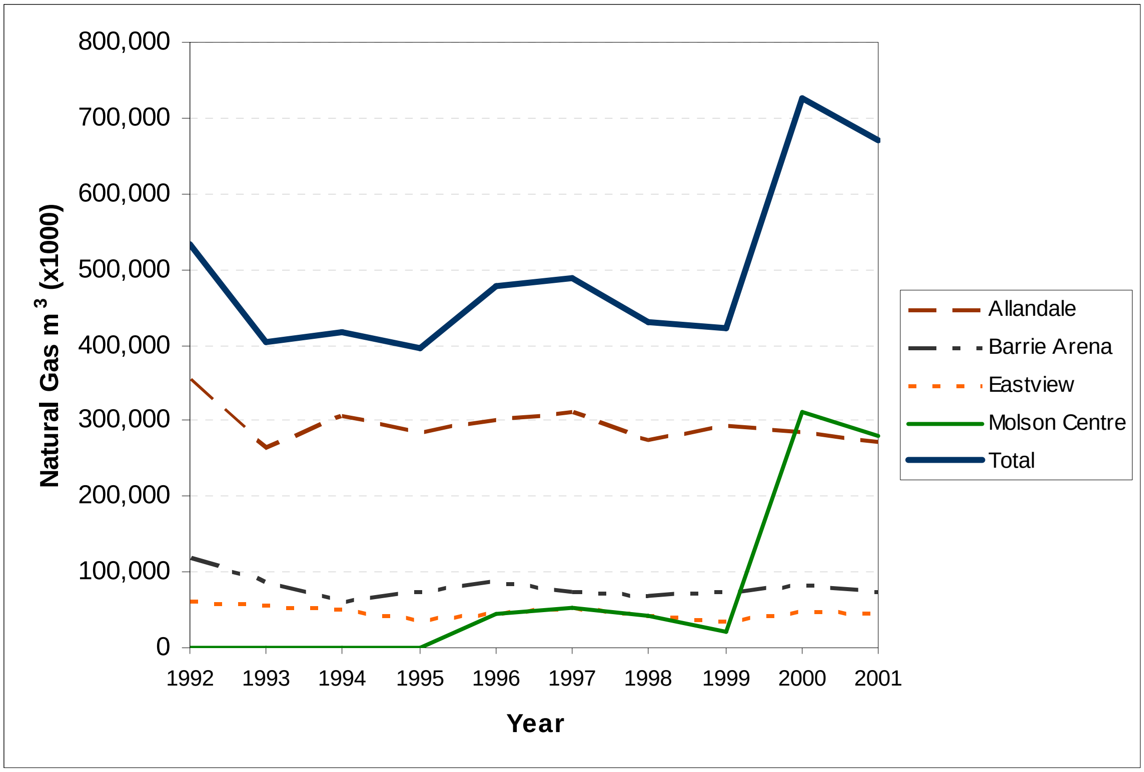


FIGURE A1-5
HISTORICAL NATURAL GAS CONSUMPTION

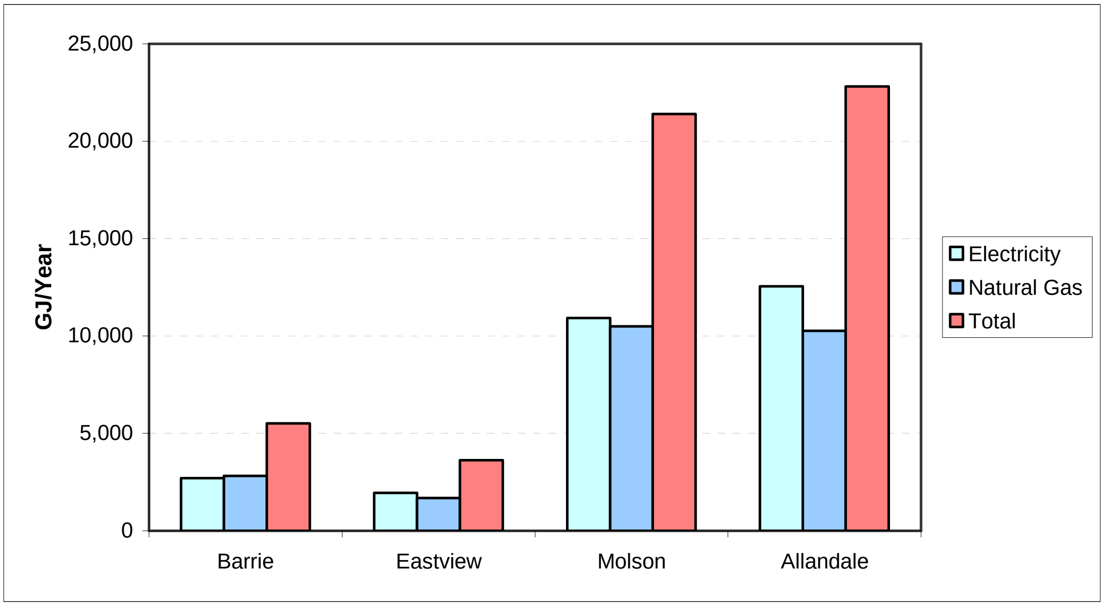


Total Annual Electric and Natural Gas Energy Consumption

Review of the total annual energy consumption provides two interesting observations. First, for all facilities the energy consumption is almost evenly split between natural gas and electricity usage. Given that these are ice rink facilities one tends to focus on electricity usage and the refrigeration plant as a primary target for energy efficiency improvements. In the past, a large portion all of the upgrades and control automation applied to the recreation facilities has been targeted at electricity usage.

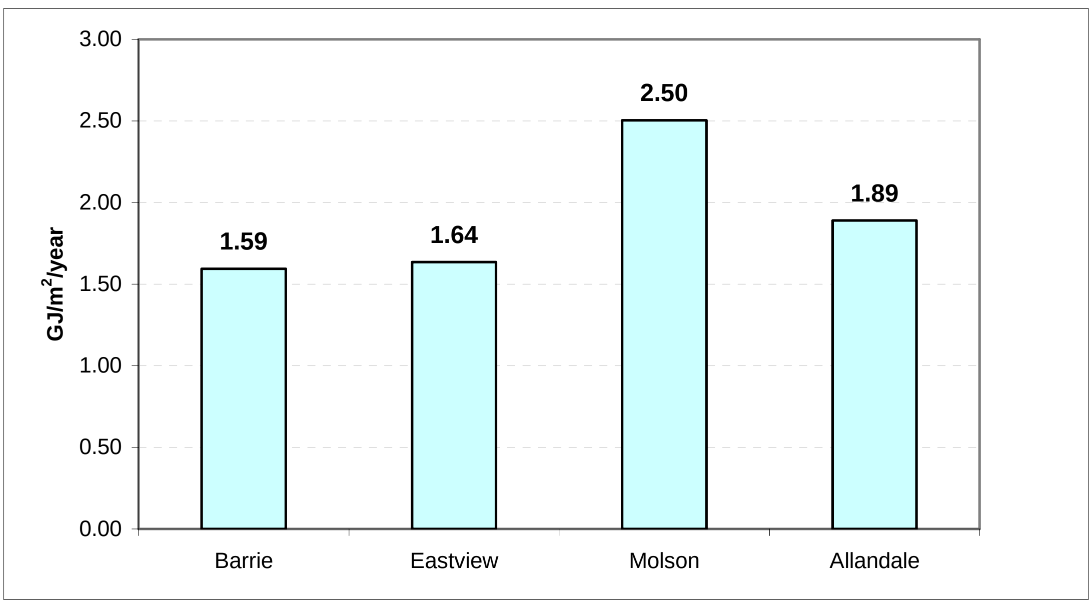
The second observation of note from Figure A1-5 is that the Molson Centre uses almost an equivalent amount of energy as Allandale – the later having a larger square footage, one additional Olympic size skating rink and a pool. The Molson Centre does have a significantly larger arena bowl volume and associated air handling equipment. As discussed in later sections, Molson's energy use would appear to be largely dominated by treatment of ventilation air.

FIGURE A1- 6
2000 TOTAL ENERGY CONSUMPTION (GJ)



As indicated by Figure A1-6, on a square footage basis, the Molson Centre has the highest energy intensity of all Barrie's Recreation Facilities.

FIGURE A1-7
RECREATIONAL FACILITY ENERGY INTENSITY



Monthly Electricity and Gas Consumption Profiles

The monthly electricity profile in Figure A1-8 shows that Eastview and Barrie Arena follow a similar load profile based on their seasonal operation. Allandale has a relatively flat load profile based on its year round operation. Molson Centre has a six week summer shutdown in May –June, but the overall consumption pattern does not show a marked decrease in kWh use. Also, the Molson Centre has a significantly high late summer/early fall demand spike. This is most likely attributable to mechanical cooling loading for arena bowl humidity control and a significant rooftop cooling load that is uncontrolled by the energy management system.

FIGURE A1-8
2000 MONTHLY ELECTRICITY CONSUMPTION PROFILE

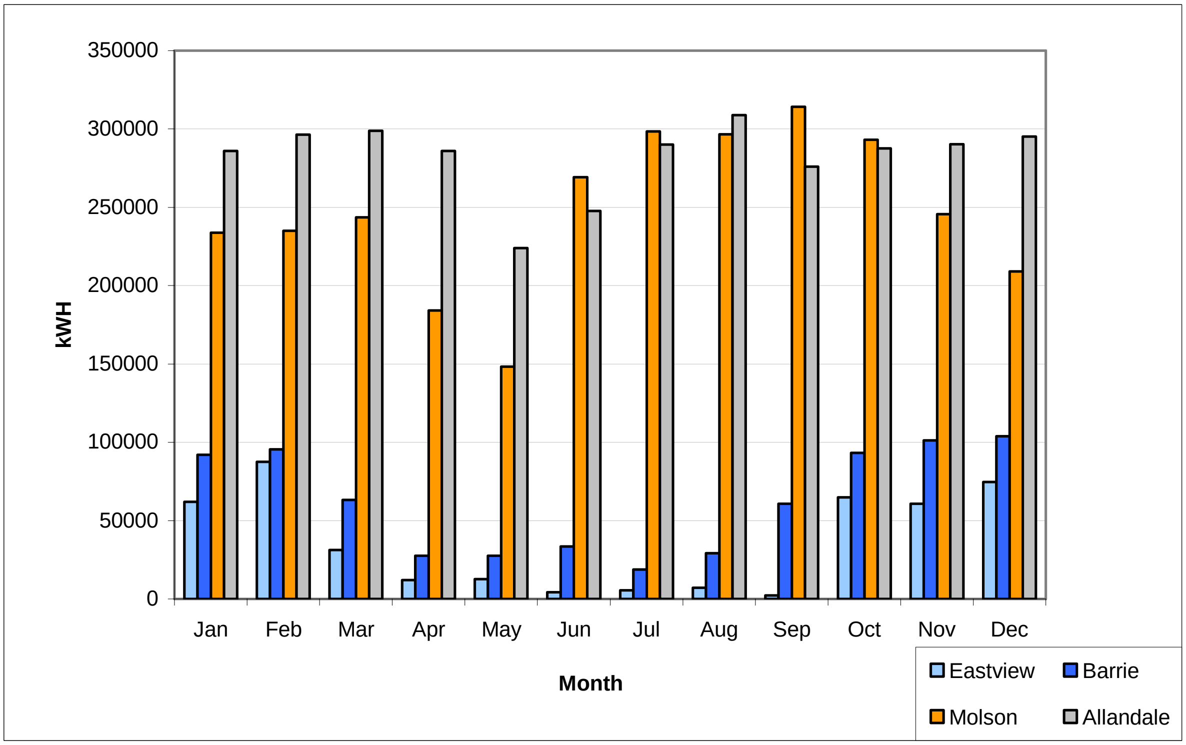


FIGURE A1-9
2000 MONTHLY KW DEMAND PROFILE

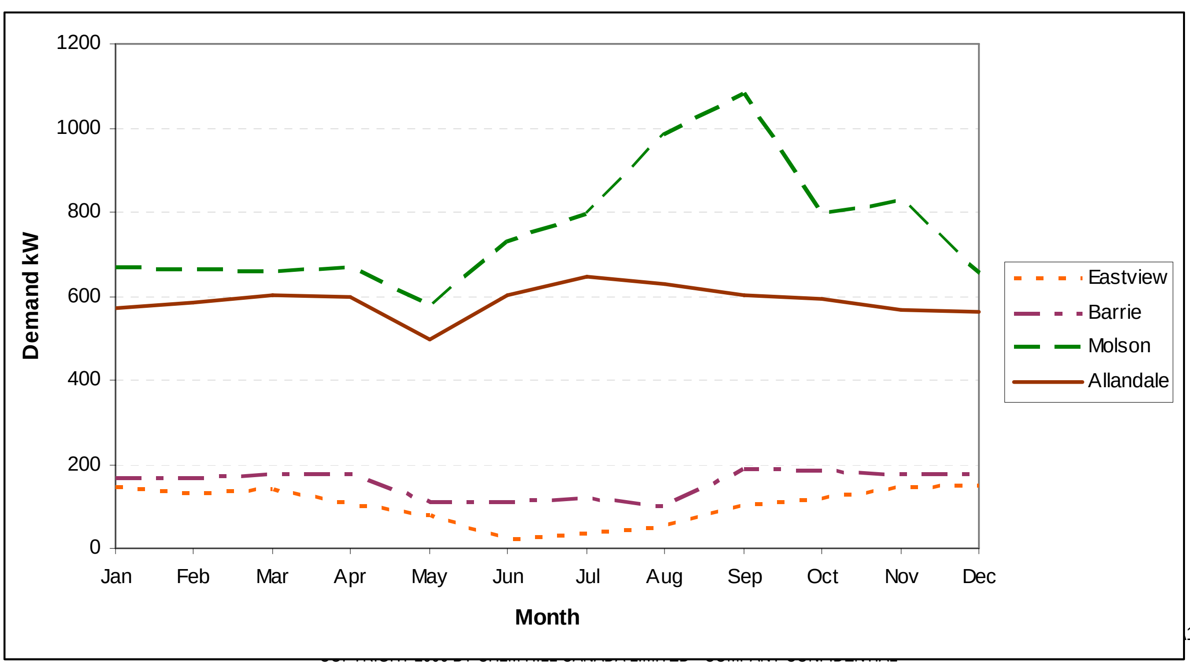
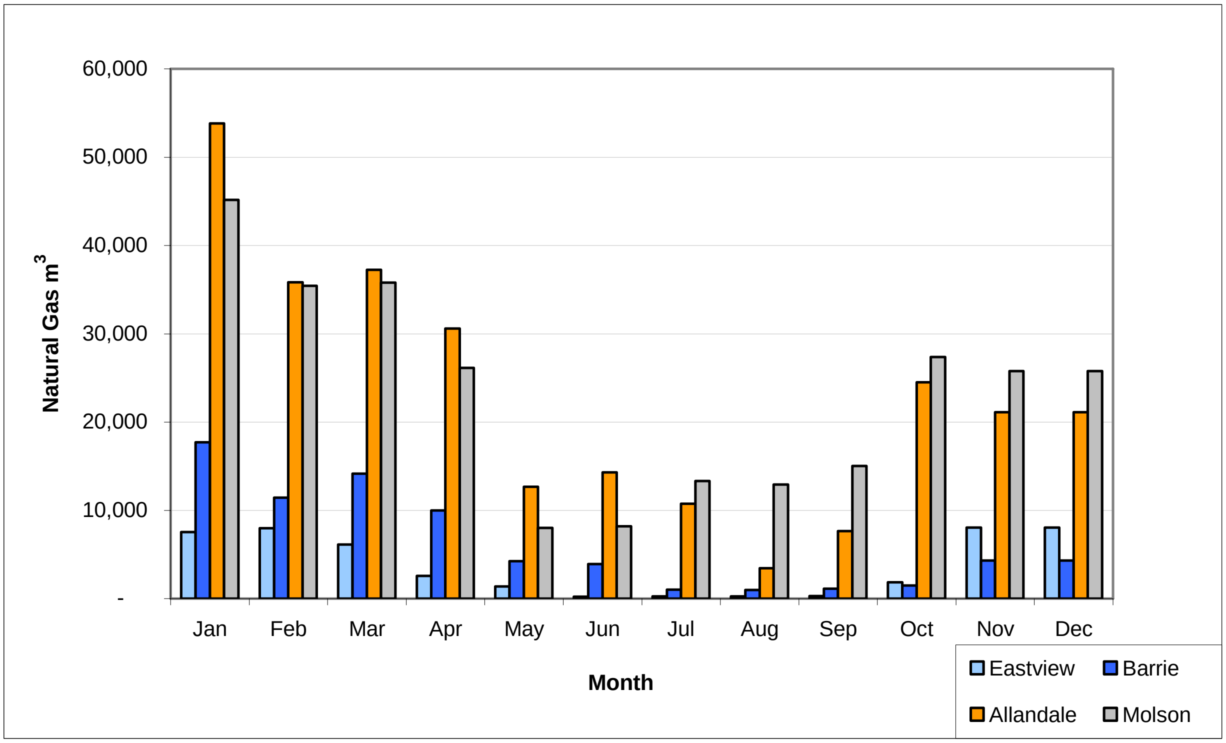


FIGURE A1-10
NATURAL GAS CONSUMPTION PROFILE



The interesting point with respect to natural gas consumption (Figure A1-10) is that the higher demand reverses between Eastview and Barrie Arena. In January through May, Barrie has a higher consumption, but in October through December Eastview has a higher demand. This reversal trend is also seen when comparing Allandale and Molson Centre. Since natural gas is used primarily for building heating and water heating it is worthwhile reviewing water consumption data for each facility.

Figure A1-11 shows the historical water consumption for all facilities. As illustrated, there is a noticeable variability in consumption from year to year. There are two interesting points on this chart. First, between August 1999 and April 2000 there was a huge water consumption spike at Molson's. By referring to Figure A1-5, Natural Gas Consumption History, it can be seen that there was a corresponding spike in natural gas use. This would tend to indicate that the water consumption spike was based on a heated water load. The second point of note is that the water consumption at Allandale appears to be trending toward increasing consumption.

Figure A1-12 shows a two year monthly water consumption profile for the period beginning January 2000. The usage at Molson's normalized around October 2001 and closely tracks the consumption at Barrie Arena. Allandale is showing consistent consumption spikes through the summer months. Referring to Figure A1-10, there is no corresponding increase in monthly natural gas consumption which would indicate a cold water make-up load. Cold water usage at Allandale would be associated with 1) pool make-up, 2) compressor jacket cooling make-up or 3) second stage evaporative cooling on refrigeration plant condensers. Since Molson's does not show a similar spike also uses second stage evaporative cooling on the condensers, the increased consumption at Allandale is likely attributable to pool make-up and/or compressor jacket cooling water make-up. (Molson's has replaced the use of city water for compressor jacket cooling with a dedicated condenser cooled glycol loop.)

FIGURE A1-11
RECREATIONAL FACILITY WATER CONSUMPTION

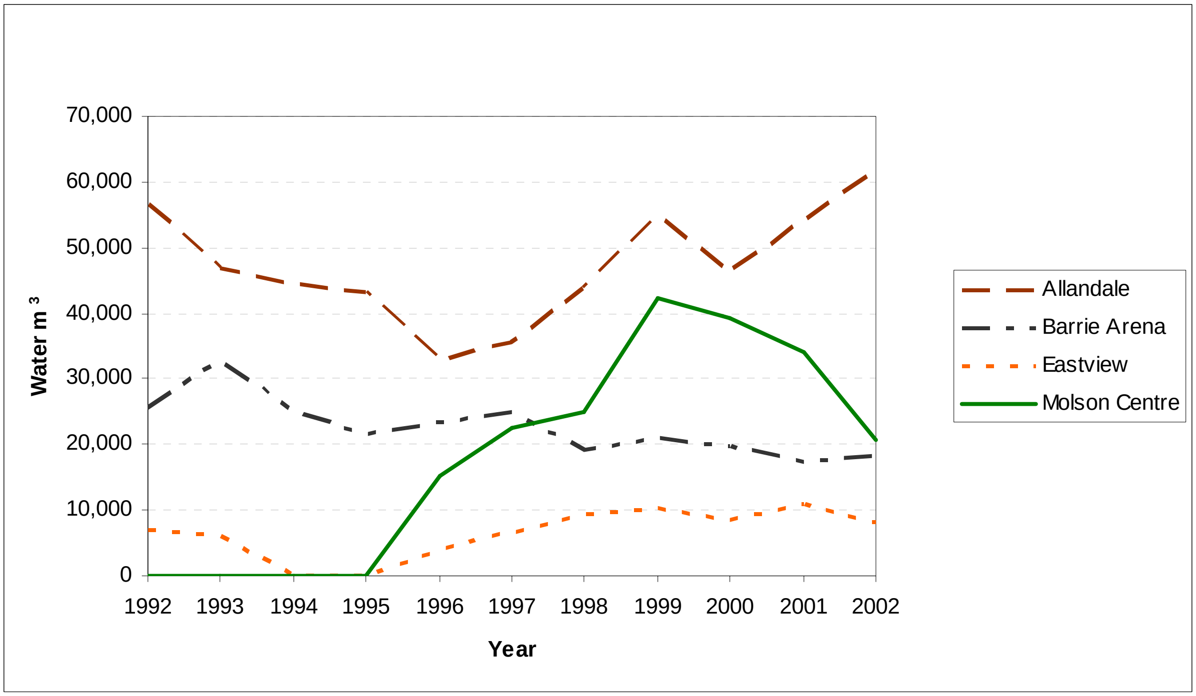
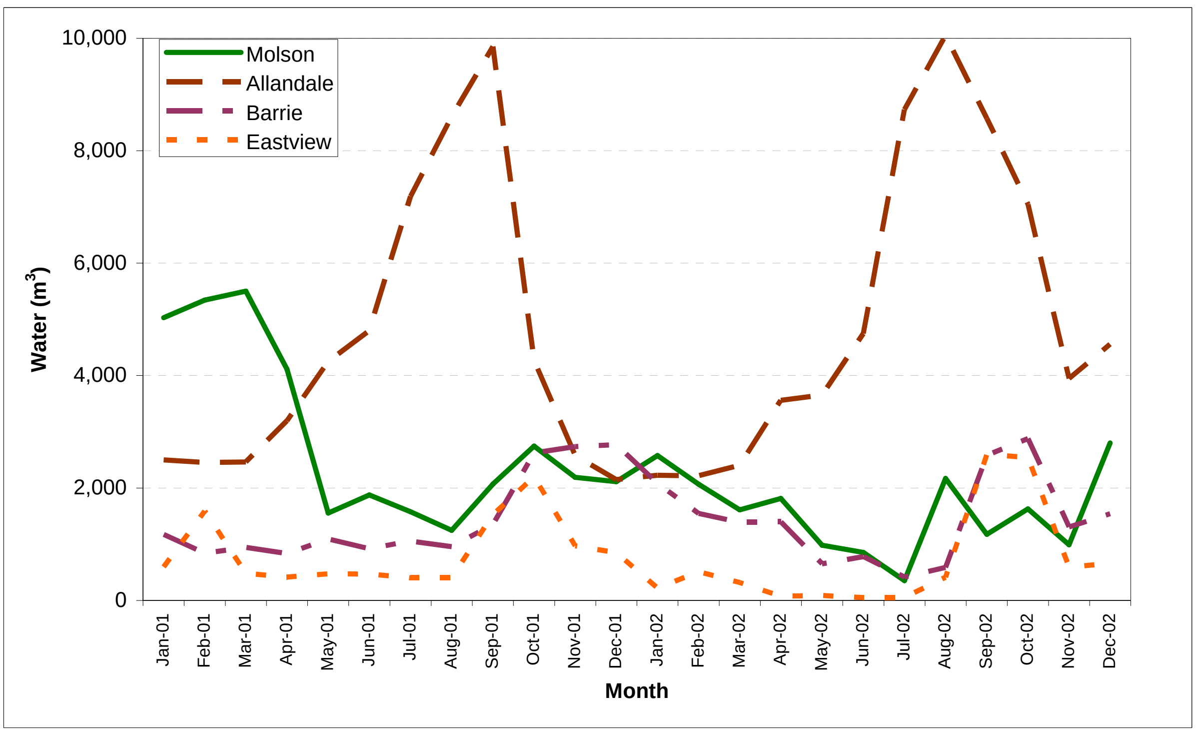


FIGURE A1-12
RECREATIONAL FACILITY WATER CONSUMPTION



PART TWO
Potential Opportunities for Improved Energy Efficiency

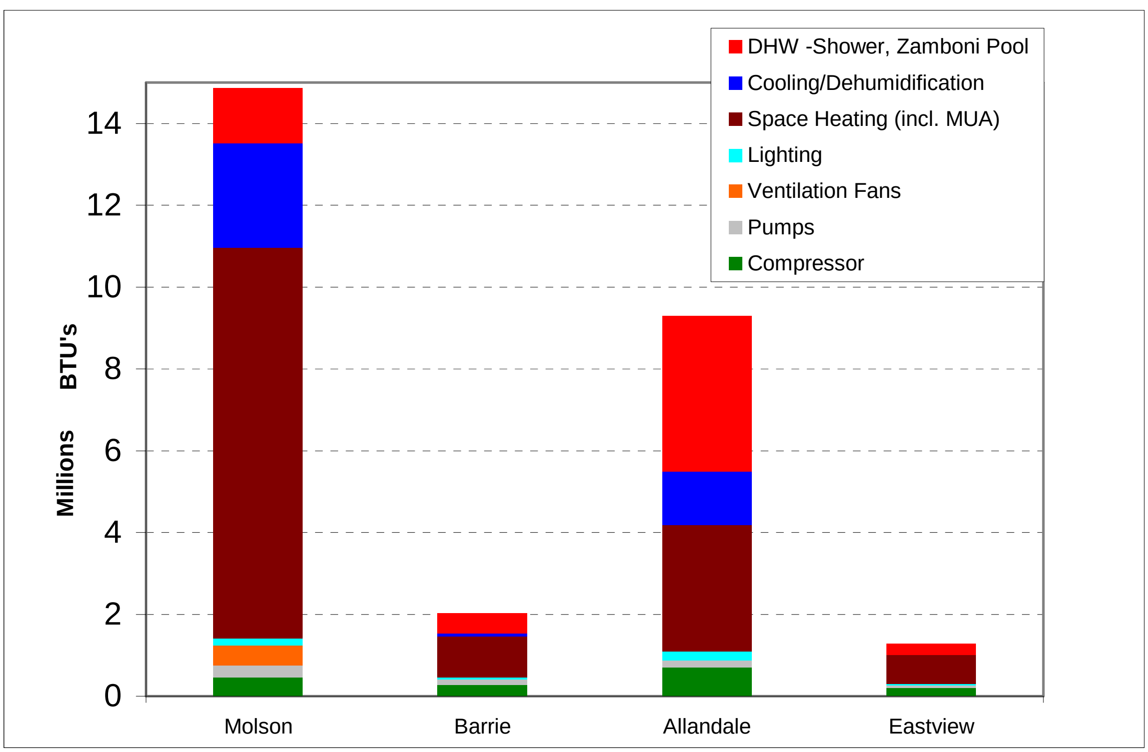
It should be again stressed that the opportunities presented in this section are only possible areas for energy efficiency improvement and further detailed evaluation is required for each measure.

General Opportunities Applicable to All Facilities

Operator Knowledge/Awareness of Energy Consumption

All Facility Personnel interviewed during the audit process were very conscious of energy efficiency and demonstrated a keen interest in the operation of their respective recreation centre. It is worthy of note, however, that all operators had an intimate knowledge of the operation of the refrigeration plant but did not have the same level of knowledge with respect to the operating parameters of building HVAC and hot water heating loads. As Figure A2-1 indicates, HVAC and hot water heating connected loads are very significant and may offer opportunities for sizable energy reduction.

FIGURE A2-1
TOTAL CONNECTED LOAD



Equipment Inventory and Operation Profile Manual

It is recommended that the equipment inventory and operational design parameters be re-established for all non-refrigeration loads. For example, Allandale has a manual for rooftop units but it has not been updated subsequent to the building expansion.

Building Air Balance

The above noted equipment inventory should also include data to allow for an overall building air balance. Important information for this purpose would include equipment volumetric flowrate, minimum damper settings and existence of automatic economizers. Poor building air balance can result in energy wastage and/or improper ventilation levels. For example, CO_2 levels were measured on two occasions at Molson Centre and Allandale ice pads. Based on an ambient CO_2 level of 390 ppm, Molson had and indoor CO_2 level of 436 ppm and Allandale had 1457 ppm – clearly indicating significantly different occupied space ventilation levels.

An overall building air balance should be correlated to ASHRAE outdoor air ventilation standards.

Energy Use and Operational Profile Logging

While all Facility Operations personnel interviewed were conscious of energy usage, they were not aware of actual consumption levels. In this context, operators do not directly see the impact of their efforts and tend to focus more on protocol than results.

By adding daily meter readings to the current operating regimen, staff will be able to see how the facility is operating on a daily basis. It has been demonstrated that daily meter readings will encourage even tighter energy use control and identify any trends of mal-operating equipment. In addition, staff will often find their own new and innovative ways to reduce energy usage when its profile and importance is raised.

Daily meter readings can be undertaken on the main gas, electric and water meters with no additional sub-metering. To make the readings more valuable on a comparative basis, other operating parameters should also be recorded. This might include: hours of operation, number of ice cleanings, volume of heated water for ice cleaning, typical number of spectators, number of shower using skaters, operating hours for lights, relative humidity (during dehumidification season) and degree days (available from local utility). These parameters in conjunction is bulk metering data will help to break out which operating characteristics have the greatest impact on overall energy usage within each facility.

Sub-Metering

At present all facilities have one main gas and electric meter with no sub-metering, except Molson Centre which has sub-metering to separate restaurant. The addition of sub-metering would allow for the identification of energy cost centres which, as Figure Twelve indicates, may be other than the refrigeration plant.

For example, sub-metering natural gas for shower and Ice resurfacing usage would allow for separation of building heating demand and evaluation of building performance. With respect to electricity, sub-metering could allow for a demand separation between space cooling and refrigeration plant load. This may identify ways to reduce energy spikes and reduce utility demand charges.

Natural gas sub-metering will require dedicated meters and a certified gas fitter to install them in-line. Electricity sub-metering can be done with either a dedicated meter or a portable clamp-on amp meter/data logger that can be used throughout each facility.

Energy Use Benchmarking

Energy use benchmarking exists for arenas but it tends to focus on electricity usage per square foot of arena surface. It is suggested that Barrie identify similar arenas throughout southern Ontario to enable benchmarking for electricity, gas and water usage.

Refrigeration Plant – Brine Temperature Float

Brine temperature is controlled to the following set points at each arena:

TABLE A2-1
BRINE TEMPERATURE SET POINTS IN EACH ARENA

Facility	Ice Temp Control	Stage 1	Stage 2	Stage 3	Stage 4
Barrie	Brine	17°F	19°F	21°F	N/A
Eastview	Brine	17°F	19°F	N/A	N/A
Allandale Blue	Brine	17°F	19°F	N/A	N/A
Allandale Red	Brine	17°F	19°F	21°F	N/A
Molson	IR	15°F	17°F	19°F	21°F

N/A – Not available at time of report

During cold winter months and unoccupied night time operation the load on the compressor plants is relatively low. Through these periods it may be possible to reset the minimum brine temperature set point to increase the operational efficiency of the compressors. An approximate 2 percent reduction in electricity usage can be seen for every 1 degree increase in minimum brine temperature. An increase in brine temperature set point would allow the compressor discharge pressures to be reduced - increasing operating efficiency and reducing wear.

Refrigeration Plant – Brine Circulation Pumps

The brine circulation pumps are interlocked to the compressors at the Molson Centre – i.e, brine only circulates when the compressors are running. At all other arenas the brine pumps run continuously. Since brine pumps add about 2,500 Btu/HP into the ice and the typical brine pump is 25 HP, this represents a continuous load of 62,500 Btuh per ice pad – in addition to the actual motor load. In addition, the brine pumps are sized to meet maximum load with all compressors running – usually only one compressor is running. Options to improve energy efficiency would include use of variable speed drives or installation of pony pumps sized for part load operation.

Refrigeration Plant – Instrumentation

Some inefficiencies within refrigeration plants can occur slowly over long periods of time. For example, heat exchanger fouling may reduce system efficiency a few percentage points per year – and possibly go undetected by operators. In general, the refrigeration plants have limited instrumentation to monitor the long-term performance of compressors, condensers and heat exchangers.

Consideration should be given to increasing instrumentation so that equipment performance can be trended and maintenance scheduled at appropriate intervals. Instrumentation may also provide insight into modified operational practices that reduce overall maintenance costs.

Facility Specific Opportunities

The building profile for the Molson Centre is provided in Table A2-2.

Molson Centre

TABLE A2-2
MOLSON CENTRE BUILDING PROFILE

Location	555 Bayview Drive
Operational Profile	Winter Season: September to April – 7 day/wk, 6:00 am to 1:00 am Spring Shutdown: 6 wk shutdown, May - June Summer Season: June - September – 5 days/wk, 8:00 am to 10:00 pm
Operations Management	By: Robin Groves
Energy Budgeting & Payment	Facility Supervisor
Building Energy Management System	HVAC EMS – for main arena bowl MUA handlers, exhaust fans and concourse heating (by TAC Controls) All Rooftop heat/cool units are not on EMS and end user controlled
Existing Metering	One Electric Meter One Gas Meter
Type of Use	Colts Hockey, Amateur Hockey, Public Skating, Figure Skating
Ice Pad	
Number of Ice Pads	One
Floor Type	Concrete
Ceiling Type	No low-e
Brine Type	Glycol

TABLE A2-2
MOLSON CENTRE BUILDING PROFILE

Ice Temperature Measurement	Yes. Ice surface is generally maintained at 29°F Ice temperature dropped to 22°F before Colts game to maintain ice quality.
Ice Thickness	1.5" – target based on liability risk – New England – Travis Roy Case
Frequency of Ice Scraping	1x per hour of operation
Brine Line	All Insulated
Compressor Room	
Compressors	50 HP – main stage 50 HP – 2nd stage 50 HP – 3rd stage 30 HP – 4th stage
Refrigerant Type	Ammonia
Compressor Staging	CIMCO Controller – Uses ice temp. as main control parameter Brine maintained at 15oF – ice quality poor after three re-surfacing if higher
Chiller Type	Plate & Frame
Brine Maintenance	By CIMCO Refrigeration
Brine Pumps	40 HP main duty, 40 HP standby Brine pump is interlocked with compressors
Compressor Room Heat Rejection/Recovery	
Condenser Type	Fan/Wet Condenser; Fan 1st stage, water 2nd stage Supplied by CIMCO
Condenser Maintenance	By CIMCO – 1x/yr cleaning of water nozzles, tighten belts etc.
Heat Recovery	Reject heat is recovered in underground circulation loop to prevent frost line migration to foundation
Ice Resurfacing Machine Room	
Ice Resurfacing machine Fuel Type	Natural Gas
Ice Resurfacing machine Water Htg	2 AO Smith natural vent water heaters – 251,000 Btu each Approximately 200 gallons per scrape.
Snow Dump Location	Snow Pit
Ventilation Control for Snow Dump	N/A

TABLE A2-2
MOLSON CENTRE BUILDING PROFILE

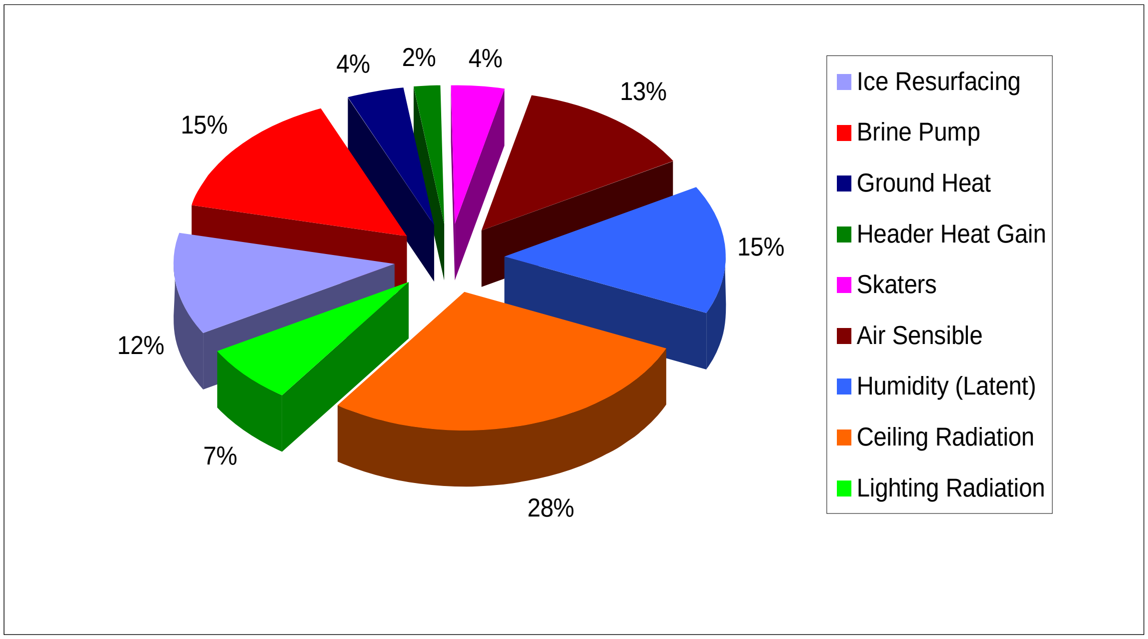
Ventilation/Building Heating	
Spectator Heating	Eng-Air MUA SF1 & SF2
Change Room Htg.	To Be Determined
Ice Pad Dehumidification	Eng-Air Make Up Air Units SF1 & SF2
General Ventilation	3 exhaust fans controlled by Energy Management system
Ice Resurfacing machine Room Htg	Gas Fired Unit Heater
Hot Water Heating	
DHW & Showers	2 - PVI Multi-Stage Atmospheric Boilers 540,000 Btu each
Building Heating	2 – Raypack Boilers 146,700 Btu each

The most distinct feature of the Molson Centre, as compared to other facilities, is the large air volume in the arena bowl. The heating, cooling and dehumidification of air in the arena bowl is managed by two large packaged units designated SF1 and SF2. Including packaged rooftop units, the connected HVAC load is over 800 kW – the total connected load of the refrigeration plant is only 218 kW by comparison. To identify energy savings potential, the interdependence of these two systems must be considered.

Figure A2-2 illustrates the typical heat gain on an ice surface[1]. The sensible (dry bulb) and latent (humidity) loads represent in the order of 28% of the heat gain on the ice surface. These loads will vary as a function of the amount of ventilation air brought into the building as well as air velocity at the ice surface. The lower the ventilation air dry bulb temperature and dew point, the lower the load on the ice surface.

[1] Source: 1994 ASHRAE Refrigeration Handbook

FIGURE A2-2
TYPICAL ICE HEAT GAIN



Arena Bowl Ventilation

The packaged rooftop units SF1 and SF2 are controlled by the buildings energy management system and operate based on control of CO_2, CO and RH within the building.

The most noticeable feature of SF1 and SF2 is that the air handlers are constant volume – each rated at 40,000 cfm (60 HP each) for a total air handling capacity of 80,000 cfm. This capacity represents approximately 20 cfm/person at full building occupancy – ASHRAE 62-1999 calls for 15 cfm/person as illustrated in Figure A2-3. As a constant volume system, this ventilation rate is not reduced during the majority of low occupancy conditions. During two site visits to Molson Centre, the CO_2 readings shown in Table A2-3 were observed:

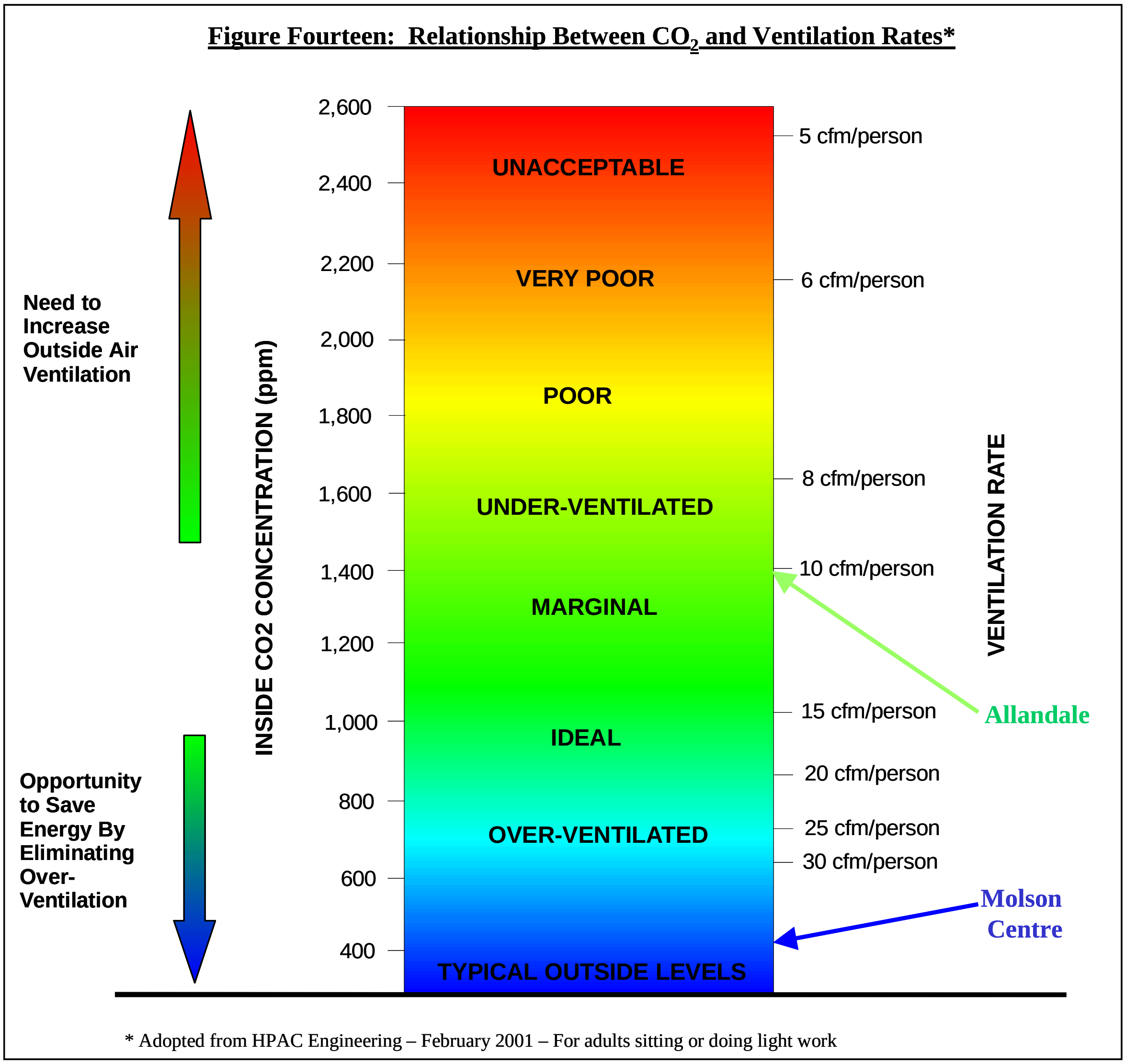
TABLE A2-3
CO_2 READINGS AT THE MOLSON CENTRE

Date	Time	Occupancy	Control	Building	Ambient
Sept 18, 2003	2:00 PM	Empty	CO_2	406 ppm	354 ppm
Sept 18, 2003	2:00 PM	Empty	CO	0 ppm	0 ppm
Sept 19, 2003	9:00 PM	Skate Practice			
Stands Empty	CO_2	482 ppm	406 ppm		
Sept 19, 2003	9:00 PM	Skate Practice			
Stands Empty	CO	0 ppm	0 ppm		
Sept 19, 2003	10:00 PM	After Boards Ice Cutter	CO	0.01 ppm	0 ppm
Sept 19, 2003	10:20 PM	After Ice Resurfacing	CO	0 ppm	0 ppm

The first important point from the above table is that CO readings are non-detectable – even at ice level after ice resurfacing. Since the ice resurfacing machine runs on natural gas its exhaust is relatively clean and does not drive ventilation requirements.

The second important point is that CO_2 levels vary, on average, 62 ppm from ambient conditions. Using Figure Fourteen as an approximation, this would tend to indicate that the Molson Centre is significantly over-ventilated during periods of low occupancy.

FIGURE A2-3
RELATIONSHIP BETWEEN CO_2 AND VENTILATION RATES*



SF1 and SF2 have economizers and minimum outdoor air damper settings. These settings were not available from staff at time of audit.

Arena Bowl Dehumidification

Air dehumidification must be considered in conjunction with ventilation levels. Dehumidification requirements are highest during fall and spring when the ambient relative humidity is high. Running SF1 and SF2 will act to lower indoor relative humidity but these systems will also increase the over latent load on the building due to the minimum outdoor damper settings and over-ventilation condition. Table A2-4 compares the operation of Allandale Blue Rink to Molson on Friday September 19th at 9:00pm – 10:00 pm.

TABLE A2-4
RINK COMPARISON OF RH AND TEMPERATURE

Date	Time	Occupancy	Parameter	Building	Ambient
Allandale Blue Rink					
Sept 19, 2003	8:30 PM	Hockey Practice ~ 30 spectators	RH Temperature	61% 56°F	80% 67°F
Molson Centre					
Sept 19, 2003	9:00 PM	Skate Practice Stands Empty	RH Temperature	70% 55°F	80% 67°F

While the measurements are only on a spot basis, it is interesting to note that Allandale with low ventilation is maintaining a lower relative humidity than Molson's. SF1 and SF2 are reducing the RH from ambient conditions, but not achieving the same RH as Allandale – thereby creating a greater latent load on the ice surface.

The use of a desiccant dehumidification system in tandem with SF1 and SF2 should be evaluated as an option for optimizing humidity removal.

Detailed Review of the Operation of SF1 & SF2

A detailed audit on the operation of SF1 and SF2 is recommended. This audit should include a review of the operating turndown capabilities, DX coil dehumidification capability, validation of CO_2, CO and RH control sensor calibration, trending analysis of control parameter driving ventilation requirements and overall energy consumption. (Trending analysis is available from Molson's energy management system – and should be validated with portable monitoring equipment.)

Integration of Rooftop Units with Energy Management System

Molson Centre has approximately 38 tonnes of rooftop heat/cool units that are not connected to the energy management system. These are end-user controlled and it is unclear if they have local set-back control and what temperature they are set at for heat/cool. The operation of these units should be reviewed and consideration given to connecting them to the Energy Management System.

Building Air Flow Balance and Closing off Arena Bowl

In reviewing the potential for reduced ventilation rates during unoccupied periods, consideration should be given to studying air flow patterns within the arena bowl to ensure proper air distribution. Also the arena bowl is currently open to the concourse in certain areas and glassed off in other sections. By completing the separation between the arena bowl and the concourse the volume of conditioned air can potentially be reduced. In addition, zone pressurization can be considered to reduce infiltration and increased latent loads.

Low-e Ceiling

Infra-red temperature measurements were taken on the ceiling at Molson's and daytime and night time temperatures averaged 53°F. By comparison, the low-e ceiling at Allandale Red Rink has a radiant ceiling temperature of 34°F. A low-e ceiling would reduce radiant heat transfer to ice surface but it is unclear whether its use may have other mitigating factors such as impact on acoustics at musical events. Evaluation of other spectator arenas with low-e ceiling could be evaluated in this repect.

Refrigeration Plant Operation- Ice Temperature & Refreezing After Flood

The Molson Centre operates with a base brine temperature of 15°F whereas all other arenas operate at a 17°F base temperature. As a general rule of thumb, for every degree the brine temperature is reduced, the power consumption will increase by 2 percent[2]. It was indicated that Molson's operates at this temperature because after three floods the ice becomes too soft. Molson's uses IR ice temperature sensors to control ice temperature to 29°F. During two visits to Molson's a contact thermometer was used to measure ice temperature and readings obtained were 30°F and 31°F. At the time the ice was at 31°F, the freezing time after flooding was approximately 12 minutes. This Molson's flood was approximately 200 gallons – by comparison other arenas are using 160 gallons. (The deeper scrape at Molson's does provide a nicer ice surface after cleaning.)

It is not possible to draw any specific conclusions but the soft ice after three floods should be further investigated as an energy saving opportunity. Ice acts as an insulator and if, for example, the IR temperature sensor is out of calibration an inadequate call for cooling may be compensated by a lower brine temperature. Humidity and air movement at the ice level could be creating a high latent loading. As another possibility, Molson Centre uses glycol as the secondary heat transfer medium whereas all other arenas use calcium chloride. Calcium chloride has better heat transfer characteristics than glycol.

Allandale Recreation Centre

The building profile for the Allandale Recreational Centre is provided in Table A2-5

TABLE A2-5
ALLANDALE RECREATION CENTRE BUILDING PROFILE

Location	190 Bayview Drive
Operational Profile	Pool – 5:30 am to 10 pm daily Winter Season: September to April – 7 day/wk, 6:00 am to 1:00 am Summer Season: June - September – 5 days/wk, 8:00 am to 10:00 pm

[2] Energy Efficiency for Recreation Facility – Accent Refrigeration Systems

TABLE A2-5
ALLANDALE RECREATION CENTRE BUILDING PROFILE

Operations Management	By City Staff
Energy Budgeting & Payment	Facility Supervisor
Building Energy Management System	Dimax EMS – Terry uncertain what equipment is controlled
Existing Metering	One Electric Meter One Gas Meter
Type of Use	Amateur Hockey, Public Skating, Mariposa Figure Skating Club
Ice Pad	
Number of Ice Pads	Two – Designated Red and Blue
Floor Type	Concrete
Ceiling Type	Red Rink –Low-e; Blue Rink – no Low-e
Brine Type	Glycol
Ice Temperature Measurement	No. Ice quality controlled by brine temperature. Brine temperature target is 17°F.
Ice Thickness	1.5” – target based on liability risk – New England – Travis Roy Case
Frequency of Ice Scraping	1x per hour of operation
Brine Line	All Insulated
Compressor Room	
Compressors	Red Rink Blue Rink 50 HP – main stage 75 HP – main stage 50 HP – 2nd stage 75 HP – 2nd stage 30 HP – 3rd stage Older model motors
Refrigerant Type	Ammonia
Compressor Staging	Honeywell Controller – Brine Temp. Main Control Parameter Red Rink Blue Rink 1st Stage – Brine 17°F 1st Stage – Brine 17°F 2nd Stage – Brine 19°F 2nd Stage – Brine 19°F 3rd Stage – Brine 21°F
Chiller Type	Shell & Tube
Brine Maintenance	By CIMCO Refrigeration
Brine Pumps	Red 30 HP always on - high eff. Blue 25 HP always on - high eff.

TABLE A2-5
ALLANDALE RECREATION CENTRE BUILDING PROFILE

Compressor Room Heat Rejection/Recovery	
Condenser Type	Fan/Wet Condenser; Fan 1st stage, water 2nd stage Supplied by CIMCO
Condenser Maintenance	By CIMCO – 1x/yr cleaning of water nozzles, tighten belts etc.
Heat Recovery	Reject heat is recovered in underground circulation loop to prevent frost line migration to foundation
Ice Resurfacing Machine Room	
Ice Resurfacing Machine Fuel Type	Natural Gas
Ice Resurfacing Machine Water Htg	1 Raypak 489,000 Btu Atmospheric
Snow Dump Location	Outside
Ventilation Control for Snow Dump	Double door system – rink door is closed before outside door is opened to dump snow
Ventilation/Building Heating	
Spectator Heating	High Intensity IR, MUA units
Change Room Heating.	To be Determined
Ice Pad Dehumidification	2 Humicon units each ice pad – 7.5 kW each
Pool Dehumidication	New system being installed – specs TBD
General Ventilation	TBD
Ice Resurfacing Machine Room Heating	Gas Fired Unit Heater
Hot Water Heating	
Pool Heater	Raytherm 2,000,000 Btu Atmospheric
DHW & Showers	2 Raypak at 664,000 Btu each – Atmospheric Solar water heating system removed.

HVAC Audit and Building Air Balance

In contrast to the Molson Centre, Allandale would appear to have marginal ventilation in certain areas. Table A2-6 provides some sample readings from the Blue and Red ice rinks:

TABLE A2-6
ALLANDALE BLUE RINK AND RED RINK COMPARISON

Date	Time	Occupancy	Parameter	Building	Ambient
Allandale Blue Rink					
Sept 18, 2003	10:30 AM	Mariposa Skate School ~ 30 skaters	CO_2 CO	**1727 ppm** 0	**354 ppm** 0

TABLE A2-6
ALLANDALE BLUE RINK AND RED RINK COMPARISON

Date	Time	Occupancy	Parameter	Building	Ambient
		~ 10 spectators	RH	56%	55%
			Temperature	56°F	68°F
Sept 19, 2003	8:30 PM	Hockey Practice	CO_2	**1426 ppm**	**410 ppm**
		~ 30 spectators	CO	0	0
			RH	61%	80%
			Temperature	56°F	67°F
Allandale Red Rink					
Sept 18, 2003	8:30 PM	Figure Skating	CO_2	**927 ppm**	**354 ppm**
		~ 6 skaters	CO	0	0
			RH	56%	55%
			Temperature	56°F	68°F
Sept 19, 2003	8:30 PM	~ 20 spectators	CO_2	**1394 ppm**	**410 ppm**
			CO	0	0
			RH	61%	80%
			Temperature	56°F	67°F

Referring back to Figure A2-3, these rinks could potentially have unacceptable CO_2 levels if the spectator stands were full. Potentially adding to the problem is high intensity IR heaters in both rinks. These units vent directly to the occupied space so they will add both humidity and CO_2. By code, the IR heaters are interlocked with exhaust fans, however, these fans are axial and produce a low static head. If the building is slightly negative the performance of these fans will be greatly reduced. Referring to September 18th data in Table A2-6, it can be seen that the Blue rink has a significantly higher CO_2 level as compared to the Red Rink. The Facility Operators noted that they had run the IR system for two hours earlier in the morning.

Note in this picture that the radiant panels are surrounded by an open air path which creates convection cooling of the panels reducing the amount of radiant energy generated. Air warmed by the panels moves toward the ceiling – not warming the spectators. There are new high intensity IR panels that minimize this convection cooling effect and offer higher overall efficiency. Upgrade to new heaters could be considered depending upon level of use. Note that mounting height evaluation is crucial with higher efficiency units.

As noted in the general recommendation section, a detailed ventilation and zone balancing audit would be valuable for ensuring proper indoor air quality. This audit should include a detailed review of the heating/cooling and cfm capacity of all rooftop units, operation of all exhaust fans and short term monitoring of CO_2 in the facility during varying occupancy conditions. In addition, a review of all air intake and exhaust stack locations should be reviewed to ensure no contamination by short-circuiting is occurring. The picture below shows the DHW boiler stack in very close proximity to building air intakes.

Pool Dehumidification

The Dry-O-Tron pool area dehumidifiers are being replaced with new mechanical dehumidification at the time of this audit. The new system will be high efficiency and will act to provide both

Pool Evaporation

The pool does not utilize a solar blanket. By covering the pool with a solar blanket, reduced evaporation will save on dehumidification, water heating and make-up water. The economics of using a solar blanket should be reviewed in detail.

Domestic Water Heating and Ice Resurfacing Machine Water Heating

Allandale has 3,817,400 Btu's of connected load for domestic hot water, pool heating and Ice Resurfacing Machine water heating. The hot water boilers are all atmospheric type and would likely operate with seasonal efficiencies between 60 and 70 percent. Atmospheric boilers will have stack losses during idle periods wasting valuable conditioned air. The pool heater and DHW heaters are both in confined spaces and utilize separate ventilation fans for combustion air – further reducing overall efficiency.

A combustion analysis and boiler test is recommended for all boilers. Newer sealed combustion and condensing boilers can offer efficiencies of up to 98%. Incentives would be available from the gas utility for any upgrades.

Lighting

Most lighting in the facility has been converted to high efficiency lamps. Some housekeeping could improve energy usage. In certain areas of the building the fixtures are dirty or completely removed. Lobby lighting and some hallway lighting is on during the day despite adequate

Light levels from windows and skylights. Operators indicated lights are left on in spectator areas to avoid shadows.

During night-time maintenance hours full rink lighting is left on for staff safety. Alternate lights could be shut down to reduce power consumption or dimmers could be applied to metal halide lamps. Dimmers will provide a turndown to 60% output.

Building Energy Management System

A Dimax Energy Management System (EMS) is controlling some portion of the heating ventilating and air conditioning (HVAC) system at Allandale. This system has no on-site monitoring interface and none of the operators interviewed were certain as to the extent of equipment currently being controlled.

This system should be reviewed in detail with the suggested ventilation audit noted previously. Ideally, the EMS should be upgraded or replaced with a system that has an on-site control interface so staff can properly monitor and control the building HVAC systems.

Low-e Ceiling on Ice Rinks

The Red Rink has a low-e ceiling and the newer Blue Rink has no low-e ceiling. During two site visits the IR temperature readings shown in Table A2-7 were taken:

TABLE A2-7
ALLANDALE BLUE RINK AND RED RINK COMPARISON

Date	Time	Parameter	Blue Rink	Red Rink
Sept 18, 2003	10:30 AM	Ice Temp	30-31°F	28°F
		Ceiling Temp over Ice	**42°F**	**32°F**
		Ceiling Temp over Stands	58°F	45°F
		Air Temp at Floor Level	55°F	55°F
Sept 19, 2003	8:30 PM	Ice Temp	29°F	29°F
		Ceiling Temp over Ice	**42°F**	**34°F**
		Ceiling Temp over Stands	52°F	52°F
		Air Temp at Floor Level	55°F	56°F

The low-e ceiling provides an average 10°F lower radiant ceiling temperature over the ice. It is recommended to estimate potential energy savings for this measure using the Stefan-Boltzmann equation, as shown below:

$$P = e\sigma AT^4 \text{ [j/m}^2\text{s]}$$

Where the Stefan-Boltzmann constant is as follows:

$$\sigma = 5.67 \times 10^{-8} \text{ W/(m}^2 \text{ K}^4\text{)}$$

A mitigating factor to implementing this energy efficiency measure on the Blue Rink is that it is used by the Mariposa Figure Skating school that likes "warmer" indoor environment. Radiant heat energy travels from a warm to cold body. Having a warmer ceiling temperature reduces the amount of radiant heat travelling from a figure skater to the ceiling – giving a perception of greater warmth. The point can be illustrated by the September 18th measurements shown in Table A2-7. Skaters indicated on that day that the Red Rink was much colder – yet the air temperatures were identical. Only the radiant ceiling temperatures were different.

It is recommended to seek the participation of the Mariposa Skating School coach to ensure that energy efficiency and rink environment objectives are mutually satisfied.

Refrigeration Plant – Compressor Jacket Cooling Water

Again referring to Figure A1-12, Allandale is experiencing 10,000m^3 to 30,000m^3 water consumption load spikes during the summer months. The pool is drained annually in the August/September time frame, however, refilling both pools only takes 644 m^3 of water. Molson Centre does not experience these load spikes and uses a glycol loop running through the refrigerant condenser to cool the compressor jackets. In this way heat can be rejected through evaporative cooling where the latent heat transfer is 1000 Btu/lb of water. At Allandale, the compressors are cooled by running a water loop through a tank of water (the tank holds water used by the condenser for evaporative cooling). If the tank temperature gets too high a solenoid opens and City make-up water is supplied to reduce tank temperature. This system only allows sensible heat transfer between the jacket cooling water and the tank water. The sensible heat capacity of water is 1 Btu/lb/F. This thousand fold difference in heat capacity may be the reason why this facility has such an astronomical water demand through the summer.

The above hypothesis should be validated by measurement and, if correct, the compressor jacket water should be put on an evaporative cooling loop. Consideration may also be given to switching to glycol to reduce potential scale formation which reduces heat transfer and overall efficiency.

If compressor jacket cooling is not the cause of the high water usage then portable ultrasonic flowmeters should be used to identify the high demand area.

Snow Dump

The ice scrapings are currently dumped outside. With cooling, dehumidification and refrigeration loads, consideration should be given to some form of energy recovery.

Barrie Arena and Eastview Arena

Tables A2-8 and A2-9 lists profiles for Barrie Arena and Eastview Arena respectively.

In addition to the comments in the general section, the following points are offered for Eastview and Barrie Arenas.

Domestic Water Heating and Ice Resurfacing Machine Water Heating

The hot water boilers are all atmospheric type and would likely operate with seasonal efficiencies between 60 and 70 percent. Atmospheric boilers will have stack losses during idle periods wasting valuable heated air. The pool heater and DHW heaters are both in confined spaces and utilize separate ventilation fans for combustion air – further reducing overall efficiency.

Newer sealed combustion and instantaneous water heaters can offer efficiencies of up to 88%. Incentives would be available from the gas utility for any upgrades.

Lighting

During daytime operation there are often periods when the ice might not be rented for a period of 1 to 3 hours. During this time, the lights are left on to avoid reducing lamp life. A dimmer system would allow the lights to be turned down to 60% output. General housekeeping to ensure all small lighting loads are on occupancy sensors would also be beneficial.

Setback Control on Building Heating Equipment

Water heaters, gas fired unit heaters and electric baseboard heaters generally do not have set back control. Adding time based controllers would reduce energy during unoccupied periods.

TABLE A2-8
BARRIE ARENA BUILDING PROFILE

Location	155 Dunlop Street
Operational Profile	September to March 6:30 AM to midnight daily
Operations Management	By City Staff
Energy Budgeting & Payment	Facility Supervisor
Energy Management System	No EMS. Energy use control by facility staff.
Existing Metering	One Electric Meter One Gas Meter
Type of Use	Amateur Hockey, Public Skating
Ice Pad	
Number of Ice Pads	One
Floor Type	Concrete

TABLE A2-8
BARRIE ARENA BUILDING PROFILE

Ceiling Type	Wood Beam
Brine Type	$CaCl_2$
Ice Temperature Measurement	No. Ice quality controlled by brine temperature. Brine temperature target is 17°F.
Ice Thickness	1.5" – target based on liability risk – New England – Travis Roy Case
Frequency of Ice Scraping	1x per hour of operation, ~160gallons per Scrape
Brine Line	All Insulated
Compressor Room	
Compressors	50 HP – main stage – motor changed out to high eff. 30 HP – 2nd stage – lower eff. motor 30 HP – 3rd stage – lower eff. motor
Refrigerant Type	Ammonia
Compressor Staging	Honeywell Controller – Brine Temp. Main Control Parameter 1st Stage – Brine 17°F 2nd Stage – Brine 19°F 3rd Stage – Brine 21°F
Chiller Type	Shell & Tube
Brine Maintenance	By CIMCO Refrigeration
Brine Pumps	25 HP main duty, 15 HP standby Brine pump is run continuously during ice season
Compressor Room Heat Rejection/Recovery	
Condenser Type	Fan/Wet Condenser; Fan 1st stage, water 2nd stage Supplied by CIMCO
Condenser Maintenance	By CIMCO – 1x/yr cleaning of water nozzles, tighten belts etc.
Heat Recovery	No heat recovery from condenser or jacket cooling water.
Ice Resurfacing Machine Room	
Ice Resurfacing Machine Fuel Type	Natural Gas
Ice Resurfacing Machine Water Htg	2 AO Smith natural vent water heaters – 251,000 Btu each
Snow Dump Location	Outside
Ventilation Control for Snow Dump	Double door system – rink door is closed before outside door is opened to dump snow

TABLE A2-8
BARRIE ARENA BUILDING PROFILE

Ventilation/Building Heating	
Spectator Heating	Low Intensity Infra Red
Change Room Heating.	Forced Air Gas
Ice Pad Dehumidification	2 dehumidifiers – mainly used for shoulder season – can get significant condensation from wood beams.
General Ventilation	2 exhaust fans at either end of building – on timer The ice resurfacing operator can switch on during ice cleaning – rarely used.
Ice Resurfacing Machine Room Heating	Gas Fired Unit Heater
Domestic Hot Water Heating	
Shower Water	2 Rheem Atmospheric – 250,000 Btu each

TABLE A2-9
EASTVIEW ARENA BUILDING PROFILE

Location	453 Grove Street East
Operational Profile	September to March 6:30 AM to midnight daily
Operations Management	By City Staff
Energy Budgeting & Payment	Facility Supervisor
Energy Management System	No EMS. Energy use control by facility staff.
Existing Metering	One Electric Meter One Gas Meter
Type of Use	Amateur Hockey, Public Skating
Ice Pad	
Number of Ice Pads	One
Floor Type	Concrete
Ceiling Type	Low-emissivity
Brine Type	CaCl2
Ice Temperature Measurement	No. Ice quality controlled by brine temperature. Brine temperature target is 17oF.
Ice Thickness	1.5” – target based on liability risk – New England – Travis Roy Case
Frequency of Ice Scraping	1x per hour of operation
Brine Line	All Insulated

TABLE A2-9
EASTVIEW ARENA BUILDING PROFILE

Compressor Room	
Compressors	50 HP – main stage – motor changed out to high eff. 30 HP – 2nd stage – lower eff. motor
Refrigerant Type	Ammonia
Compressor Staging	Honeywell Controller – Brine Temp. Main Control Parameter 1st Stage – Brine 17oF 2nd Stage – Brine 19oF
Chiller Type	Shell & Tube
Brine Maintenance	By CIMCO Refrigeration
Brine Pumps	25 HP main duty, check if stand-by exists Brine pump is run continuously during ice season
Compressor Room Heat Rejection/Recovery	
Condenser Type	Fan/Wet Condenser; Fan 1st stage, water 2nd stage Supplied by CIMCO Refrigeration
Condenser Maintenance	By CIMCO Refrigeration – 1x/yr cleaning of water nozzles, tighten belts etc.
Heat Recovery	No heat recovery from condenser or jacket cooling water.
Ice Resurfacing Machine Room	
Ice Resurfacing Machine Fuel Type	Propane
Ice Resurfacing Machine Water Heating	See DHW Heating – Same Heater
Snow Dump Location	Outside
Ventilation Control for Snow Dump	Double door system – rink door is closed before outside door is opened to dump snow
Ventilation/Building Heating	
Spectator Heating	Low Intensity nfra Red
Change Room Heating.	Forced Air Gas
Ice Pad Dehumidification	None
General Ventilation	2 exhaust fans at either end of building – on timer The ice resurfacing operator can switch on during ice cleaning – rarely used.
Ice Resurfacing Machine Room Heating	Gas Fired Unit Heater
Domestic Hot Water Heating	
Shower Heating	A.O. Smith Atmospheric Boiler – 270,000 Btu

APPENDIX B

MODULE 2

CITY OF BARRIE BUILDINGS: CITY HALL, LIBRARY, POLICE STATION, FIRE HALLS, AND BARRIE TRANSIT TERMINAL

City of Barrie Corporate Energy Plan

Review of Energy Efficiency Opportunities

Module 2:
Buildings: City Hall, Library, Police Station, Fire Halls, Barrie Transit Terminal

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Figures

List of Tables

PART ONE

Review and Profile of Energy Consumption in Facilities

Background

This audit document is intended as a sub component to Barrie's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its commitment to the Federal Government's Partners for Climate Protection Program (PCP program). The recommended Green House Gas reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 1994 energy use levels, by the year 2011.

The objective of this audit is to provide a high level review of various corporate buildings energy use and identify target areas where opportunities for improved energy use may exist. The facilities covered in this module include: City Hall and the Provincial Offences Office; the Barrie Public Library; the Barrie Police Station; the Transit Terminal Building; the Main Fire Hall and three Fire Hall additional substations; the Dorian Parker Centre; the Lampman Lane Community Centre; the Southshore Community Centre; the Parkview Seniors Centre and the Operations Centre. Due to the availability of data, 1995 was used instead of 1994 to provide a benchmark for comparison.

Overall Energy Consumption

Figure B1-1 provides an historical trend of overall energy use in the City of Barrie's buildings listed in this module. As indicated by the red line, the total overall energy use for these buildings has increased 72.4 percent since 1994. The steep rise in energy consumption over 1994 to 1997 can be attributed to the addition of new buildings/additions and an increase in energy use at each facility. As a result, such a steep rise in overall energy consumption poses a monumental task to achieve the PCP reduction targets goal in absolute terms.

FIGURE B1-1

OVERALL CO_2 EMISSIONS (TONNES) DERIVED FROM ELECTRICITY USE

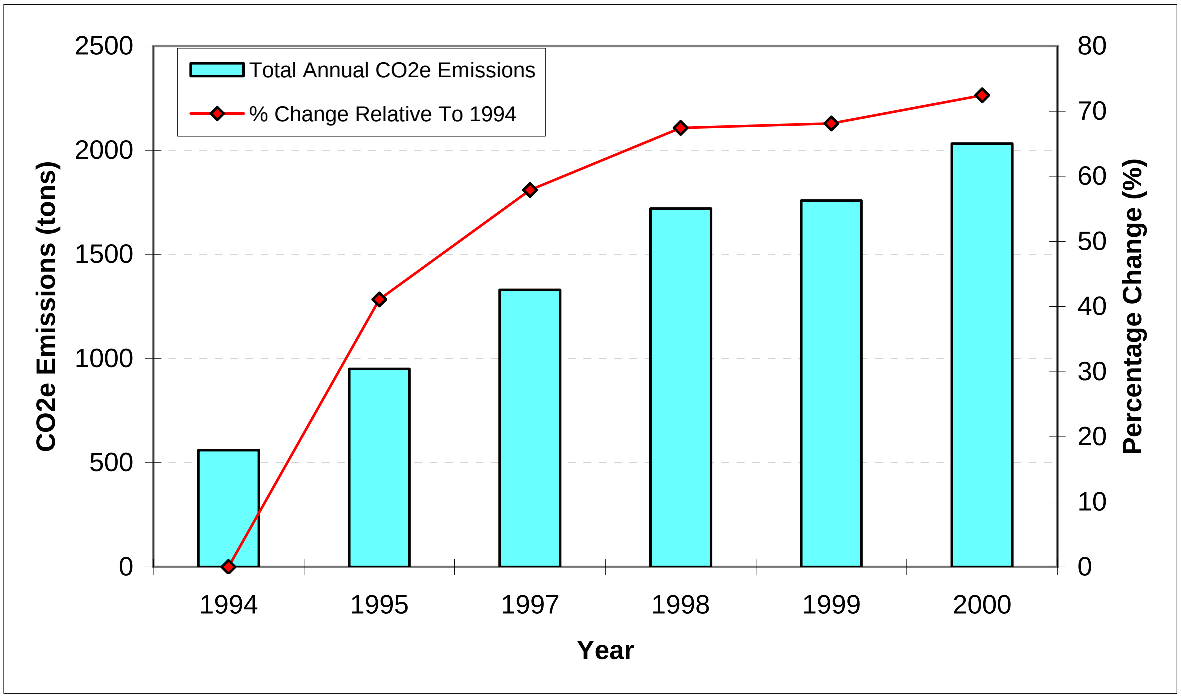


Table B1-1 presents the CO_2e emission differences between 1994 and 2000 o n an individual and collective basis for Barrie's facilities. Note that 1995 was selected as a base year for Fire Hall #3. No comparisons have been indicated for Fire Hall #4 since it was built in 2000 and only 2000 data is available.

TABLE B1-1

INDIVIDUAL AND COLLECTIVE CO_2E REDUCTION TARGETS (DERIVED FROM ELECTRICITY USE)

Facility	Year Built	Area m² [1]	1994 CO_2e (tonnes)	2000 CO_2e (tonnes)	Reduction from 2000 to meet 20% target
City Hall [2]	Tower 1972 Addition 1984	7060	298	754	516
Barrie Public Library	1995	3716	0	224	224
Transit Terminal	1994-95	2323	55	161	106
Police Station	1993/4	4600	143	409	295
Fire Hall #1 (Main Fire Hall)	1964	2230	66	195	142
Fire Hall #2	1970s	436	7	17	11
Fire Hall #3	1995	550	7	20	14
Fire Hall #4	2000	604	0	20	20
Dorian Parker Centre	House –1930 Addition 1970	729	5	18	14

TABLE B1-1
INDIVIDUAL AND COLLECTIVE CO_2E REDUCTION TARGETS (DERIVED FROM ELECTRICITY USE)

Facility	Year Built	Area m² [1]	1994 CO_2e (tonnes)	2000 CO_2e (tonnes)	Reduction from 2000 to meet 20% target
Lampman Lane Community Centre	1982	1198	5	15	11
Southshore Community Centre	1994	1815	19	43	28
Parkview Seniors Centre	1930s/ 1974/ 1998	1500	22	61	43
Operations Centre	1973	6912	89	384	313
Totals[3]		**33,237**	**716**	**2,321**	**1,748**

1 Building Floor Area excluding cold storage areas
2 Includes the Provincial Offences Offices
3 Totals exclude Recreational Facilities

As indicated in Table B1-1, there has been an increase of approximately 1,605 tonnes of CO_2e from 1994 to 2000. A reduction to 20% below 1994 levels would require reducing GHG emissions by 1,748 tonnes CO_2e.

Energy Use Trending and Benchmarking Performance

As a starting point for this audit, it is useful to review historical energy use trends and benchmark the energy efficiency of each facility to its counterparts. Table B1-2 provides a facility and operational profile to demonstrate the size of the facilities and the different functions they perform.

TABLE B1-2
FACILITY COMPARISON ON A BUILDING FLOOR AREA AND OPERATIONAL PROFILE BASIS

Facility	Area m² [1]	Date Built	Hours of Operation	Operational Profile
City Hall (including: the Provincial Offences Offices)	7060	Tower built in 1972 Addition added in 1984	5 days/week, 8am to 5pm Weekends: 7am to 4pm	Offices, Meeting Rooms, Council Chambers, Administrative functions
Barrie Public Library	3716	1995	6 days/week, 10am to 9pm Sunday: 12pm to 5pm	Offices, Public reading areas
Transit Terminal	2323	1995	7 days/week, 7am to 1am	Offices, Waiting area
Police Station	4600	1993/4	7 days/week, 24 hours a day	Offices, Garage, Equipment Storage, Holding Cells, Common Areas, Training Rooms

TABLE B1-2
FACILITY COMPARISON ON A BUILDING FLOOR AREA AND OPERATIONAL PROFILE BASIS

Facility	Area m^2 [1]	Date Built	Hours of Operation	Operational Profile
Fire Hall #1 (Main Fire Hall)	2230	1964	7 days/week, 24 hours a day	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Fire Hall #2	436	1970s	7 days/week, 24 hours a day	
Fire Hall #3	550	1995	7 days/week, 24 hours a day	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Fire Hall #4	604	2000	7 days/week, 24 hours a day	Offices, Garage, Equipment Storage, Common Areas, Training Rooms
Dorian Parker Centre	729	Club House in 1930s Conversion in 1970	Limited use in the winter (twice a week) Daily use in the summer	Main Hall, Kitchen, Bar and Storage
Lampman Lane Community Centre	1198	1982	Monday to Thursday 4:30pm to 8pm (after school) Saturday 9am to Noon Extended Summer Hours	Main Lobby, Offices, small Kitchen, Change rooms, Classroom, shared Gymnasium and an Outside Pool
Southshore Community Centre	1815	1994 Original structure over 100 years old	Monday to Saturday 8:30am to 4:30 pm Weekend and evening functions	Main Hall, Tourist Offices Lower levels house equipment storage, workshops and a common area for the local canoe and rowing clubs
Parkview Seniors Centre	1500	Main building in 1930s/1974 /1989	8:30 am to 9:30 pm	Offices, Activity/Banquet rooms, Kitchens, and a Library
Operations Centre	6912	1973	Monday to Friday 7:30 am to 4 pm Extended hours for plowing as required	Greenhouses, Park and Recreation offices, Garages, Repair and Maintenance shops, Change Rooms, Administration offices and other common areas

Note: 1 Building Floor Area excluding cold storage areas

As Table B1-2 indicates, the range of facilities reviewed in this module varies greatly in terms of size, operational hours and function. The Police and Fire Stations, as well as the Operations Centre, operate constantly on a daily basis while City Hall follows a routine business schedule. The operation of the community centres vary from routine hours at the Parkview Seniors centre to more sporadic hours at the Dorian Parker centre, with some extended hours of operation during the summer.

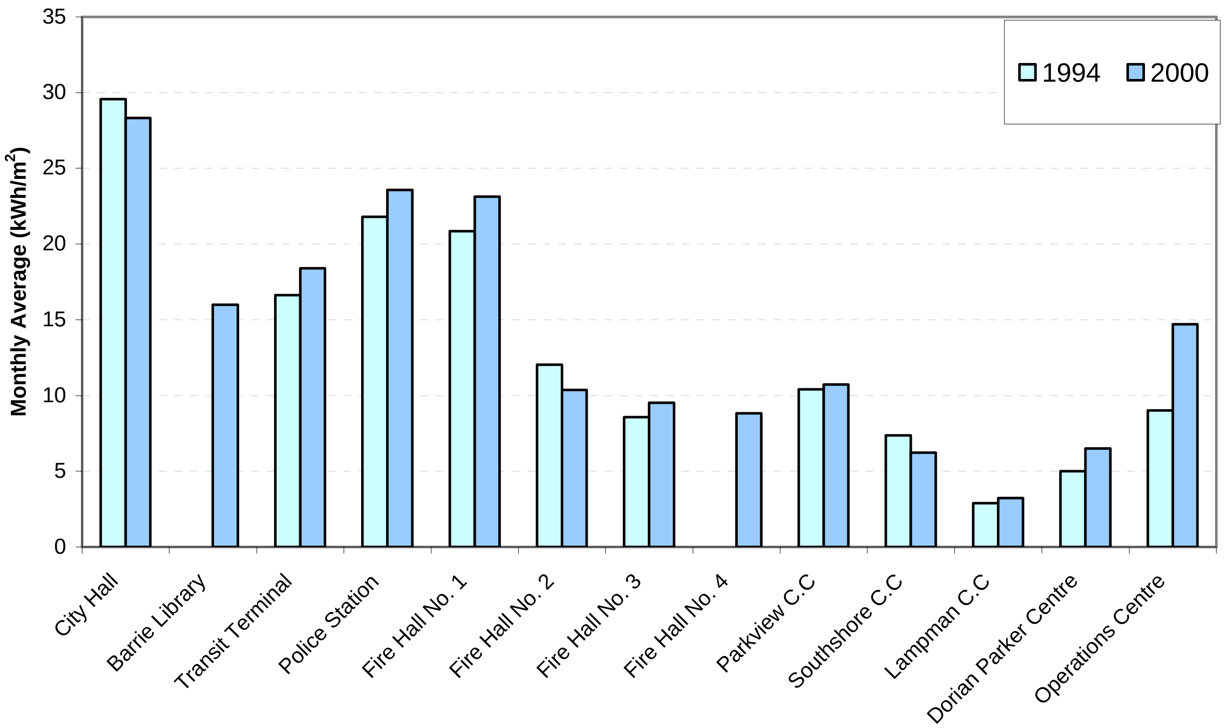
Based on these different operational profiles the ability to compare facilities to each other is limited. Consumption and load profiles of each building will be directly related to the duration and type of operations that the facilities provide.

In order to provide a basis of comparison, total electricity usage has been divided by the floor area for each building in Figure B1-2 (and Table B1-3) to provide an energy intensity factor. City Hall stands as the most populated and largest building as well as the highest energy user per floor area. Although recent electricity conservation efforts have decreased use by 20 MWh per metre square per year, City Hall still consumes almost twice as much electricity as the next major power consumer, the Operations Centre. Although comparable in size, the major portion of the floor area at the Operations Centre is made up of garages and greenhouses that are heated by natural gas. Energy use at the Operations Centre has also increased 20 kWh per square metre from 1994 to 2000. The Police Station maintains a similar energy consumption rate, compared to the Operations Centre, although its floor area is much lower. The Transit Terminal and Main Fire Hall (No.1) have similar electrical use on a floor area basis while the electrical use at the remaining Fire Halls are negligible by comparison.

TABLE B1-3
SUMMARY OF TOTAL ELECTRICITY USAGE AND INTENSITY FOR EACH BUILDING

Facility	Area m^2	1994 Electricity Use (MWh)	1994 Intensity MWh / m^2	2000 Electricity Use (MWh)	2000 Intensity MWh / m^2
City Hall	7060	2505	0.355	2399	0.340
Barrie Public Library	3716	0	0	713	0.192
Transit Terminal	2323	464	0.200	513	0.221
Police Station	4600	1204	0.262	1302	0.283
Fire Hall #1 (Main Fire Hall)	2230	558	0.250	619	0.278
Fire Hall #2	436	63	0.145	54	0.124
Fire Hall #3	550	57	0.103	63	0.114
Fire Hall #4	604	0	0	64	0.106
Dorian Parker Centre	729	44	0.060	57	0.078
Lampman Lane Community Centre	1198	42	0.035	46	0.039
Southshore Community Centre	1815	160	0.088	136	0.075
Parkview Seniors Centre	1500	187	0.125	193	0.129
Operations Centre	6912	748	0.108	1220	0.177

FIGURE B1-2
AVERAGE MONTHLY ELECTRICAL USE BY BUILDING BY FLOOR AREA



The buildings have been ranked by overall electricity usage and their average electrical use by the floor area of each building (Table B1-4). Note, in terms of absolute electricity use, the Police Station is ranked second, where as on a floor area basis, the Transit Terminal and the Main Fire Hall use almost the same amount of electricity.

For the most part, all buildings are heated by natural gas systems (except the Main Fire Hall); however, there is significant electricity demand from Cooling Tower/ Chiller Systems as well as Air Handling Units (AHUs) and supplemental heating/cooling systems.

TABLE B1-4
SUMMARY OF MAJOR AND MINOR ELECTRICITY USERS AND THEIR ENERGY SYSTEMS

Facility	Year Built	Area m^2	Electricity Use Ranking (2000)[2]	Electricity Use Ranking (by m^2) [3]	Heating/Cooling Systems
City Hall	Tower 1972 Addition 1984	7060	1 (Top User)	1 (Top User)	Natural Gas (Boilers) 10 AHUs Natural Gas Space Heaters (Garage) Cooling Tower (summer only)
Barrie Public Library	1995	3716	Not Available	Not Available	Natural Gas (Boilers) *Reheat coils present

TABLE B1-4
SUMMARY OF MAJOR AND MINOR ELECTRICITY USERS AND THEIR ENERGY SYSTEMS

Facility	Year Built	Area m^2	Electricity Use Ranking (2000)[2]	Electricity Use Ranking (by m^2)[3]	Heating/Cooling Systems
Transit Terminal	1994-95	2323	5	5	4 Natural Gas Roof Top Units 2 Boilers (Basement)
Police Station	1993-94	4600	2	3	2 Natural Gas Boilers 2 AHUs
Fire Hall #1 (Main Fire Hall)	1964	2230	4	4	Electric Baseboard and In-Line Duct Heaters
Fire Hall #2	1970s	436	8	8	Natural Gas (Forced Air)
Fire Hall #3	1995	550	8	7	Natural Gas (Forced Air)
Fire Hall #4	2000	604	Not Available	9	Natural Gas (Forced Air)
Dorian Parker Centre	House – 1930 /1970	729	10	10	Natural Gas (Forced Air) and Electric Baseboards/ Space heaters
Lampman Lane Community Centre	1982	1198	9	8	Natural Gas (Forced Air) and Electric Baseboards
Southshore Community Centre	1994	1815	7	6	Propane Heating
Parkview Seniors Centre	1930s/ 1974/1998	1500	6	5	5 Natural Gas units and supplemental Electric Heating
Operations Centre	1973	6912	3	2	10 Natural Gas units, 6 In-line heaters, 58 radiant tube heaters (garage), 16 natural gas space heaters (greenhouses) and supplemental Electrical Heating

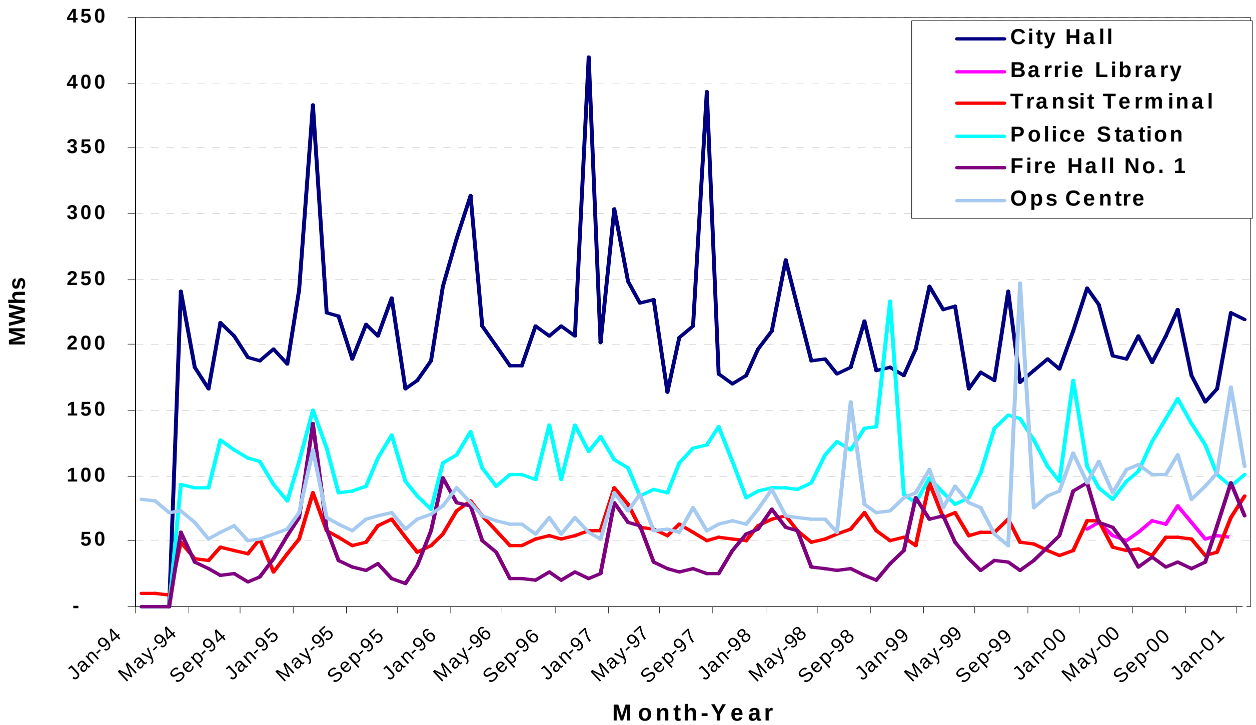
Note:
[1] Building Floor Area excluding cold storage areas
[2] Electricity Use Ranking based on total electricity use for 2000, similar usage received the same ranking
[3] Electricity Use Ranking based on average electricity use by square meter for 2000

Historical Energy Use Patterns

A review of available historical energy use patterns can provide insight into changing operational patterns or significant load additions at each facility. Figures B1-3.A and B1-3.B provide historical perspectives of electricity usage at each building from 1994 to January 2001. The major electricity users can be found on within Figure B1-3.A, and minor electricity users on Figure B1-3.B. Note that some data gaps in 1994, 1996 and 1997 exist for the community centres and City Hall (1994 winter months).

Upon review of the major electricity users shown in Figure B1-3.A, it is apparent that City Hall has experienced significant peaks in electricity use in the past, typically in the winter and summer months. After 1997, the magnitude of the peak demand diminished; however, the characteristic pattern of winter and summer peak demand remains constant. The demand during these seasons is due to the weather extremes creating more demand upon heating and cooling systems; such as, the blowers, pumps, air handling units and other equipment that work in tandem with the natural gas fired boilers and help distribute the warm/cold air and hot water throughout the building.

FIGURE B1-3.A
HISTORICAL ELECTRICITY USE (MAJOR USERS) BY BUILDING (1994 – JANUARY 2001)



Several changes to the operation and maintenance of these heating and cooling systems in recent years have lead to the decrease in overall electricity use and peak demands. The cooling tower is now turned off during the winter months and a new DIMAX system with programmable computer settings have optimized outside air exchange, night time set backs as well as more control over building ventilation.

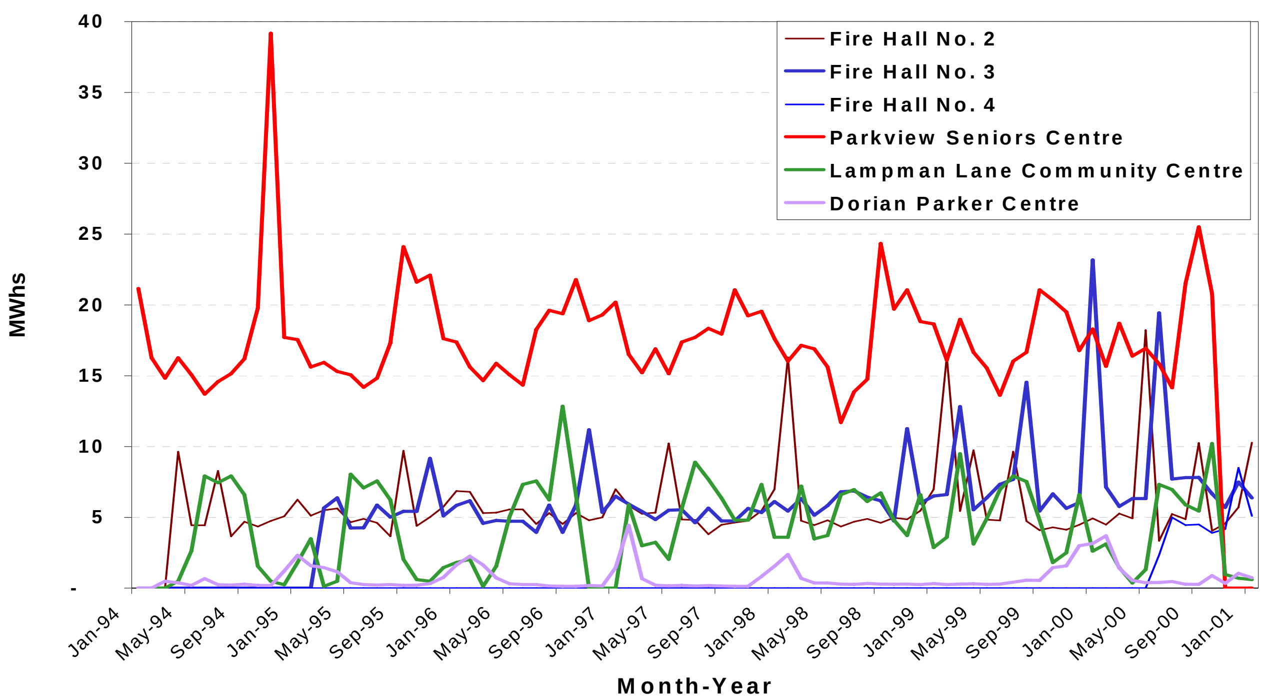
The Police Station building has experienced regular peak electricity demand in the summer and winter with growing peak demands in 1999 and 2000. The regular fluctuations in electricity use are a reflection of the building's operational function, working 24 hours a day. No setback or energy conservation efforts have been undertaken due to the extended hours of operation.

The Operations Centre building's electricity use has increased over 1999 and 2000 and become less stable with higher peak demands. While no new additions or major renovations have been conducted on the building itself, a large portion of the building's operation is devoted to servicing the City of Barrie's vehicle fleet (including snow plows) The rise in the number of city vehicles and demand of other support services may have lead to an increase in electricity use. Furthermore, the Operations Centre has experienced several office changes that have resulted in the adjustment of office space that circumvents proper heating/cooling controls. Office space area previously serviced by one natural gas unit is shared with other units, resulting in conflicting controls and settings that require routine oversight.

The Transit Terminal has experienced a regular electricity use pattern use from 1994 to 2000 with peak demands typically falling in the winter months. Support equipment associated with the natural gas heating system is likely resulting in the increased demand.

Figure B1-3.A demonstrates a typical cyclical electricity use pattern for the Main Fire Hall (No.1) where the building relies on electric baseboard heating during the winter months. With the introduction of more window air conditioning units, the overall electricity demand has increased over recent years. Historical electricity use at the other facilities are ranked lower overall and have much lower demands compared with previously discussed buildings. As a result, these buildings will be discussed in more detail in Part 2.

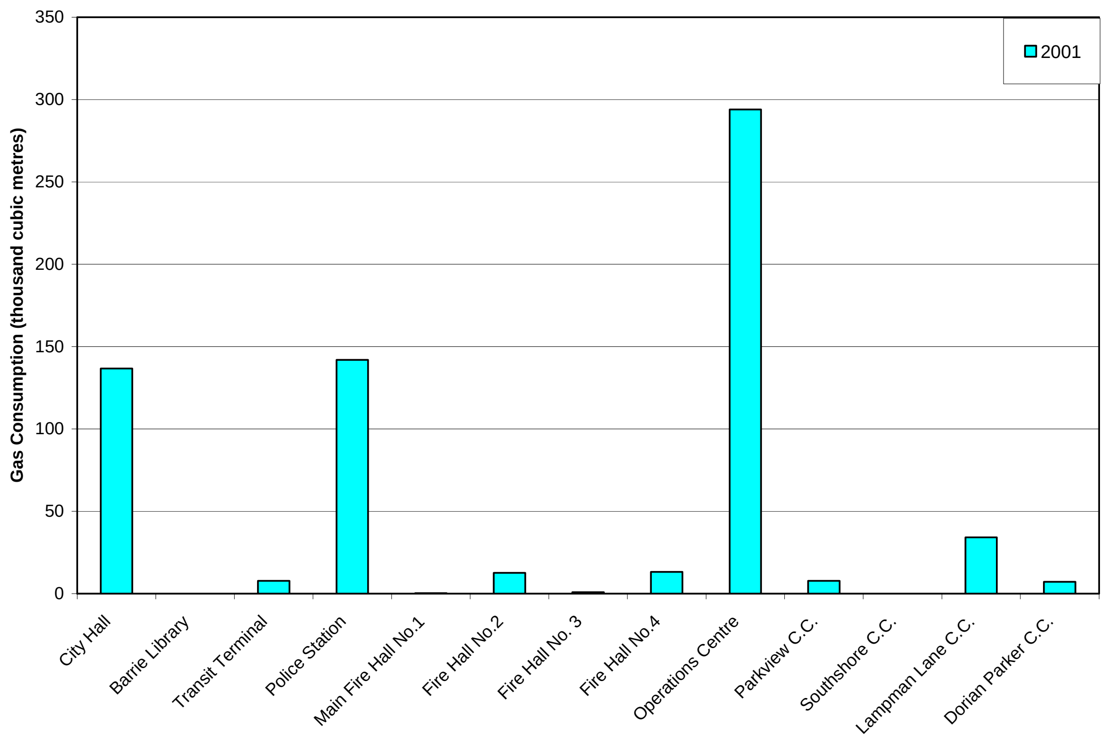
FIGURE B1-3.B
HISTORICAL ELECTRICITY USE (MINOR USERS) BY BUILDING (1994 – JANUARY 2001)



Natural Gas Consumption

Figure B1-4 presents the total gas consumption for 2001 for each building discussed in this module. While no previous gas data was available, 2001 data indicates that the main electricity users identified earlier in this report are also among the highest gas consumers. Operations Centre was the highest gas consumer with a total gas consumption of almost 300,000 cubic meters. The Police Station and City Hall share similar total gas consumptions of approximately 140,000 cubic metres. Note that no data was available Barrie's Public Library at the time of this report. Southshore Community Centre uses propane instead of natural gas.

FIGURE B1-4
NATURAL GAS CONSUMPTION FOR 2001 BY BUILDING



PART TWO

Potential Opportunities for Improved Energy Efficiency

The opportunities presented in this section are initial recommendations for energy efficiency improvement and further detailed evaluation is required for each measure.

General Knowledge/Awareness of Energy Consumption

All Facility Personnel interviewed during the audit process were very conscience of energy efficiency and demonstrated a keen interest in the operation of their respective buildings. Each operator had detailed knowledge of the facilities they managed; however, the particular operating details of the HVAC, hot water heating among other electrical loads were not readily available during the interview due to the complexity of some systems and the level of responsibility of the operator who are required to look after several buildings. More information should be made available in a centralized location.

Equipment Inventory and Operational Profile Manual

It is recommended that the equipment inventory and operational design parameters are established in a manual for each facility. The City Hall facility recently switched to a DIMAX control system with programmable computerized settings. The independent contractor who installed the DIMAX system also set-up and optimized various settings for the building. To a lesser extent, the Library also has a similar system controlled with programmable computerized settings; however, less control is available to the operator. Similar manuals should be established for other facilities discussed in this module.

Energy Use and Operational Profile Logging

While all Facility Operations personnel interviewed were conscience of energy usage, they were not aware of actual consumption levels. In this context, Operators do not directly see the impact of their efforts and tend to focus more on protocol than results.

By adding daily meter readings to the current operating regimen, staff will be able to see how the facility is operating on a daily basis. It has been demonstrated that daily meter readings will encourage even tighter energy use control and identify any trends of mal-operating equipment. In addition, staff will often find their own new and innovative ways to reduce energy usage when its profile and importance is raised.

Sub-Metering

For the most part, all facilities in this module have one main gas meter (if present) and one main electrical meter with no sub-metering. The addition of sub-metering would allow for the identification of energy cost centres and prioritize areas of each facility that need to be addressed.

For example, sub-metering electrical demand on a work area basis at the Operations Centre or on a floor by floor basis at City Hall would allow for a demand separation. While most of the floors at City Hall have a similar number of people, renovations have only been completed on certain floors and as a result, equipment such as light fixtures vary greatly. Although renovations are planned at the Main Fire Hall, sub-meters in this facility would have been an important means to separate electrical demand from different tenants and identify malfunctioning thermostats. Sub-meters will help identify ways to reduce energy spikes, reduce utility demand charges and prioritize efforts for energy conservation.

Natural gas sub-metering will require dedicated meters and a certified gas fitter to install them in-line. Electricity sub-metering can be done with either a dedicated meter or a portable clamp-on amp meter/datalogger that can be used throughout each facility.

Metering will have to be analyzed for cost effectiveness. Manual data logging may indirectly increase costs through data management compared to the potential energy savings. Automated systems may have more initial capital costs.

Energy Use Benchmarking

Energy Use benchmarking exists for different types of offices and commercial structures exists but it tends to focus on electricity usage per floor area. It is suggested that Barrie identify similar facilities in other Cities in southern Ontario to enable benchmarking for electricity and gas usage.

Facility Specific Opportunities

City Hall

Table B2.1 provides a summary of the building profile.

TABLE B2-1
CITY HALL BUILDING PROFILE

Location	70 Collier Street
Operational Profile	Business Hours: 5 days/wk, 9:00 am to 5:00 pm Weekends: 7:00 am to 4:00 pm (Weddings and Farmer's Market)
Building History	Tower was built in 1972 Addition was built in 1984
Operations Management	Fred Snelleman Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available

TABLE B2-1
CITY HALL BUILDING PROFILE

Building Energy Management System	Heating, Cooling, Humidity and Air Flow settings are managed through a computer system (DIMAX) No programmable controls for lighting Gas heating in the underground garage monitored manually
Lighting	
9th Floor	Mini TLs, Standard T-12 Fluorescent fixtures
8th Floor	4-bulbs, T-12 fixtures (swapped out with full spectrum as required)
5th Floor (Computer Server)	4-bulbs, T-12 fixtures (swapped out with full spectrum as required)
2nd Floor	Retrofitting quads with 9 Watts at elevators
Mayor Office	T-12, Mini TLs, Incandescent
Council Chambers	Multi vapour (which take a long time to warm up and are not ideal for meetings and presentations), Halogens (250 Watts) and Fluorescent
1st Floor/ Main Entrance	300 Watt Halogens, mixed lighting and spot lighting
Parking Lot	Lights are controlled with a photocell and timer
Elevators	
Office Elevator	Two Diesel Elevators service the main office tower and provide access to each floor.
Parking Elevator	One Hydraulic Elevator provides access to the underground parking garage
Renovations	New equipment is scheduled to be installed 2004.
Building Heating/Cooling/Air Flow and Ventilation	
Air Handling Units	10 Air Handling Units (AHUs) with one each floor
Hot Water Heating	Gas and Electric Hot water tanks (uninsulated)
Boilers	Boiler #1 –Raypack, Natural Gas (437000 BTUs), night setback; Boiler #2 –Teledyne, Natural Gas (293,300 BTUs), night setback; 3 baseboard heating loops around the perimeter of the building
Cooling Tower	Cooling Tower located on the roof – cooling for addition. (turned off during the winter – connected to cols water from Kempenfelt Bay)
Natural Gas Heating Units	At least ten or more gas fired heaters are used in the parking garage. Two additional roof-top heating units provide peak demand supply
Air Compressor, Pumps and various equipment	
Air Compressor	Pneumatic controls and Parking Elevator
Pumps	4 Pumps and 4 Sumps which includes boiler and direct heating pumps, condenser and chilled water pumps, separate sewer and storm water pumps and a booster pump for the building's overall water pressure. Additional backup pumps for fire suppression.
Blowers	4 main blowers/fans for delivering and re-circulating air

TABLE B2-1
CITY HALL BUILDING PROFILE

Computers	An extensive network of computers, server located on the 5th floor and UPS emergency UPS backup located in the basement.
Emergency Generator	An emergency Diesel generator (1000) and tank are located in a separate room in the parking garage. Capable of running continuously for 3 days.
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.(Trulite CMHC)
Doorways	All entrances have a vestibule (double doors). The door near the skating rink uses a positive pressure curtain.
Meterage	
Gas	The tower and addition are on separate meters.
Electricity	One meter for the building
Water	The city has been testing several water meters. The tower and addition are on separate meters.

City Hall is a modern building that was built in two stages. The nine-floor tower, a former bank building, was constructed in 1972 and a new addition, which currently houses the council chambers and the municipal by-law offices and court, was built in 1984. Several renovations have been completed, including an extensive renovation of the ninth floor. The new addition shares electrical services; however, it has its own Heating/Cooling and Air Handling systems. Supplemental information concerning the addition is included in the summary table for the Provincial Offences Office which is located at 56 Collier St. Two levels of underground parking exists under the building. During the summer, a pond and fountain operate in the front of the building and in the winter, the pond is converted into a circular public skating rink. A smaller building, operated by Parks and Recreation, houses a small zamboni to clear the skating rink.

A variety of lighting equipment can be found in the City Hall Building, including: Mini TLs and T-12 Fluoresce (347 volt), multi-vapor, Halogens (~250 watt) among others. Currently, the operations manager is following a strategy of replacing burned-out lights with longer lasting (up to 5000 hours) and more luminescent (full spectrum) light fixtures as well as new electric ballasts. New replacement bulbs provide more luminescence for the same wattage; however, they do not provide additional energy savings. Fluorescent fixtures support both paired and alternating lighting strategies and attempts have been made to reduce lighting in some areas by untwisting alternating lights. In some locations, natural lighting is provided through sky lights and windows. Lighting around these natural sources of light remain lit due to variable natural light levels.

Although there are a few dimmer switches located in various offices, there are no main controls or automatic switches. Maintenance employees make rounds to turn on and off day lights before and after building operating hours. Several areas remain lighted, including the washrooms and the council meeting room and other Parking lot lights are controlled with a timer and photocell and are typically turned on at dusk with the photocell, turned off at 1:00 AM and turned on again at 5:00 AM.

The main mechanical room for the first and second floor exists in its own room on P2 level of the parking garage, including the main operating control systems. Heating/Cooling and air flow are controlled, for the most part, through the DIMAX system. The electric DIMAX control system controls previously existing pneumatic (Honeywell) controls and allows maintenance personnel to monitor and adjust temperatures and air flow throughout the building. Day and night time schedules, as well as holidays, have been programmed for the building; however, weekend set backs are limited due to the extended operating hours of the building on weekends.

The operation of the heating/cooling system also monitors outside temperature and alters outside air exchange for cooling. Approximately ten percent fresh air is mixed and re-circulated with building air on a regular basis. The Tower and the new addition are connected electrically but have their own heating/cooling and air handling systems. Each floor has a mechanical room which houses a Air Handling Unit and Humidifier. The air handlers have two sets of filters that are changed every month. Mr. Fred Snelleman, head mechanical maintenance supervisor, has begun to develop a list which details major equipment including their respective age, life expectancy and approximate cost of replacement.

Approximately ten gas-fired heaters are hung from the ceiling in the underground parking are used to prevent pipes from freezing and dry the floor. Typically, garage temperatures are kept at 16^{o}C (Fred); however, the ambient temperature was much higher during the site visit due to a recent cold weather system. The heaters are adjusted and monitored manually by maintenance personnel. Some attempts have been made to place heaters in colder areas while isolating the gas feeding burners in areas were less heat is required. A new heated ramp leading to the underground parking was installed recently for safety concerns. This new heated ramp has increased the energy usage of the underground parking lot.

Other various equipment includes electric pumps that are required to boost water pressure in the tower. Additional pumps are available to backup the fire suppression system.

An active transformer is located in the mechanical room of the ninth floor. The transformer was previously used to power building signage when the tower used to be bank. Currently the transformer is used to power lights of the clock tower.

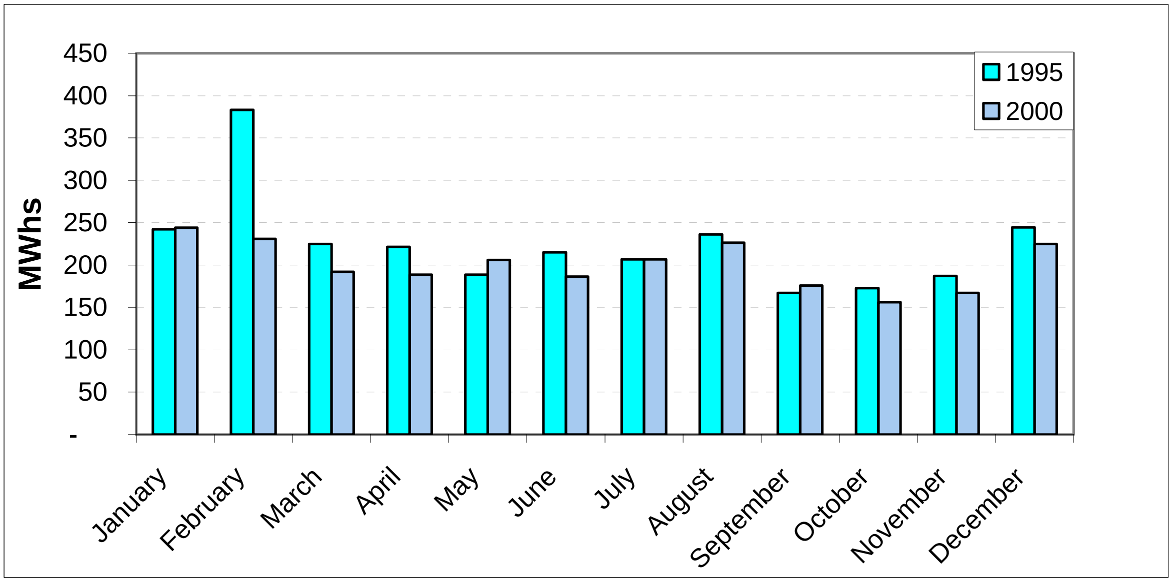
While most hot water lines are insulated, none of the hot water tanks were double insulated with a second wrap.

There is an extensive computer network in the office. Currently there is no computer power usage policy. Employees are expected to turn their computers off at night. Individual computer power saving features is controlled by Windows XP ©.

Electricity Use

Figure B2-4 illustrates the electricity use profile for City Hall for 1995 and 2000. As discussed earlier, City Hall is the largest electricity consumer in this module, in terms of overall use and on a floor area basis. Although dramatic spikes in demand during 1997 shown in (Figure B2-3.0A and B2-3.0B) are not shown in the following figure, efforts to control electricity use in 1999 and 2000 appear to have tempered these demand spikes. Electricity use patterns observed in 1995 appear to closely match more recent usage in 2000 and in most cases, electricity use has experienced a slight decline.

FIGURE B2-1
CITY HALL ELECTRICITY USAGE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Assess the distribution of load throughout the facility, electrical sub-meters could be installed for each floor and the new addition.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis. While fluorescent fixtures are being exchanged with brighter full spectrum bulbs, opportunities to reduce or eliminate lighting in certain areas may become more apparent;
- The operations manager indicated that the transformer located in the mechanical room on the ninth floor should be removed.
- Insulate hot water tanks and associated piping.
- Based on more recent data after 2000, electricity and gas use should be re-evaluated in conjunction with the buildings programmable settings to ensure optimal settings are being used. Settings include damper/ventilation positions, chilled water temperature reset, operating points among others.

- Daily meter/sub-meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper. For example, during the summer, peak loads typically occur during the late afternoon (approximately 3:00 PM) when buildings have absorbed sufficient radiant heat from the sun resulting in increased air conditioning loads.

Other Recommendations

- Implementing gas sub-meters to assess usage by boilers and other equipment from heaters located in the garage.
- An evaluation of the heating strategy in the underground parking lot may also provide a significant area for improvement in terms of efficiency and cost savings. Options to help reduce the amount of heating required in the underground garage may include the application of a special coating to protect the garage floor in the winter; more insulation of piping and along exterior walls; placement of heating units; and, the installation of a dry fire suppression system. It should be noted that some dry systems contain chemicals considered to be greenhouse gases and a full evaluation should be conducted so that the solution is not a larger contributor through testing than the status quo.
- Although a comprehensive computerized system and operating manual are in place, it would be valuable to expand this manual to include information about each equipment, such as, its efficiency as well as its electrical/ gas demand and the area it services.
- Cold water cooling loop from Kempenfelt Bay

Provincial Offences Office Building

The provincial offences office is a recent addition on to the City Hall. The building profile is provided in Table B2-2.

TABLE B2-2
PROVINCIAL OFFENCES OFFICE BUILDING PROFILE

Location	56 Mulcaster Street
Operational Profile	Business Hours: 5 days/wk, 9:00 am to 5:00 pm
Building History	Built as an addition to City Hall in 1984
Operations Management	Fred Snelleman Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating, Cooling, Humidity and Air Flow settings are managed through a computer system (DIMAX) No programmable controls for lighting Gas heating in the underground garage monitored manually

TABLE B2-2
PROVINCIAL OFFENCES OFFICE BUILDING PROFILE

Lighting	
Offices	Mixed lighting, Mini TLs and T-12 fixtures (swapped out with full spectrum as required)
Building Heating/Cooling/Air Flow and Ventilation	
In Line Heater	In Line heater to reheat air near court rooms.
Natural Gas Heating Units	At least ten or more gas fired heaters are used in the parking garage. Four roof-top heating units (approximately 10 tonne each)
Various equipment	
Hot Water Heating	Electric Hot Water Tank for Domestic Use
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrance has a vestibule (double doors).
Meterage	
Gas	The tower and addition are on separate meters.
Electricity	Connected with the Tower building meter
Water	The city has been testing several water meters. The tower and addition are on separate meters.

Barrie Public Library

The building profile for Barrie Public is listed in Table B2.3.

TABLE B2-3
BARRIE PUBLIC LIBRARY BUILDING PROFILE

Location	60 Worsley Street
Operational Profile	Business Hours: 7 days/wk, 10:00 AM to 9:00 PM (staff typically arrive at 8:00 AM), Closed on Observed Holidays
Building History	Built in 1995
Operations Management	Fred Snelleman Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating, Cooling, Humidity and Air Flow settings are managed through a computerized system No programmable controls for lighting

TABLE B2-3
BARRIE PUBLIC LIBRARY BUILDING PROFILE

Lighting	
Main Library and Administrative Offices	Mixed lighting and spot lighting, Mini TLs and T-12 fixtures (swapped out with full spectrum as required)
Parking Lot	Lights are controlled with a photocell and timer
Elevators	
Library Elevator	One hydraulic elevator provides access to the second floor.
Building Heating/Cooling/Air Flow and Ventilation	
Hot Water Heating	Electric Hot water tanks (uninsulated)
Natural Gas Heating Units	4 - Roof-top natural gas boilers (2 Quays, 2 Acons) provide hot water heat for library
Boilers	2 – Boilers in the basement provide baseboard heating
Reheat coils	Reheat coils are present at several locations
Various Equipment	
Humidifier	One humidifier is gas, others are electric (one per air handling unit)
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrance has a vestibule (double doors).
Meterage	
Gas, Electric, Water	One meter for each utility.

The library is a modern building that was built in 1995. The majority of the building exterior consists of tinted, thermo double-paned glass. The City of Barrie owns all utilities and equipment inside Library.

A variety of mixed lighting equipment (13 W mini fluorescence, multi-vapours) are utilized by the Barrie Public Library. Currently, the City of Barrie is following a strategy of replacing burned-out lights with longer lasting (up to 5000 hours) and more luminescent (full spectrum) light fixtures as well as new electric ballasts. New replacement bulbs provide more luminescence for the same wattage; however, they do not provide an energy savings. In some locations, natural lighting is provided through sky lights and windows. Lighting around these natural sources of light remains lit due to variable natural light levels.

There are no main controls or programmable light switches. Some of the lighting systems have been combined into one switch on the upper floor. Employees are asked to turn off lights in unoccupied offices and at the end of the day. Maintenance employees make rounds to turn on and off day lights before and after building operating hours.

Heating/Cooling and air flow are controlled through a computerized/programmable system. The system allows maintenance personnel to monitor and adjust temperatures and air flow throughout the building. Day and night time schedules, as well as holidays, have been programmed for the building; however, weekend set backs are limited due to the extended operating hours of the building on weekdays and weekends.

While most hot water lines are insulated, none of the hot water tanks were double insulated with external wrapping.

There is an extensive computer network in the office. Currently there is no computer power usage policy. Employees are expected to turn their computers off at night. Individual computer power saving features is controlled by Windows XP ©.

Electricity Use

Data not provided.

Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- To obtain and analyze all available electricity and gas usage to determine historical electricity and gas usage profiles. This data could be used to evaluate electricity and gas demands in conjunction with the building's programmable settings to ensure optimal settings are being used.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting and/or evaluate lighting requirements on an office by office basis. While fluorescent fixtures are being exchanged with brighter full spectrum bulbs, opportunities to reduce or eliminate lighting in certain areas may become more apparent;
- Insulate hot water tanks and associated piping.
- Daily meter/sub-meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper. For example, during the summer, peak loads typically occur during the late afternoon (approximately 3:00 PM) when buildings have absorbed sufficient radiant heat from the sun resulting in increased air conditioning loads.
- Although a computerized system and operating manual are in place, it would be valuable to expand this manual to include information about each equipment, such as, its efficiency as well as its electrical/gas demand and the area it services.

Transit Terminal

The building profile for the transit Terminal is listed in Table B2.4.

TABLE B2-4
TRANSIT TERMINAL BUILDING PROFILE

Location	24 Maple Street
Operational Profile	PMCL Business Hours: 7 days/wk, 7:00 am to 1:00 am (following day) Business hours for other tenants are more limited. Tenants include Burger King, PMCL (Grey Coach), Doctor Neiman (Dentist), Smoke and Ticket (variety store), a Barrie Police satellite office and a promotional company
Building History	Built in 1995
Operations Management	Fred Snelleman Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating, Cooling, Humidity and Air Flow settings are manually controlled through thermostats No programmable controls for lighting Parking lot lights are control with a photocell and timer
Lighting	
Main Public Area	A neon light along the top of the ceiling.
Parking Lot	Lights are controlled with a photocell and timer
Building Heating/Cooling/Air Flow and Ventilation	
Natural Gas Units	2 Natural Gas heating roof-top heating units
Various Equipment	
Hot Water	One Electric Hot Water Tank for Domestic Use
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrances have a vestibule (double doors).
Meterage	
Gas	One natural gas meter for the whole building
Electricity	One main meter with sub meters for each tenant

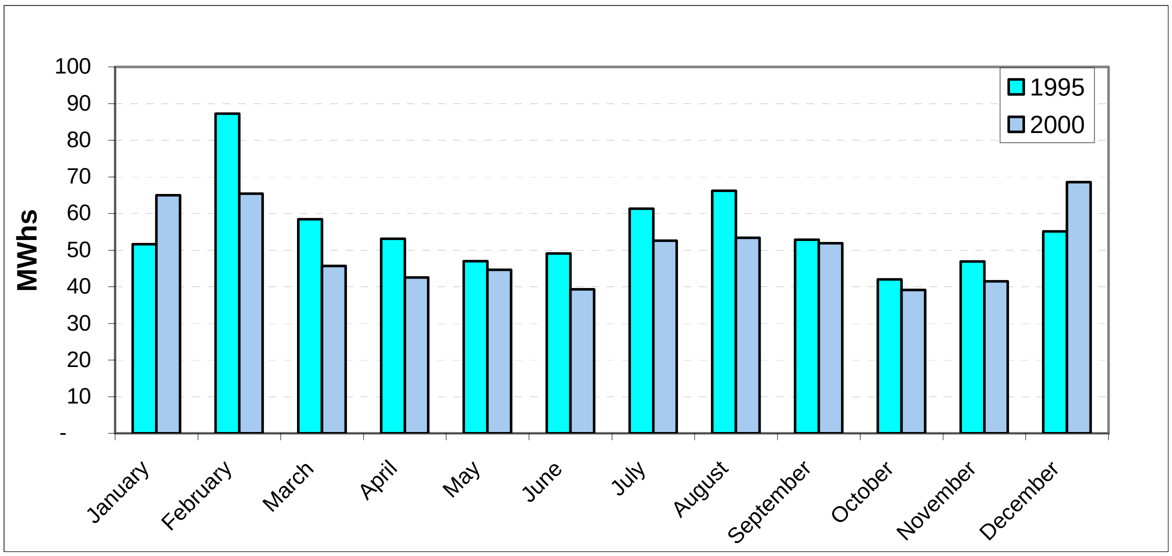
The Transit Terminal Building was built in 1995 and its primary function has been to operate as a bus station for PMCL (Grey Coach); however several other tenants also occupy the building, including Burger King, Doctor Neiman (Dentist), Smoke and Ticket (variety store), a Barrie Police satellite office and a promotional company. The main floor includes a large narrow waiting room, washrooms, service desks and access to Burger King and variety store. The police station and doctor's office have separate outside entrances. Typically, the transit terminal experiences a moderate volume of passengers that travel through the facility on a regular business day.

The entire facility is heated via two natural gas roof top units; however, the gas is not sub-metered to individual tenants. Tenants do have individual electricity sub-meters, however, only total electricity use was available for the facility at the time of this report (Figure 6).

Electricity Use

Figure B2-2 illustrates the electricity use profile for the Transit Terminal for 1995 and 2000. The Transit Terminal ranks fifth overall with respect to overall electricity use and electricity use by floor area. Notable peaks during the late summer and winter months indicate that electricity demand is also related to seasonal changes. For example, equipment such as fans, that support the distribution of heat from the natural gas roof top units.

FIGURE B2-2
TRANSIT TERMINAL ELECTRICITY USE



While overall electricity use has experienced a slight decline in 2000, winter months have experienced an increase in electricity use.

Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Convert manual controls and thermostats into more automated controls with programmable settings. Although the building operates on an extended schedule, night set backs are still possible. Currently thermostats are in locked boxes, some of which were unlocked at the time of the site visit.
- Insulate hot water tanks and associated piping.
- Daily meter/sub-meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy

to shift peak loads to times where electricity may be cheaper and help identify maintenance issues requiring attention. For example, during the summer, peak loads typically occur during the late afternoon (approximately 3:00 PM) when buildings have absorbed sufficient radiant heat from the sun resulting in increased air conditioning electricity loads.

- Due to the number of different tenants, individual electricity demands should be tracked separately in addition to the overall facility.
- An operations manual for the facility should be developed, outlining operating procedures as well as information about each equipment, such as, its efficiency as well as its electrical/ gas demand and the area it services.

Other Recommendations

- Implementing gas sub-meters to assess usage by different tenants would be valuable in identifying and tracking peak load demands.

Police Station

The building profile for the Police Station is listed in Table B2-5.

TABLE B2-5
POLICE STATION TERMINAL BUILDING PROFILE

Location	29 Sperling Drive
Operational Profile	7 days/wk, 24 hours a day
Building History	Built in 1993/1994
Operations Management	Peter Assistant Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating, Cooling, Humidity and Air Flow settings are manually controlled through thermostats and a main programmable switchboard. No programmable controls for lighting, Parking lot lights are controlled with a timer
Lighting	
Main Entrance Area	Fluorescent Lighting
Parking Lot	Lights are controlled with a timer
1st Floor	TLs (13 Watt tube flow) and standard T-12 Fluorescent (34 Watts)
2nd Floor	TLs (13 Watt tube flow) and standard T-12 Fluorescent (34 Watts)
Basement	Standard Fluorescent T-12 fixtures
Garage	Standard Fluorescent T-12 fixtures
Building Heating/Cooling/Air Flow and Ventilation	
Air Handling Units	Two Sheldon units, ACS#1 handles the basement and 1st floor, ACS#2 handles the 2nd floor.

TABLE B2-5
POLICE STATION TERMINAL BUILDING PROFILE

Hot Water/Boilers	2 boilers and associated pumps provides a hot water circuit for perimeter heating (baseboard) through the office space.
Cooling Tower	Located outside on top of the second floor, associated
Natural Gas Heating Units	A space heater and tube heater have been installed in the garage
Air Compressor/Pumps and Various Equipment	
Air Compressor	Devilbiss compressor for pneumatic controls.
Pumps	Four heating pumps circulate hot water to/from the boilers
Elevators	One main hydraulic elevator services all levels.
Computers	24 hour computer and communication system with a UPS backup system
Emergency Generator	Diesel Generator
Hot Water Heating	Two natural gas fired hot water tanks (Rheem Ruud) provide hot water for domestic use in the building.
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrance and exit doors have a vestibule (double doors).
Meterage	
Gas, Electricity	One main meter for each service for the building

The Barrie Police Station is a modern building that was built in 1993/1994. Approximately fifty people work at the station during a typical day. The building has two floors, a basement, a link area (connecting to the garage) and a garage. The first floor (main level) consists of the main foyer and desk, offices, meeting rooms, cells, communication center and dispatch, a fitness room, garage and storage. The second floor consists of more offices, change rooms, a lunch room and storage lockers. The basement has interview rooms, storage and the main electrical room. The exterior of the building consists of tinted, thermo double-paned glass and brick. All windows and doors are sealed units and there is a vestibule in the main entrance. Some of the office windows can be opened.

The City of Barrie owns all utilities and equipment inside the building and looks after routine maintenance issues (i.e. changing filters). Most of the original equipment remains in the building, although some parts of the building have undergone renovations. Major repairs are conducted by outside contractors.

The majority of lighting consists of either TLs (13 Watt tube flow) fixtures or standard four foot fluorescent T-12 (34 Watt) bulbs that provide either warm or cool lighting. Most lighting is controlled on a room by room basis, while common areas are combined. Lights are replaced with regular standard bulbs as required. The lunchroom has two light settings.

Office lights are turned on during the day and off at night, while the majority of other common working area lights remain on all day. There are no automatic switches or control settings for lighting or other appliances. For example, switches in the main lunchroom and common area are manual and there are opportunities to leave lights and other appliances (i.e. television) on while the room is unoccupied. Other lights in common areas, including lights in the link area, are only controlled at the breaker. In the event of power failure, one light in each area are designed to stay on at all times.

In some locations, natural lighting is provided through sky lights and windows. Most offices also have windows with blinds and there are several skylights throughout the building (main foyer and stairwell). Lighting around these natural sources of light remain lit due to variable natural light levels.

The heating/cooling, humidity and airflow systems are controlled through a programmable system located on the second floor in the mechanical room (301) and the boiler room (302). The systems are controlled by RTS controls and have night setback capabilities; however, the building operates 24 hours a day and therefore, no setbacks are programmed. Controls are limited to temperature, humidity and airflow settings. While most hot water lines are insulated, none of the hot water tanks were double insulated.

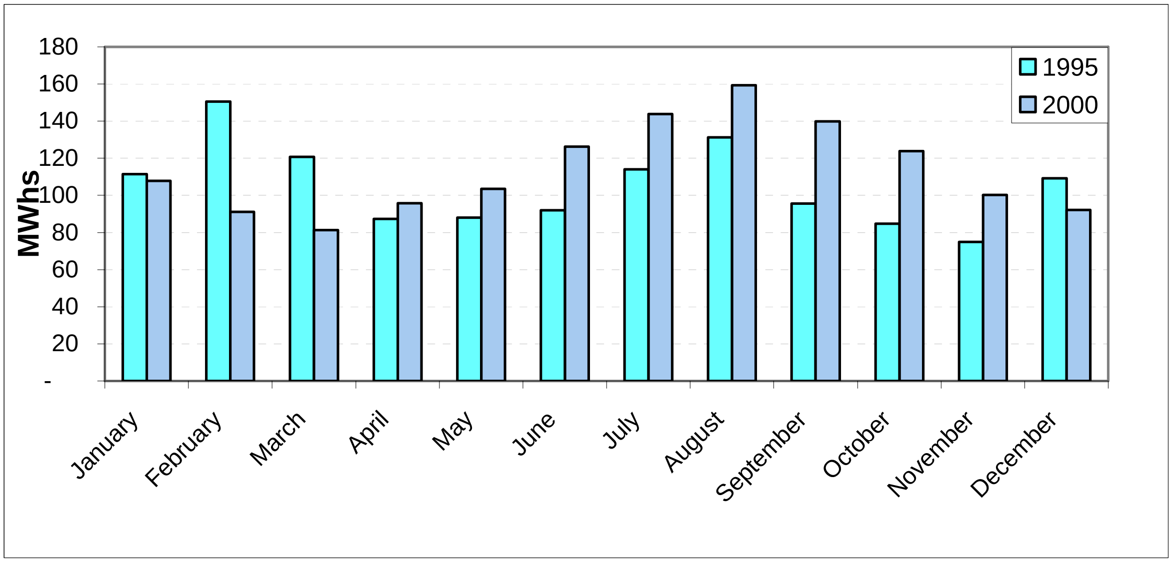
Staff have noted several energy needs and inefficiencies. Meeting rooms on the first floor are typically cold. Heat in the meeting room adjacent to the main foyer is supplemented by electric baseboard heaters. Garage heating has been problematic and inefficient. The original gas space-heater in the garage was often left on at the end of the day and the pilot light became problematic (often going out). Heating in the garage was supplemented by a larger tube gas-fired heater, however, the heater was noted by staff to be oversized for the space it is heating. The heater adjacent the exit doors on the west side was operating on high at the time of the site visit. There are plans to add a thermostat to the (west) exit door heater.

There is an extensive computer network present in the building that operates 24 hours a day. Some of the computers in the office have energy saving options and are turned off at night. However, many of the communication systems and computer are critical and are left on 24 hours a day. The telephone system in the building also operates on a low voltage system.

Electricity Use

Figure B2-3 illustrates the electricity use profile for the Police Station for 1995 and 2000. The Police Station ranks second overall with respect to overall electricity use and third for electricity use on a floor area basis. Notable peaks during the late summer and winter months indicate that electricity demand is also related to seasonal changes. Significant increases have been observed during the summer while winter months have experienced a slight decline. While some electricity demand is related to supporting gas fired boilers such as fans and pumps, some of the electrical demand in colder may be related to the supplemental electrical heating required in some parts of the building.

FIGURE B2-3
POLICE STATION ELECTRICITY USE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis. For example, due to the extended hours of operation of the building, some locations may benefit with the installation of dimmer switches where incandescent lights are present (main communications room). Moreover, eliminating lighting from the cola machine will provide opportunities for saving energy.
- The heating and ventilation system should be evaluated in the building to determine corrective measures required to reduce the amount of supplemental electrical heating required, if possible.
- Electric heaters and thermostats should be checked to ensure they are working properly.
- Insulate hot water tanks and associated piping.
- Based on more recent data after 2000, electricity and gas use should be re-evaluated in conjunction with the buildings operational settings to ensure optimal settings are being used.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads

to times where electricity may be cheaper and help identify maintenance issues requiring attention.

Other Recommendations

- Implementing gas sub-meters to assess usage by the garage heaters versus other equipment such as the boilers would assist in determining the distribution of gas demand.
- Develop an operating manual for the building that describes major systems; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.
- Installing a programmable thermostat in the garage will also help moderate temperatures. Good examples of controlling radiant gas tube heaters can be found at the shops in the Operations Centre and the newly constructed Landfill buildings.

Main Fire Hall (#1)

The building profile for Fire Hall #1 is listed in Table B2.6.

TABLE B2-6
MAIN FIRE HALL (#1) BUILDING PROFILE

Location	65 Vespra St.
Operational Profile	7 days/wk, 24 hours a day
Building History	Built in 1964
Operations Management	Peter Assistant Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating is achieved through the use of electric baseboard heaters and heating coils in the duct work. Cooling is provided in limited locations with air-conditioning window units in various offices. No programmable controls or setbacks for heating, cooling or lighting (building is always in operation) Parking lot lights are control with a timer
Lighting	
Main Floor	T-12 Fluorescent and Incandescent
1st /2nd/3rd Floor	Standard T-12 Fluorescent and Incandescent Lights
Basement	Standard T-12 Fluorescent and Incandescent Lights
Garage	Standard T-12 Fluorescent
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric baseboard and inline duct heaters

TABLE B2-6
MAIN FIRE HALL (#1) BUILDING PROFILE

Cooling	Two roof top units and at least 8 window units.
Air Compressor/ Pumps and Various Equipment	
Computers	24 hour computer and communication system with a UPS backup system
Emergency Generator	Diesel Generator
Hot Water Heating	Two electric hot water tanks for domestic use
Building Envelope	
Windows	Both new and old windows, most can be opened
Doorways	Main entrance and exit doors have no vestibule (double doors).
Meterage	
Electricity	One main meter for the building

The Main Fire Hall (#1) located on 65 Vespra St., was built in 1964 and is the oldest of the four Fire Halls. The building has been renovated several times; however, some aspects of the original building remain (i.e. windows). The building has three floors, a basement and a garage with a typical daily population of 20 to 30 people. The exterior of the building is mostly brick with narrow windows. Some of the windows have been replaced with new double paned windows. Most of the windows can be opened

The building used to be shared between the Fire Department and the Police Department and building was split into two separate offices. Currently, the Fire Department occupies the whole building and leases the third floor to a non-profit community organization, Recreational Social Vocational and Peer Support (RSVP). RSVP provides a community service to people in the community with special needs. RSVP will be moving into another facility in the spring. An additional space is leased to the Barrie Food Bank and is strictly used for food storage.

The staff noted several energy deficiencies and areas for improvement. The window in the Assistant Chief's office was found to lack proper sealing. In the winter, snow has drifted across the desk even with the window closed. In other offices, drafts near the windows have been noted. Insufficient sealing for both old and new window types were noted. Older windows are split into two sliding panels while newer windows have a single paned that tilts inside when opened. Most windows have blinds.

The majority of lighting consists of either standard four-foot fluorescent T-12 (34 Watt) bulbs or Incandescent bulbs. Most lighting is controlled on a room by room basis, while common areas are combined. Lights are replaced with regular standard bulbs as required. Lighting in one equipment room is controlled by a motion sensor as the equipment is light sensitive. The lunchroom has two light settings with 75 Watt R30 Type bulbs installed on a dimmer switch.

Office lights are turned on during the day and off at night, while the majority of other common working area lights remain on all day. There are no automatic or programmable switches or control settings for lighting or other appliances in certain areas. For example, switches in the main lunchroom and common area are manual and there are opportunities to leave lights and other appliances (i.e. television) on while the room is unoccupied. In the basement, the switch for the sauna was found to be on even though the switch is on a timer.

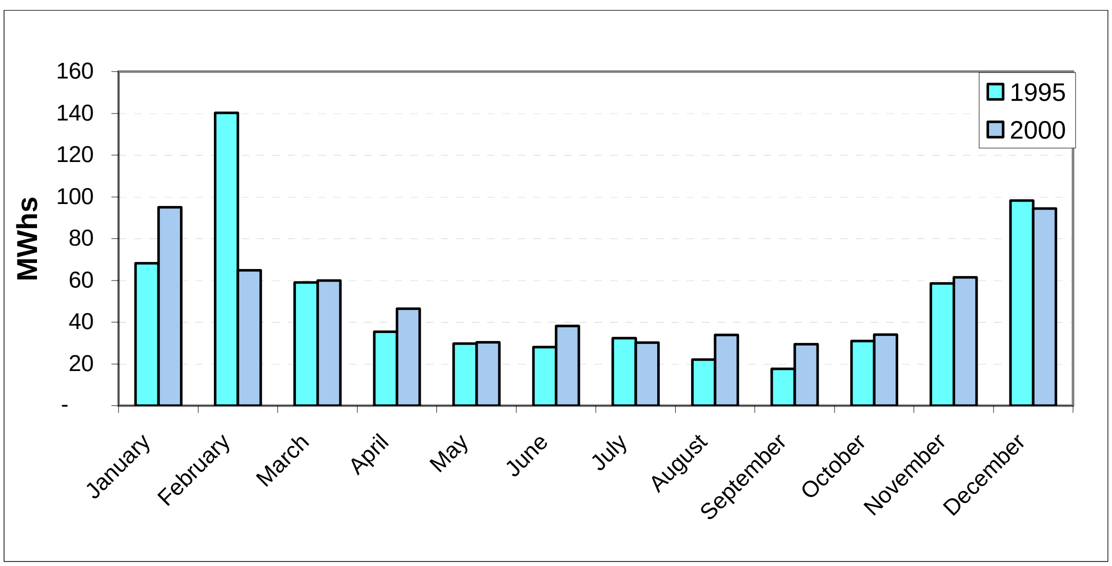
During the site visit, RSVP reported that the control settings for the heaters have been inoperable for some time. Many of the heat registers were very hot and several windows were left open as a means to control heat.

Heating in the building is strictly electrical with baseboard heaters and heating coils in the air ducts. In the garage, six electric heaters attached to posts and five ceiling mounted fans help circulate warm air throughout the garage. Cooling is achieved with at least 8 individual air conditioning window units and two roof top units.

Electricity Use

Figure B2-4 illustrates the electricity use profile for the Main Fire Hall for 1995 and 2000. The Main Fire Hall ranks fourth overall with respect to overall electricity use and fourth for electricity use on a per floor area basis. More then twice the amount of electricity demand during the winter months is a reflection of the Main Fire Hall reliance on electrical baseboards and inline duct heaters. Despite some renovations and upgrades to several exterior windows, the lack of sufficient sealing around windows and doors have provided little to no decrease in electricity demand.

FIGURE B2-4
MAIN FIRE HALL (NO.1) ELECTRICITY USE



Facility Recommendations

Currently, the City of Barrie is planning major renovations to the Main Fire Hall. In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations during there renovations:

- Install natural gas unit(s) to replace the present electrical heating system.
- Replace individual air conditioning window units with a centralized air conditioning system.
- Install a double door vestibule in the main entrance and improve the overall building envelope seal, such as, replacing the remaining old windows, improving seals around existing windows and adding insulation where possible.
- Replace older lights with newer energy efficient lights.
- Install gas and electrical sub-meters on each floor if tenants continue to occupy the building. Sub-meters will help determine load distribution in the building and ensure that tenants follow the same standards of energy conservation that the City of Barrie adopts.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations. and evaluate lighting requirements on an office by office basis. For example, due to the extended hours of operation of the building, some locations may benefit with the installation of dimmer switches where incandescent lights are present. Moreover, eliminating lighting from the cola machine, will provide opportunities for saving energy.
- Insulate hot water tanks and associated piping.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper and help identify maintenance issues requiring attention.

Other Recommendations

- Develop an operating manual for the building that describes major systems; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.
- Installing a programmable thermostat in the garage will also help moderate temperatures. Good examples of controlling radiant gas tube heaters can be found at the shops in the Operations Centre and the newly constructed Landfill buildings.

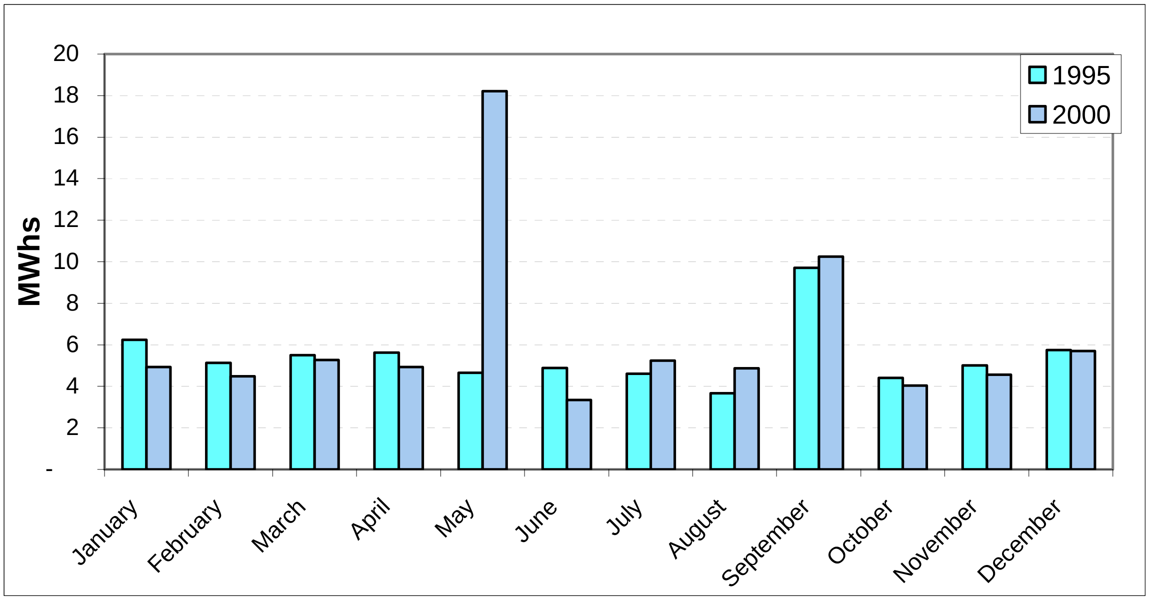
Fire Hall #2

Fire Hall #2, located at 15 Bell Farm Road, was originally built in the 1970s. The facility is currently under major renovation. Windows, doors and the interior of the building have been removed and replaced with new equipment (including a new furnace).

Electricity Use

Figure B2-5 illustrates the electricity use profile for the old Fire Hall No.2 for 1995 and 2000. Although Fire Hall #2 is a lesser electricity user in this module, an unexplained spike was observed in May 2000.

FIGURE B2-5
FIRE HALL NO. 2 ELECTRICITY USE



Fire Hall #3

The Building profile for Fire Hall #3 is provided in Table B2.7.

TABLE B2-7
FIRE HALL #3 BUILDING PROFILE

Location	340 Big Bay Point Road
Operational Profile	7 days/wk, 24 hours a day
Building History	Built in 1995
Operations Management	Peter Assistant Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating and Cooling are controlled by natural gas systems with thermostats. There are no programs or setbacks in place since the building is always in operation.
Lighting	
Main Floor	Standard T-12 Fluorescent
Garage	Standard T-12 Fluorescent and Mercury Vapour

TABLE B2-7
FIRE HALL #3 BUILDING PROFILE

Building Heating/Cooling/Air Flow and Ventilation	
Heating/Cooling	Heating and Cooling are controlled through a forced air system powered by natural gas (Lennox). One electric baseboard heater was noted in the bathroom of the basement.
Ventilation	The main building and garage have separate ventilation systems.
Air Compressor/ Pumps and various equipment	
Pollution Control System	Installed in the garage to control exhaust fumes from running trucks
Computers	24 hour computer and communication system with a UPS backup system
Compressor	Used to fill air (breathing) tanks
Emergency Generator	Diesel Generator
Hot Water Heating	One natural gas Hot water tank
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrance and exit doors have a vestibule (double doors).
Meterage	
Natural Gas	One main meter for the building
Electricity	One main meter for the building

Fire Hall #3 is located on 340 Big Bay Point Road and was built on 1995. This modern building has one main floor, a basement and an adjoining separated garage. The facility includes office space, a common room with a kitchen, another common room/sleeping area, an exercise room (basement), storage and a garage (~ 50% of the building). The building is occupied 24 hours a day with rotating shifts. Normally, a crew of approximately eight people occupy the building. The exterior of the building is brick with double paned glass sealed windows as well as two tall skylight towers that extend out of the garage and main building.

The majority of lighting consists of standard four-foot fluorescent T-12 (34 Watt) bulbs and a few PLs tube lights. Most lighting is controlled on a room by room basis, while common areas are combined. Lights are replaced with regular standard bulbs as required. Garage lights were originally mercury vapour lights; however, these lights were found to be insufficient and later supplemented by fluorescent lights. Lighting in one equipment room is controlled by a motion sensor since the equipment is light sensitive.

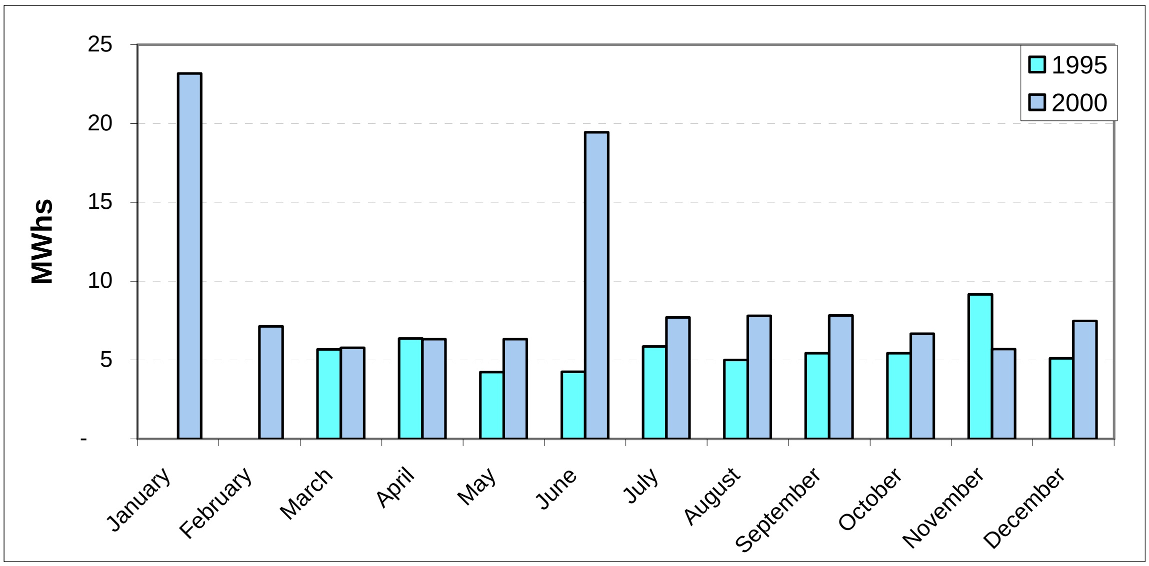
Office lights are turned on during the day and off at night, while the majority of other common working area lights remain on all day. There are no automatic or programmable switches or control settings for lighting or other appliances in certain areas. For example, switches in the main common area are manual and there are opportunities to leave lights and other appliances (i.e. television) on while the room is unoccupied.

Heating and Cooling are powered by a natural gas forced air system (Lennox). Separate ventilation systems exist for the office and garage. Visible air ducts were wrapped and insulated. All equipment is owned by the City of Barrie and maintained by the city and external contractor.

Electricity Use

Figure B2-6 illustrates the electricity use profile for Fire Hall No.3 for 1995 and 2000. Although Fire Hall No.3 is a lesser electricity user in this module, unexplained spikes in electricity use were observed in the months of January and June in 2000.

FIGURE B2-6
FIRE HALL NO.3 ELECTRICITY USE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations. Lights could be dimmed while supplemental natural light from skylights and windows increase during the day. Implement more task lighting in offices. Due to the extended hours of operation of the building and quick exists from the building during response to calls, appliances can be left turn on for long periods of time.
- Insulate hot water tanks and associated piping.
- Based on more recent data after 2000, electricity and gas use should be re-evaluated in conjunction with the buildings operational settings to ensure optimal settings are being used. The reasons for peak electricity use in January and June (2000) should also be determined to identify corrective actions required.

- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper and help identify maintenance issues requiring attention.

Other Recommendations

- Develop an operating manual for the building that describes major systems; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.
- Installing a programmable thermostat (with a timer) in the garage will also help moderate temperatures. Good examples of controlling radiant gas tube heaters can be found at the shops in the Operations Centre and the newly constructed Landfill buildings.

Fire Hall #4

The building profile for Fire Halls #4 is provided in Table B2-8.

TABLE B2-8
FIRE HALL #4 BUILDING PROFILE

Location	250 Ardagh Road
Operational Profile	7 days/wk, 24 hours a day
Building History	Built in 2000
Operations Management	Peter Assistant Mechanical Maintenance Superintendent
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating and Cooling are powered by natural gas systems and controlled by thermostats. There are no programs or setbacks in place since the building is always in operation.
Lighting	
Main Floor	Standard Fluorescent (T-12s) and T-8s
Garage	Standard Fluorescent (T-12s) and T-8s
Building Heating/Cooling/Air Flow and Ventilation	
Heating/Cooling	Heating and Cooling are controlled through a forced air system powered by natural gas (Hydro Therm furnace).
Ventilation	The main building and garage have separate ventilation systems.
Air Compressor/ Pumps and various equipment	
Pollution Control System	Installed in the garage to control exhaust fumes from running trucks (Lifebreath)
Computers	24 hour computer and communication system with a UPS backup system

TABLE B2-8
FIRE HALL #4 BUILDING PROFILE

Compressor	Used to fill air (breathing) tanks
Emergency Generator	Natural Gas Generator
Hot Water Heating	One natural gas Hot water tank for domestic use
Building Envelope	
Windows	All exterior windows are tinted, thermo, double-paned sealed units.
Doorways	Main entrance and exit doors have a vestibule (double doors).
Meterage	
Natural Gas	One main meter for the building
Electricity	One main meter for the building

Fire Hall #4 is located on 250 Ardagh Road and was built in 2000. Fire Hall #4 is the newest building in the Fire Department. The facility has only one main floor and includes office space, a common room with a kitchen, another common room/sleeping area, an exercise room, storage and a garage (~50% of the building). The layout of the building was based on other modern firehalls and designed by fire-fighters. The building is occupied 24 hours a day with rotating shifts (~8 people). The exterior of the building is brick with double paned glass sealed windows. Two back garage doors are made of insulated materials while the two front garage doors are made of plastic greenhouse panels.

The majority of lighting consists of standard four-foot fluorescent T-12 (34 Watt) and T-8 bulbs. Most lighting is controlled on a room by room basis, while common areas are combined. Lights are replaced with regular standard bulbs as required. Garage lighting is supplied by several rows of fluorescent; however, additional lighting from the garage bay doors can provide sufficient lighting at times. Lighting in one equipment room is controlled by a motion sensor since the equipment is light sensitive.

Office lights are turned on during the day and off at night, while the majority of other common working area lights remain on all day. There are no automatic or programmable switches or control settings for lighting or other appliances in certain areas. For example, switches in the main common area are manual and there are opportunities to leave lights and other appliances (i.e. television) on while the room is unoccupied. Furthermore, there are no automated systems to supplement natural lighting with artificial lighting in the garage.

Heating and Cooling are powered by a natural gas forced air system). Separate ventilation systems exist for the office and garage. All equipment is owned by the City of Barrie and maintained by the city and external contractor.

Electricity Use

Data not provided.

Facility Recommendations

- In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations. Lights could be dimmed while supplemental natural light from skylights and windows increase during the day. Implement more task lighting in offices. Due to the extended hours of operation of the building and quick exists from the building during response to calls, appliances can be left turn on for long periods of time.
- Insulate hot water tanks and associated piping.
- Based on more recent data after 2000, electricity and gas use should be re-evaluated in conjunction with the buildings operational settings to ensure optimal settings are being used.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in helping to identify maintenance issues requiring attention.

Other Recommendations

- Develop an operating manual for the building that describes major systems; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.
- Installing a programmable thermostat (with a timer) in the garage will also help moderate temperatures. Good examples of controlling radiant gas tube heaters can be found at the shops in the Operations Centre and the newly constructed Landfill buildings.

Dorian Parker Centre

The building profile for the Dorian Parker Centre is provided in Table B2-9.

TABLE B2-9
DORIAN PARKER CENTRE BUILDING PROFILE

Location	227 Sunnidale Road
Operational Profile	Limited Use / Occupancy in the Winter (twice a week, used by a singing group and other groups that rent the hall occasionally) Daily Use in the Summer
Building History	Approximately 40 to 50 years old, some minor renovations The Club House was originally built in 1930, conversion was completed in 1970.
Operations Management	Steve Harriman

TABLE B2-9
DORIAN PARKER CENTRE BUILDING PROFILE

Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating is accomplished with a natural gas furnace (main hall only) and electric baseboard and space heaters. There is no air conditioning available in the building. There are no programmable settings for the furnace.
Lighting	
Main Floor	Standard Fluorescent T-12s
Exterior Lights	Controlled by a timer, exterior building lights only
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Heating controlled through a forced air system powered by natural gas in the Main Hall Kitchen, meeting rooms and storage heated with electric heaters
Ventilation	Roof vents and windows
Other Equipment	
Hot Water Tanks	Two older gas fired hot water heaters provide hot water for domestic use in the building
Building Envelope	
Windows	Both single (meeting rooms)and double paned glass (main hall)
Doors	Steel doors
Meterage	
Natural Gas	One main meter for the building
Electricity	One main meter for the building

The Dorian Parker Centre, previously a club house for the golf course, is a community centre with a main hall, meetings rooms, storage rooms, a bar, washrooms and a kitchen on one main floor. The electrical room and furnace are located in the basement. The building is between 40 and 50 years old and has not undergone any major renovations. The last addition/conversion was completed in 1970. The Dorian Parker Centre is used almost daily in the summer by the public while in the winter; the building is only used two or three times a week on average. The building is used regularly by a choir for practice and rented occasionally by the public for events.

The building envelope includes brick, single and double paned glass (Main Hall) windows and several metal exit doors. Most of the windows can be opened. In some locations, the weather striping was missing around windows and doors, leaving small gaps to the outside. In the main hall, the windows have blinds while other windows remain uncovered. Meeting room doors are typically left closed and locked and air exchange between the main hall and adjacent rooms appear to be limited.

Lighting consists of T-12 fluorescent fixtures, which typically remain off during the day unless there is an event. Exterior building lighting is controlled with a timer.

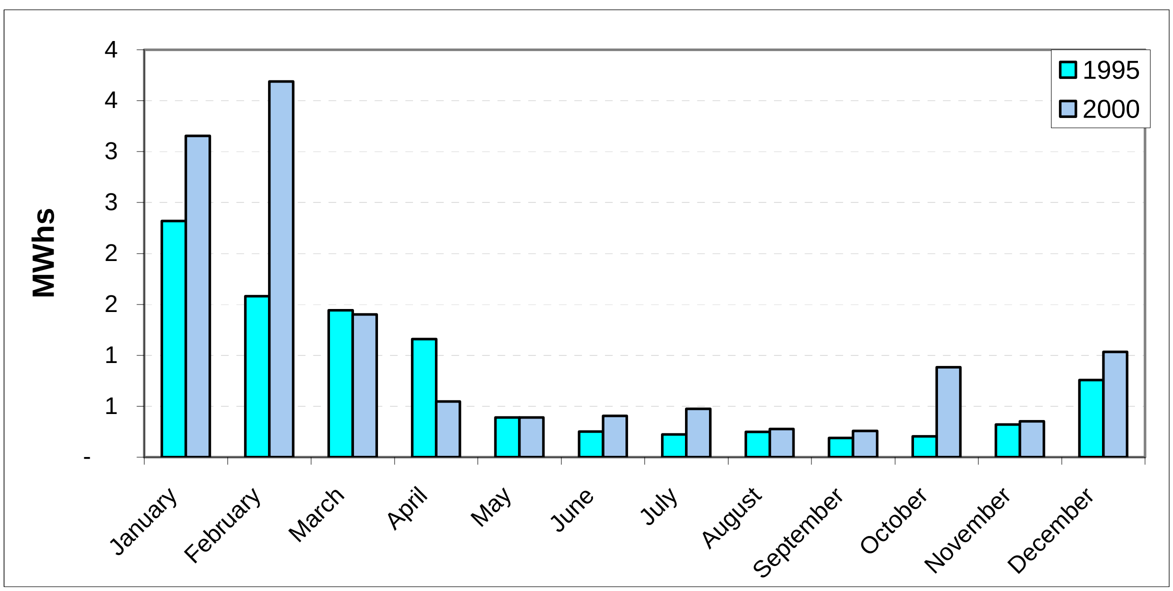
Heating in the main hall is provided by a natural gas furnace in the basement and controlled through a thermostat (non-programmable). Adjacent rooms, such as the kitchen and meeting rooms are supplied with electrical heat and manual controls. Only some of the thermostats have locked boxes. Renters that adjust temperatures are instructed to turn down thermostats and fridges off after using the facilities. However, renters sometime leave appliances on and thermostats set high. Typically the building is kept at 20 degrees Celsius to help prevent pipes freezing in the winter. In the summer, the building is notably hotter and windows are left open since there is no air conditioning. John Verbeka, with the City of Barrie, makes routine visits to the building to check systems and make repairs.

Other major equipment in the building includes electric fridges (bar and kitchen), a gas stove and two gas hot water heaters. All appliances appeared to be original and older models. At the time of the site visit, the bar fridge door didn't close properly and several appliances appeared to be running (fridges were on with their temperature settings on low).

Electricity Use

Figure B2-7 illustrates the electricity use profile for the Dorian Parker Centre for 1995 and 2000. The Dorian Parker is one of smaller electricity users discussed in this Module, however, it is important to note the sharp rise in electricity usage during the winter. Electricity demand is highly dependent upon events scheduled at the facility. Sharp increases in electricity use from 1995 to 2000 during the winter may be a reflection of both increased use of the facility and the deterioration of weather stripping around windows and doors. During the summer, electricity use is minimal as no air conditioning system has been installed in the building.

FIGURE B2-7
DORIAN PARKER CENTRE ELECTRICITY USE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Develop a lighting/energy saving strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations. For example, ensure blinds are used to cover windows while the facility is not in use. Moreover, all interior doors should be left open during the winter months to improve air circulation and increase the range of gas heating during the winter months.
- Insulate hot water tanks and associated piping.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands during the winter months. Establishing this detailed baseline of electricity use will assist in identify maintenance issues requiring attention and reduce the chance of having appliances running and elevated thermostat settings while the building is unoccupied.

Other Recommendations

Future renovations should include the improvement of the building envelope and include more insulation and more energy saving doors and windows.

Develop an operating manual for the building that describes major systems present; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.

Renters should be advised of the proper use of the facility heating/cooling system and given operating instructions to follow while the facility is in use as well as a check list of items to address when they leave. For example, thermostats settings should be specified.

Lampman Lane Community Centre

The building profile for the Lampman Lane Community Centre is listed in Table B2-10.

TABLE B2-10
LAMPMAN LANE COMMUNITY CENTRE BUILDING PROFILE

Location	59 Lampman Lane
Operational Profile	Monday to Thursday 4:30 to 8 PM, Saturday 9:00 AM to 12:00 PM Extended hours in the Summer when the Pool is open
Building History	Built in 1983 as an addition to the school already present
Operations Management	Steve Harriman
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating/Cooling is accomplished with two roof top natural gas units (on separate meters – one for maintained by the city and the other by the school), electric heaters and a natural gas boiler (hot water loop). There are no programmable settings for the lighting or heating systems.

TABLE B2-10
LAMPMAN LANE COMMUNITY CENTRE BUILDING PROFILE

Lighting	
Main Floor	Standard Fluorescent T-12s
Exterior Lights	Controlled by a timer, exterior building lights only
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Both natural gas roof top units and electric baseboard units are present. Perimeter heating is provided by a hot water loop.
Ventilation	Roof vents and windows
Other Equipment	
Hot Water Heater	One natural gas hot water heater in the mechanical room supplies hot water for domestic use in the building. Another hot water heater located in an outside shed is associated with the outside pool and operates during the summer.
Building Envelope	
Windows	Double thermo paned glass, most windows can open
Doors	Double door vestibule at the main entrance
Meterage	
Gas	One main meter for the building
Electricity	One main meter for the building

The Lampman Lane Community Centre was built in 1983 as an extension to an existing school. The facility has a main lobby, offices, kitchen/storage room, a classroom, an outside pool, change rooms/washrooms and shares the gymnasium with the school. All equipment in the building is original and no major renovations have been completed.

In the winter months, the building is used in the morning as a childcare centre and in the evening as an activity centre. In the summer, the exterior pool opens and building hours are extended during the day (summer day camps and swimming programs).

The building is heated and cooled with natural gas roof top units. Supplemental heat is provided by electric heaters and a hot water loop that provides perimeter heating. Natural gas is also used to heat water for domestic use as well as heat pool water (from Jun to August). The water heater for the pool is located in a separate room that was not accessible during the building site visit. None of the thermostats are programmable and most were accessible by the public (no lock boxes). The building was found to be above 25°C during the site visit.

Two rooftop units are used to heat the school and Lampman Lane Community Centre. One roof top unit is maintained by the city while the other is maintained by the school (metered separately). The overall gas consumption of the building used to be estimated up to the end of September 2003 until Enbridge switched to basing gas consumption on actual readings. Prior estimated gas consumption was underestimated, resulting in a spike of $4,000 in the cost of operating the building.

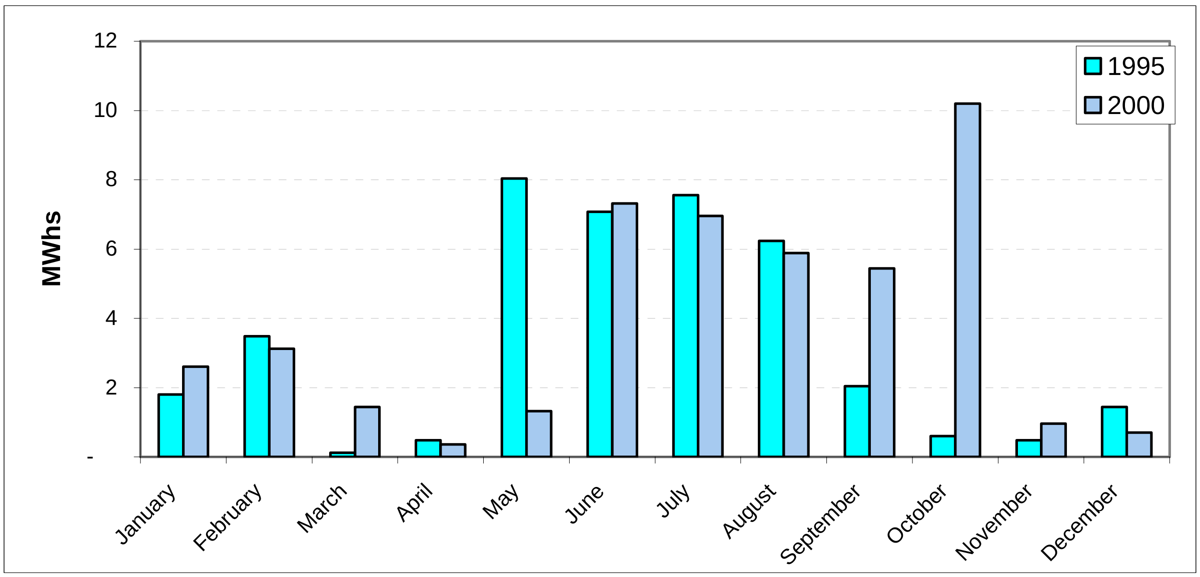
The majority of lighting in the building was T-12 fluorescent fixtures as well as some incandescent fixtures. Lights are turned off during the day when the building is not in use. Exterior lights are controlled with a timer.

All exterior windows were double paned and tinted glass. The windows in the foyer were sealed units while many of the windows in the classrooms and offices could be opened. The main entrance was a double door vestibule heated with an electric heater.

Electricity Use

Figure B2-8 illustrates the electricity use profile for the Lampman Lane Community Centre for 1995 and 2000. Lampman Lane is one of smaller electricity users discussed in this Module, however, it is important to note the sharp rise in electricity usage during the summer months. Electricity demand is highly dependent upon the extended working hours of the facility during the summer while children are out of school. Winter operating hours are limited to daycare and evening classes. Sharp increases in electricity use in May 1995 and October 2000 may be a reflection of both increased use of the facility and scheduled events.

FIGURE B2-8
LAMPMAN COMMUNITY CENTRE ELECTRICITY USE



Facility Recommendations

- In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:
- Develop a lighting/energy saving strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands during the winter months. Establishing this detailed baseline of electricity use will assist in identify maintenance issues requiring attention

and reduce the chance of having appliances running and elevated thermostat settings while the building is unoccupied.

Other Recommendations

- Develop an operating manual for the building that describes major systems present; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies. This operating manual should be written in a manner that is easily understood and followed by support staff that is present at the facility everyday.

Southshore Community Centre

The building profile for the Southshore Commuity Centre is provided in Table B2.11.

TABLE B2-11
SOUTHSHORE COMMUNITY CENTRE BUILDING PROFILE

Location	205 Lakeshore Road
Operational Profile	8:30 to 4:30, 6 days a week (Winter) Weekend schedule may vary, extended hours during summer.
Building History	The original building used to be an old mechanical building for CN Rail is over 100 years old. A new addition was constructed in 1995 (Main Hall).
Operations Management	Steve Harriman
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating/Cooling in the new addition is accomplished with three roof top units and an additional three units in the basement. All units and several appliances operate on Propane (not natural gas). Supplemental heat in the old building is electrical. There are no programmable settings for the lighting or heating systems.
Lighting	
Main Foyer	Incandescent (150 Watt and Metalarc bulbs)
Offices / Washrooms	Standard Fluorescent T-12s and Incandescent
Kitchen	Standard Fluorescent T-12s
Lower Level	Standard Fluorescent T-12s
Exterior Lights	Controlled by a timer, exterior building lights only
Building Heating/Cooling/Air Flow and Ventilation	
Heating	6 Propane (York) units (3 rooftop and 3 basement units)
Ventilation	New ducting mostly in the new addition and kitchen
Other Equipment	
Hot Water Heater	One propane hot water heater in the mechanical room supplies hot water for domestic use in the building
Stove	Propane stove in the kitchen for cooking
Fridges	Electric

TABLE B2-11
SOUTHSHORE COMMUNITY CENTRE BUILDING PROFILE

Building Envelope	
Windows	Double thermo paned glass in main hall, original single paned glass windows in older part of the building
Doors	Double door vestibule at the main entrance, Garage Doors in the lower level
Meterage	
Propane	No meter, fill tank as required.
Electricity	One main meter for the building

The Southshore Community Centre is mix of old and new architecture. The original stone building used to be an old mechanical building used by CN Rail. In 1995, the building was renovated and a new addition was built, creating a large main hall made of glass. The older building has two floors and is currently used for office space, washrooms, a kitchen and a front foyer. The new addition faces the waterfront and has two floors as well. The main hall is on the main floor and has high ceilings, panoramic double glass windows overlooking the water and a skylight. The use of the lower level of the new addition is split between the local canoeing and rowing clubs. Two large storage areas house equipment; there is a exercise lounge area and a work shop. The Rotary Club uses the main hall for meetings on a weekly basis. On average, the main hall is also rented four times a week for various activities. The Barrie tourist information office occupies the offices on the main floor.

The building envelop consists of double paned sealed glass units and new building materials in the new addition while the older portion of the building still has the original single paned windows. The main entrance has been enclosed to provide a double door vestibule. Windows in the main hall have two blinds, a sun screen and a cover. The skylight in the main hall also has a blind that is usually closed. Garage doors provide access to the waterfront in both equipment storage rooms.

Heating/Cooling for the new addition is provided by three roof-top unit and three basement units that run on propane. The three roof top units provide heat to the main hall and offices while the basement offices provide heat for the lower and level and offices. Supplemental heating in the older portion of the building is provided by electric heaters. A space heater as well as an inline duct heater was observed in the lower level of the new addition.

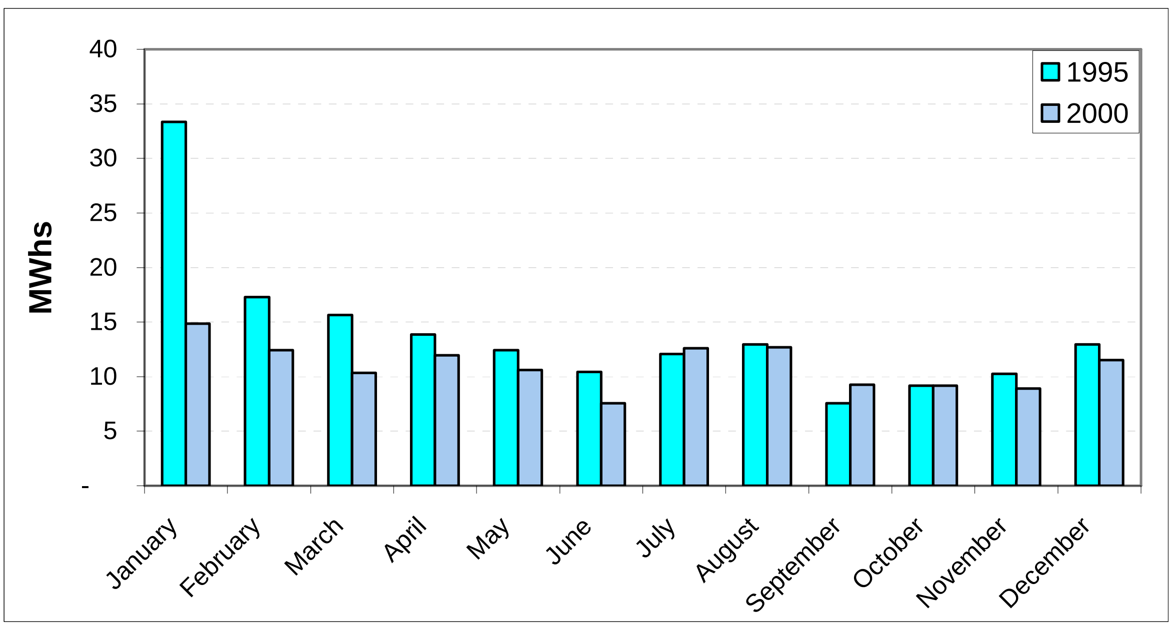
The building operating temperature is usually set at 25 degrees Celsius. During the site visit, the offices were notably warmer with thermostats set above room temperature. Employees are instructed to turn temperatures down at the end of the day to approximately 18 degrees Celsius. Although the exercise room and shops are used on a regular basis at night and on weekends, the temperature of the shops and equipment storage areas are kept at approximately 15 degrees Celsius unless the temperature is adjusted by occupants. Renters often adjust thermostats in the main hall during events as well and city staff routinely check and readjust temperature settings.

Lighting in the building is a mixture of fluorescent and incandescent fixtures. The main foyer, hall way and main hall have large incandescent lights as well as PL tubes (13 Watt). Two types of incandescent bulbs are used, 150 Watt and Metalarc bulbs. Fluorescent T-12 fixtures are found in the offices, kitchen and most areas in the lower levels of the new addition. Exterior building lights are control by a timer while parking lot lights are tied into street lighting.

Electricity Use

Figure B2-9 illustrates the electricity use profile for the Southshore Community Centre for 1995 and 2000. The Southshore Community Centre ranks seventh overall with respect to overall electricity use and sixth for electricity use on a floor area basis. Electricity demand appears to remain stable through out the year and consistent between years. However, an unexplained peak has been observed, notably in January 1995. This peak may be the result of building construction which was completing at approximately the same time. While the electricity use profile appears to reflect a consistent operating procedure, variations in use may be explained with occasional events that are held at the facility. While some areas of the building have supplemental electric heating, improvements in the building exterior may have resulted in some of the declines in electricity use observed in 2000.

FIGURE B2-9
SOUTHSHORE COMMUNITY CENTRE ELECTRICITY USE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Develop a lighting/energy saving strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations.

For example, ensure blinds are used to cover windows (and skylights) while the facility is not in use.

- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands during the winter months. Establishing this detailed baseline of electricity use will assist in identify maintenance issues requiring attention and reduce the chance of having appliances running and elevated thermostat settings while the building is unoccupied.
- Insulate hot water tanks and associated piping.

Other Recommendations

Future renovations should include the improvement of the building envelope and include more insulation and more energy saving doors and windows.

Develop an operating manual for the building that describes major systems present; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies. This operating manual should be written in a manner that is easily understood and followed by support staff that is present at the facility everyday.

Renters should be advised of the proper use of the facility heating/cooling system and given operating instructions to follow while the facility is in use as well as a check list of items to address when they leave. For example, thermostat settings should be specified.

Parkview Seniors Centre

The building profile for the Parkview Seniors Centre is provided in Table B2.12.

TABLE B2-12
PARKVIEW SENIORS CENTRE BUILDING PROFILE

Location	189 Blake Street
Operational Profile	8:30 to 9:30 PM Sunday to Friday with the occasional Saturday
Building History	The original building is over 100 years old. The first addition was added in 1974 and the second addition was added in 1989. Several renovations have been completed and several more are required and are being planned.
Operations Management	Steve Harriman
Energy Budgeting & Payment	Facility Supervisor
Building Energy Management System	Heating/Cooling in the building is provided by five natural gas units located in the basement and supplemented by electric baseboard heaters (mainly in the older part of the building)
Lighting	
Main Foyer	Standard Fluorescent T-12s and Incandescent
Offices / Washrooms	Standard Fluorescent T-12s
Kitchen / Upper Level Activity Room	Standard Fluorescent T-12s

TABLE B2-12
PARKVIEW SENIORS CENTRE BUILDING PROFILE

Lower Level Activity Room (Secondary Kitchen)	Standard Fluorescent T-12s and Incandescent
Library and Sitting Room (Secondary Kitchen)	Standard Fluorescent T-12s
Exterior Lights	Controlled by a timer, exterior building lights only. The Gazebo has a motion detector for security reasons
Building Heating/Cooling/Air Flow and Ventilation	
Heating	5 natural gas units as well as supplement electric baseboard heaters. Cooling? 4 units or 2 AC units?
Ventilation	New ducting mostly in the new addition, ceiling fans help circulate air in the older portion of the building.
Other Equipment	
Hot Water Heaters	One natural gas and one electric hot water heater in the mechanical room in the basement supplies hot water for domestic use in the building
Hydraulic Elevator	Connects the main entrance with the main floor and basement.
Stove, Fridges, Dishwasher	In total, there are three electric stoves, four electric fridges and a dishwasher in the kitchens and sub kitchens.
Building Envelope	
Windows	Double thermo paned glass in main hall, original single paned glass windows in older part of the building
Doors	Single doors at the main entrance, open to the main building. Some exit doors lack weather stripping
Meterage	
Natural Gas	One main meter for the building
Electricity	One main meter for the building

The Parkview Senior Centre provides a meeting and activity center for local senior citizens. The original building is over 100 years old. The building has an upper and lower level. The upper level has offices, a library, an activity room, a kitchen, washrooms and library/sitting room with an additional sub kitchen. The lower level has another activity room, storage rooms, washrooms and a small kitchenette. A first addition was first added in 1974 with a second addition following in 1989 along with several renovations have been completed over the years on the building. Currently, the roof in the older building (over the library and sitting room) has poor insulation, several beams are rotten and ceiling leaks are a common occurrence. There are plans to fix the roof; however, the attic must be cleared of old insulation and bat/bird droppings before the contractor will begin repairs.

The centre operates on a regular schedule of activities for the seniors. On average, the halls are rented twice a month for events. Building staff are always present when the building is open, even when the hall is rented.

The main entrance is a circular vestibule with a single set of doors and a high ceiling (with skylights). The main entrance provides direct access to the hydraulic elevator and to the upper and lower levels. Personal have noted that since the main entrance is open to the entire building, employees find areas near the main foyer cold at times. An exit door close to the main desk also lacked proper weather stripping. Windows in the older portion of the building are original single paned glass while the new addition has double paned glass. Several patrons mentioned that the older part of the building was often cooler, especially in the reading room area. Most windows had blinds or other window coverings.

Heating for the building is provided by five natural gas furnaces located in a utility room in the basement. An electric air conditioning unit (manual controls) was noted in the ceiling of the upper level activity room. Building management maintains strict enforcement of thermostat settings and building operations. Most thermostats and control settings were found to have locked boxes. Window handles were also removed where possible to provide unauthorized opening. Thermostats were set at 22 degrees Celsius at the time of the site visit. Thermostats also have programmable day and night time settings. An "IFC Fuel Saver" meter was observed during the site visit; however, the exact purpose and operation of the meter was unknown by the building management.

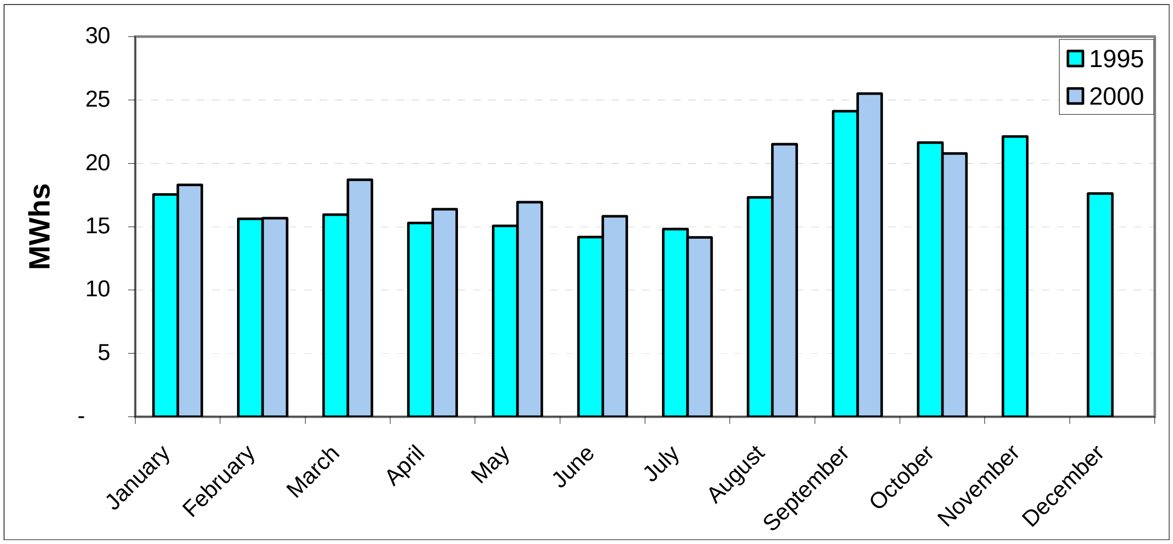
Other equipment in the building includes one natural gas hot water heater and one electric hot water heater located in the basement (domestic use). A coke machine with a lighted sign is situated in the main entrance. The main kitchen and sub kitchens have electric refrigerators that continually operate. The main kitchen and one sub kitchen also have electric stoves. A small compressor located in another utility room services the hydraulic elevator.

The majority of lighting in the building consists of fluorescent T-12 fixtures and some incandescent fixtures (main desk). During the day, natural light in the upper and lower activity rooms is sufficient and supplemental lighting is not required. Lights are turned off by staff at the end of the day. External lights are controlled by a timer. The gazebo has a motion detector for lighting due to security reasons.

Electricity Use

Figure B2-10 illustrates the electricity use profile for the Parkview Seniors Centre for 1995 and 2000. The Parkview Seniors Centre ranks sixth overall with respect to overall electricity use and fifth for electricity use on a floor area basis. Electricity demand appears to remain stable from January to July with increasing usage near the end of the year. This increase in electricity use from August to November may be a reflection of an increase in activities scheduled at the seniors centre as well as air conditioning. The months of October and November may also see the use of air conditioning and heating in the same day. The consistent electricity use profiles of 1995 and 2000 may also be a reflection of the strict control over regular operations.

FIGURE B2-10
PARKVIEW SENIORS CENTRE ELECTRICITY USE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Although thermostat settings are strictly enforced, it may be possible to reduce and optimize thermostat settings. Although the building operates on an extended schedule from time to time, night set backs are still possible. Staff were unaware if the night setbacks are functioning and what the settings actually were.
- Develop a lighting/energy saving strategy for the building. Install automatic sensors or timers in certain locations to turn lights and appliances on and off in certain locations. For example, ensure blinds are used to cover windows (activity rooms) while the facility is not in use.
- Daily meter readings should be incorporated into routine tasks as well as increased observation of peak demands during the winter months. Establishing this detailed baseline of electricity use will assist in identify maintenance issues requiring attention, reduce the chance of having appliances running and elevated thermostat settings while the building is unoccupied.
- Insulate hot water tanks and associated piping.

Other Recommendations

- Future renovations should include the improvement of the building envelope and include more insulation and more energy saving doors and windows. Current plans focus on insulating the attic in the older portion of the building and replacing the roof. Ideally, the main entrance of the facility may be another area to consider for renovations. Currently, the entrance has a single set of doors and an elevated ceiling. As a result, staff at the front has commented on the “draftiness” that the main foyer creates at the front desk. It may be possible to install a second set of doors in the main foyer and in effect, create a separate vestibule. Moreover, weather-stripping on doors and windows should also be addressed

- Develop an operating manual for the building that describes major systems present; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies. This operating manual should be written in a manner that is easily understood and followed by support staff that is present at the facility everyday. For example, staff were unsure of how may rooftop units are present at the facility and what the function was of the "IFC" Fuel Saver meter.

Operations Centre

The building profile for the Operations Centre is listed in Table B2-13.

TABLE B2-13
OPERATIONS CENTRE BUILDING PROFILE

Location	165 Ferndale Dr.
Operational Profile	7:30AM to 4:00PM, Monday to Friday with extended hours as required (winter plowing)
Building History	Built in 1973, no major renovations have been conducted
Operations Management	Dana
Energy Budgeting & Payment	Not Available
Building Energy Management System	Heating/Cooling in offices and garage are natural gas and supplemented with some electrical baseboard heaters, inline duct heaters and air conditioning window units. Controls are present; however, the programmable settings are used. The building is maintained at a constant temperature due to poor insulation. Some lighting controls present.
Lighting	
Greenhouses	Fluorescent and growing lamps
Vehicle Repair and Garages	Ceiling mounted Fluorescent fixtures (ranging 4 to10 feet) and 35 - 400 Watt metal halide lights Workbench fluorescent lighting
Offices (2nd Floor) Including lunch and meeting rooms	Standard fluorescent fixtures with some incandescent spot lighting. Many lights previously controlled by breakers have been isolated to switches. Previous attempts to automate light switches have been problematic. Only washrooms have operating motion detector light switches.
Exterior Lights	Operated by Timers
Building Heating/Cooling/Air Flow and Ventilation	
Roof Top Units	10 roof top natural gas units (ranging from 3 to 10 ton) provide heating and cooling needs for the offices on the second floor

TABLE B2-13
OPERATIONS CENTRE BUILDING PROFILE

Electric InLine Duct Heaters and Baseboard Heaters	6 In-Line duct heaters are present in the main offices. These units are not used often according to maintenance staff. Baseboard heaters, which were present before the gas units were installed, are used occasionally to provide supplemental heat.
Garage	Garage, shops and vehicle repair have natural gas tube heaters (58 individual units in total). Tube heaters are controlled individually by thermostats set by employees. Fans on the ceiling help redistribute the heat. No cooling is provided for the garages.
Garage and other Offices	Some of the offices located in the garage have their own space heaters and window air conditioning units. The meter shop has a 80,000 BTU gas space heater.
Greenhouses	12 Natural Gas space heaters (80,000 BTU each) supply heat to the 4 greenhouses
Air Compressor/ Pumps and Various Equipment	
Emissions Tester	The City of Barrie has its own emissions tester for City Vehicles
Wash Bay Water Heater	A wash bay water heater, powered by natural gas, instantly heats water for the wash bay
Fans and Blowers	The greenhouses have several fans/blowers to help distribute the heat evenly and provide ventilation in the summer.
Appliances and Power Tools	Various power tools, compressors, welding machines, vehicle hoists and a vehicle emissions tester in the shops Fridges, stove, microwave and vending machines in the lunch rooms
4 Hot Water Heaters	2 old hot water natural gas heaters (one 80L and one 120L, original equipment) still operate and provide hot water to the service bays. One new (5+ years old) and one old (30 years old) hot water natural gas heaters supply hot water for domestic use to the washrooms, lunchrooms and other areas.
Emergency Generator	One diesel generator
Building Envelope	
Windows	Office windows are mostly double paned, greenhouses are single paned.
Doorways	The main public entrance has a double set of doors.
Garage Bay Doors	Old doors have been replaced with new doors as required. Many of the older doors that are still in place have holes and cracks. While the older doors allowed a lot of light into the bays, the new doors are insulated and have limited windows.
Walls and Roof	The majority (approximately 90 %) of the building exterior is sheet metal and/or concrete cinder block. The garage bays and shops do not have insulation and other office exterior walls have poor insulation.
Meterage	
Gas	One meter for the entire facility
Electricity	One meter for the entire facility

The Operations Centre, built in 1973, is a large facility that provides a multitude functions for the City of Barrie. The main building currently includes four greenhouses which grow plants for all the city parks, the Parks and Recreation offices, garages and working areas; a city vehicle repair and maintenance shop (including a welding shop and wash bays); vehicle storage bays; the main city's stores and supplies; a meter shop (maintains and services parking and transit meters); administration offices; washrooms; common areas as well as other support facilities (surveying office, traffic office, signage room, water department offices). A newly constructed separate building was constructed in 2003 for additional vehicle and materials storage.

The main building has not undergone any major renovations but several smaller renovations have been completed over the years. Approximately 100 employees work at the facility throughout the year with an additional 40 seasonal workers in the summer. The building typically operates from 7:30AM to 4:00PM; however, these hours may be extended in the winter when plowing is required.

The main building and adjacent facilities lack insulation for the most part. The greenhouses are constructed of single panes of glass which are not sealed together. Large fans, with freely moving louvers, are situated at the end of the greenhouses to provide ventilation. During the winter, the heat is quickly lost through gaps in the frame and the fans. In the summer, the greenhouses become extremely hot and ceiling vents are opened. The main operations building has a total of 78 garage doors which have been an area of continual maintenance and improvement. Several garage doors have been systematically replaced with new doors as they have been damaged or failed. All the bay doors are controlled separately with electric motors but many fail to fully seal when they are closed. Insulation along the ceiling of the garages is minimal and there is no insulation along most of the walls. Many of the old doors still in operation have holes or cracks. For the most part, offices are isolated from the garages and shops; however, the supplies store provides open exchange of air from the lower level and the loading dock bays. All exterior office windows are double paned and can be opened. Staff noted that offices with windows can be drafty depending on the direction of prevailing winds. The newly constructed vehicle and materials storage building is not heated nor is it insulated. The main public entrance does have a double door vestibule. Some of the exterior windows have been replaced with double paned glass and most can be opened.

Heating/Cooling for the facility includes both natural gas and electrical units. The four greenhouses are separate from the main building and are heated with twelve natural gas space heaters (80,000 BTUs/2 per greenhouse). The greenhouses are operated throughout the year, especially in preparation for the spring propagation of flowering plants for the city's 80 parks. A total of 58 tube natural gas heaters provide heat for the garages, shops and vehicle bays. Tube heaters, some of which are 17 years old, were installed to replace older less effective ceiling mounted space heaters. Although not connected or in service, all the old space heaters are still in place. All tube heaters are controlled with their own thermostats that can be access by any employee and adjusted as required. Tube heaters operate but super heating outside air and blowing the hot air and exhaust through the tube until it eventually vents to the outside. Garages also have ceiling fans to help circulate air and distribute heat. Temperatures are usually maintained between 17 and 19 degrees Celsius. Note that all fire extinguishers in the vehicle service and storage bays are dry systems.

Ten roof top natural gas units, ranging from 3 to 10 tonne units, provide heating and cooling for the offices. Controls are present for the rooftop units but programs and settings have not been implemented due to the lack of insulation in the building. Constant temperatures are set during the winter to prevent the freezing of water pipes. Furthermore, due to the possibility of extended operating hours (plowing during the winter), night time setbacks make it difficult to adjust temperature in the building comfortably. Most offices have individual thermostats that are located in the ceiling and are only adjusted by maintenance staff.

Currently, several offices are vacant (previously United Way office), however, the heating systems (2 roof top units) can not be isolated since they service other parts of the building that are occupied. Due to several office changes over the last few years, several offices on the second floor that were previously split are now open. As a result, separate roof top units now service the same office space and in some cases, influence each others' thermostat settings. For example, one roof top unit's heating cycle may cause another roof top unit to enter a cooling cycle. Staff currently monitors thermostat settings on a daily basis to ensure a balance exists between roof top units; however, changes in outside temperatures can easily upset this balance. Some offices on the first and second floor (fleet supervisor) are serviced by separate units. Electric baseboards are still present in some offices (fleet supervisor) and common areas (lunch room) but they are no longer in use or used sporadically when there are extreme outside temperatures.

A variety of lighting exists in the building, including fluorescent fixtures, incandescent and 400 watt metal halide lamps. In the greenhouses, fluorescent light fixtures T-12 and growing lamps provide additional lighting during the shorter winter daylight hours to propagate plants. Lights are controlled manually; however, some growing benches have timers. Many of the workshops are lighted with ceiling fluorescent fixtures that range from 4 to 10 feet long. For the past five years, bulbs have been replaced with new Duratest™ full spectrum bulbs. The newer bulbs also have less mercury. During the site visit, many of the common areas and offices were very bright. In the garages and shops, fluorescent and 400 Watt Metal Halide light fixtures are used. The majority of fixtures are located on the ceiling with the exception of workbench lights. Offices are mostly fluorescent fixtures with some incandescent spot lighting. Some lighting has been decreased in offices to reduce glare on computer screens. At night, employees are instructed to turn off all day lights. In the garages, workbench lights are let on to provide night time lighting.

Previous attempts to implement lighting controls have been made with varying success. In the common areas, the contacts in costly motion detectors that were installed in the lunch room fused together and failed to operate after a period of time. Lights were also found to burn out much more quickly. Motion detectors located in the washrooms on the second floor are still operating correctly. Since Dana began overseeing maintenance and operation of the facility, many lights previously controlled at the breaker box have been isolated on wall switches. In many places contacts exist were timers or controls can be installed if required. For example, the washbay has limited lighting; however, additional lighting is available when a timer is set (one hour max.)

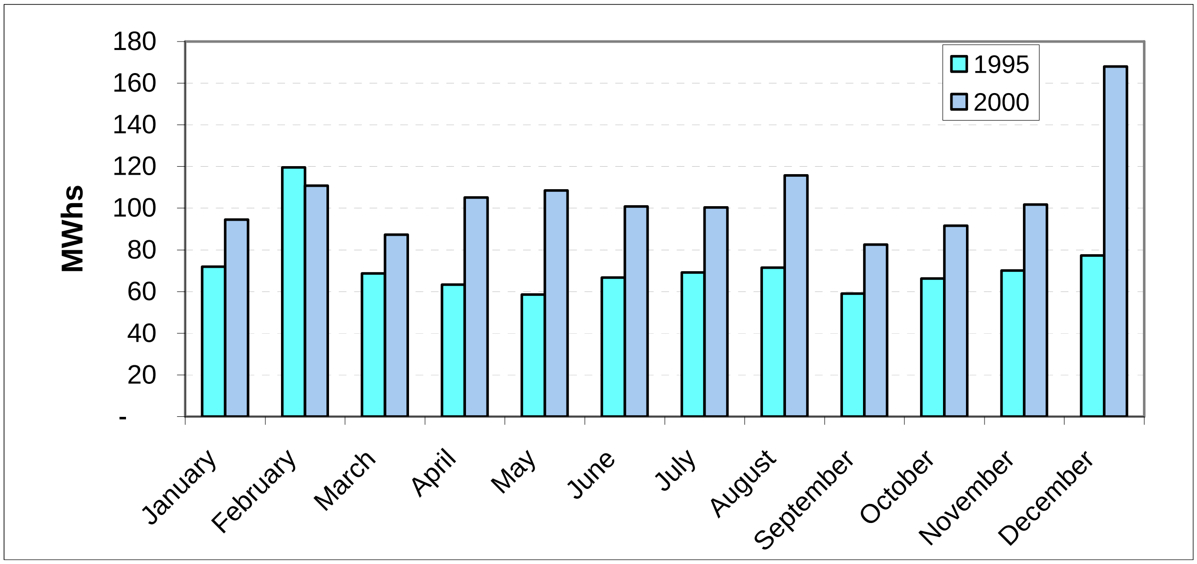
Other major equipment includes a pollution control system for the garage. When oxides of nitrogen (NOx) and oxides of carbon (Cox) monitors detect hazardous concentrations in the ambient air, exhaust fans automatically start. Exhaust Fans also have a timer over ride switch when required. The welding shop has a different exhaust management system consisting of drop pipes that connect to tailpipes and vent the exhaust directly to the outside. Various equipment such as compressors, saws, electric and air tools as well as hydraulic lifts/hoists can be found in various locations throughout the shops. The wash bay is equipped with a water heater/compressor (Natural Gas) which instantly heats the water and provides a high pressure wash for vehicles. An air emission tester and related equipment is usually left on and is used to monitor all city vehicles. The entire building, including garage bay doors, has alarm systems installed for security purposes.

A new vehicle and material cold storage building (160'X240'X50'), built in 2003, is separate from the main operations building. Twelve bay doors line each side of building and provide storage for plows, vehicles and other equipment. In the middle section of the building separates the bays on each side and is used for storing salt and mixing brine for road application. All doors are powered by electric motors. Heating is limited in the building to one electric heater and one natural gas space heater in two separate enclosed workshops/garages at one end of the building. The sprinkler system is dry throughout the building which allows the overall building temperature to fall below zero. Lighting in the building is supplied by 24 rows of fluorescent lighting in the bays and 12 metal halide (400 watt) light fixtures inside the salt and brine storage area. Vehicle bay lights are usually turn on and off as required and the salt storage bay lights are often left on. External lights are controlled by a timer. Gas and electrical feeds to the building are tied into the main operations building and are not metered separately.

Electricity Use

Figure B2-11 illustrates the electricity use profile for the Operations Centre for 1995 and 2000. As discussed earlier, the Operations Centre is the third largest electricity consumer in overall usage and second in terms of electricity use on a floor area basis for this module. While the overall electricity use remains relatively consistent throughout the year, the Operations Centre has experienced a dramatic overall increase in power consumption of 15 to 20 MWhs on average each month. Elevated electricity usage during the winter months may be attributed to supplemental electrical heating used in some parts of the building as well as greenhouse operations, which begin to propagate flowering plants in the late winter/early spring.

FIGURE B2-11
OPERATIONS CENTRE ELECTRICITY USAGE



Facility Recommendations

In an attempt to further reduce electricity use and peak demands, the City of Barrie may wish to consider the following recommendations:

- Assess the distribution of load throughout the facility, electrical sub-meters should be installed in designated areas, especially where supplemental electrical heating is supplied.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis. Several opportunities to reduce or eliminate lighting in certain areas were observed during the site visit (upstairs lunch room). Automatic sensors have failed in the past, however, recent technological improvements may hold better and cheaper alternatives.
- Insulate hot water tanks and associated piping.
- Based on more recent data after 2000, electricity and gas use should be re-evaluated in conjunction with the buildings programmable settings to ensure optimal settings are being used. Settings include damper/ventilation positions and operating points among others.
- Daily meter/sub-meter readings should be incorporated into routine tasks as well as increased observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.

Other Recommendations

- An evaluation of the heating strategy and overall zoning in the facility (esp. 2nd floor offices) needs to be addressed as soon as possible. Changes to office space have created a number of issues in terms of thermostat controls and zone settings. For example, roof top units previously servicing separate enclosed office areas are now servicing the same area and often compete with each other resulting in inefficiencies. Moreover, other areas of the building do not receive sufficient heat from roof top units and rely on supplemental heat from baseboard heaters. While operations staff are aware of this problem and monitor the settings closely, the system creates major inefficiencies and requires constant maintenance.
- Future renovations should include improvements to the building's exterior envelope. Inadequate and non-existent insulation in the walls and ceiling, combined with inadequate distribution of heat, limit the use of programmable settings even though they are available.
- Develop an operating manual for the building that describes major systems present; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.
- Implementing gas sub-meters to assess usage by the garage heaters, greenhouses as well as other equipment such as the roof top units (servicing offices) would assist in determining the distribution of gas demand and help earmark areas for improvement. Garages represent about half of the floor area of the facility.
- Develop an operating manual for the building that describes major systems; provides strategies for heating and cooling the building as well as lists equipment and their efficiencies.

APPENDIX C

MODULE 3

CITY OF BARRIE LANDFILL AND SOLID WASTE

City of Barrie Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module 3: Landfill and Solid Waste

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Figures

List of Tables

PART ONE

Review and Profile of Waste Management

Background

This audit is intended as a sub-component to Barrie's overall community energy plan.

Waste Diversion

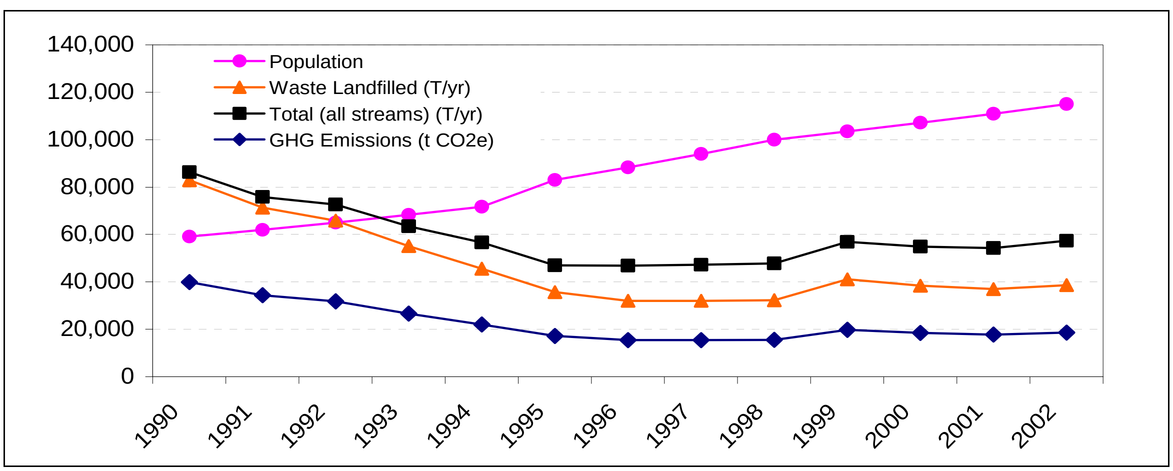
The City of Barrie owns and operates the Sandy Hollow Landfill under the Ministry of Environment (MOE) Certificate of Approval No. A250101. The landfill site is located at the west end of the city, near the intersection of Edgehill Drive and Ferndale Drive. The overall site area is 121.3 ha, of which approximately 17 ha is designated as the waste fill area. Waste disposal at the site began in the 1960's.

Currently the landfill receives solid non-hazardous industrial, commercial, institutional, and municipal wastes generated only within the City of Barrie. Residential waste from small vehicles, curbside collection and multi-residential waste represented 80% of the total waste received at the site in 2001.

From site opening in the 1960's to the early 1980's the site received a greater variety of waste types including liquid industrial and some hazardous waste in the early years of operation. In an effort to reduce the quantity of waste disposed of at the Sandy Hollow Landfill and prevent the disposal of Household Special Waste (hazardous waste) the City has developed several waste reduction and waste diversion initiatives over the years.

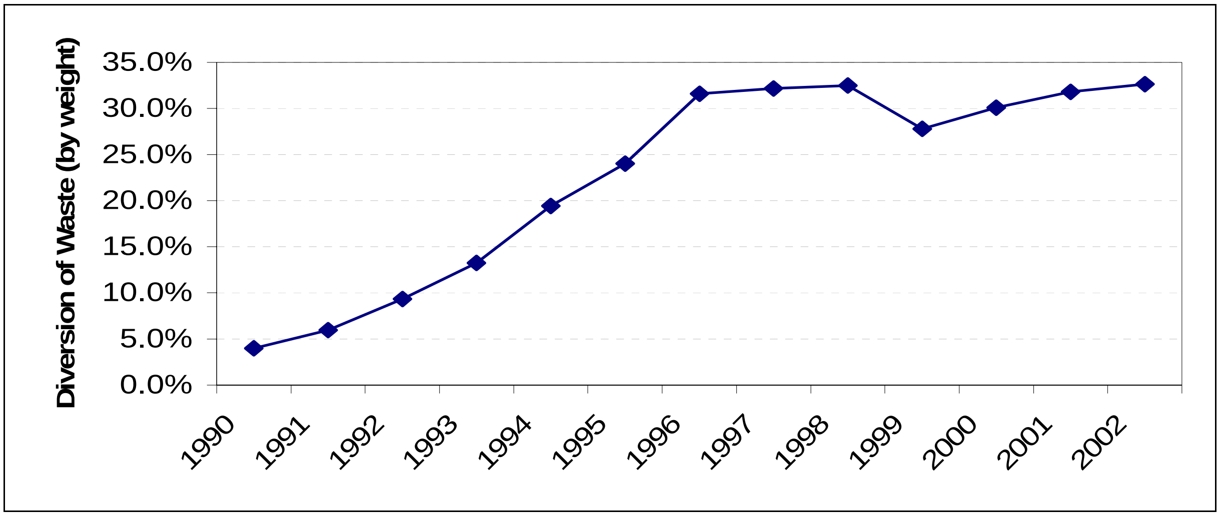
Figure C1-1 shows that while the population has increased significantly, waste landfilled and thus GHG emissions have decreased. The PCP software credits 0.482 tonnes of CO2e for every tonne of waste deposited into a landfill. By increasing their waste diversion, the City would be able to keep the GHG emissions from increasing.

FIGURE C1-1
BARRIE WASTE AND GHG TREND



Recently a new landfill segregation facility was constructed, which has allowed for the separation of cardboard, metal and electronics from waste delivered to the site by small vehicles. As a result of the new segregation facility, the amount of recyclables diverted from the landfill has increased significantly. Figure C1-2 shows the steadily increasing waste diversion at the landfill.

FIGURE C1-2
BARRIE WASTE DIVERSION RATE HISTORY



The City is planning on implementing several initiatives with the goal to reduce waste generation or increase waste diversion (Barrie Revised Design and Operations Plan, 2004). The following list briefly describes these initiatives:

- Building an education/interpretation area for tour groups near the new Environmental Centre which may include:
  - A compost demonstration site
  - Muskoka gardens information
  - Landfill model with explanation about operation and regulations
  - Visual waste reduction facts and information.
- Developing a survey for Barrie residents with Georgian College Research Analyst students to be followed by an organics curbside collection pilot. An estimated diversion rate of 10% is expected through the addition of a full-scale organic curbside program.
- Planning to conduct truckload composter sales in the southend of the city to increase backyard composter sales and improve diversion rate in that area.
- Planning to make an application to City Council to reduce the residential bag limit and increase the cost per garbage tag.
- City staff has developed an education workbook with an environmental theme to be presented to the School Board for potential curriculum approval.
- Planning to create a Reuse Centre to be permanently located at the new Waste Segregation Facility.

- Planning not to accept any asphalt or concrete waste within five years. Residential and commercial loads will be directed to be disposed of at alternative locations such as local recycling companies.

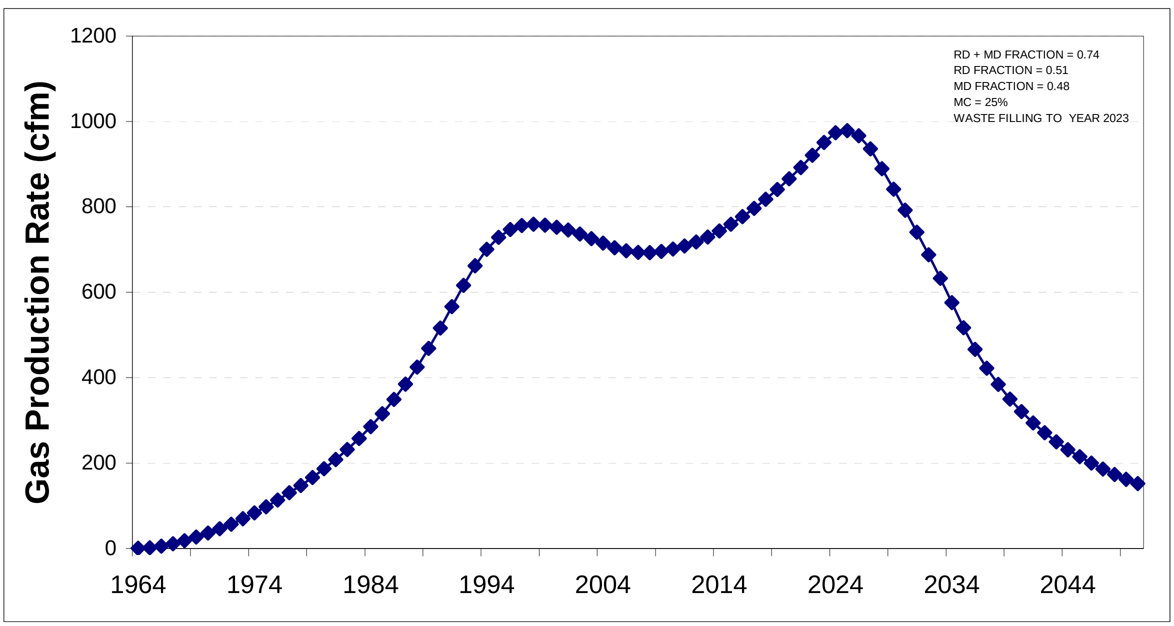
Any of the above initiatives will help the City increase the current rate of diversion of 32%.

Landfill Gas

Barrie's landfill currently does not have a landfill gas collection system in place. Landfill gas is composed primarily of methane, carbon dioxide and trace organic compounds. It is produced by the decomposition of waste and is estimated to contribute up to three per cent of Canada's GHG emissions. Flaring destroys the methane in landfill gas, and therefore reduces the GHGs. Utilization instead of flaring provides additional benefits, including generating revenue at sites where landfill gas utilization is economically viable. The capture of landfill gas provides a source of renewable energy, primarily for heating and generating electricity, but also for new uses such as vehicle fuel.

Methane gas production at the Sandy Hollow Landfill was estimated to determine the potential supply of methane and is shown in Figure C1-3. Since there is a finite amount of biodegradable material, the amount of gas will decrease over time. For more than 20 years, assuming no change in landfill operation, approximately 51,000 tonnes of CO_2e per year would be reduced by flaring the gas. Even more could be realized if the gas was used to create energy.

FIGURE C1-3
TOTAL LFG PRODUCTION FOR SANDY HOLLOW LANDFILL



The term "landfill gas" is generally used to refer to the entire mixture of methane, carbon dioxide, and other trace compounds as generated by decomposition of wastes placed in a landfill. The term "landfill methane" is often used to refer only to the methane component of landfill gas.

The environmental and human health impacts related to landfill gas depend on the exposure pathways and include the following:

- Air:
  - odours
  - degradation of local air quality
  - release of greenhouse gases to the atmosphere
- Soil:
  - explosion hazard in enclosed spaces
  - asphyxiation in enclosed spaces and low-lying areas toxicity hazards in enclosed spaces on or near landfills
  - vegetation stress on or adjacent to landfills
- Groundwater:
  - dissolution of methane in groundwater
  - dissolution of trace compounds at gas/groundwater interface
  - impacts to vadose zone chemistry and background geochemistry

Methane concentrations ranging from 5 to 15 percent by volume in air are explosive. The risk of a landfill gas explosion is generally associated with subsurface migration of landfill gas into structures located on or near landfill sites. If landfill gas is allowed to accumulate in these areas, explosive concentrations of methane can develop. When combined with a source of ignition, an explosion could result in the presence of atmospheric oxygen. Accumulation of landfill gas within an enclosure can also create an environment that is toxic and oxygen deficient, and therefore hazardous to humans.

Due to the presence of trace constituents, the release of landfill gas into the air can contribute to odours in the vicinity of the site. Landfill gas odours are caused primarily by hydrogen sulphide and mercaptans that are commonly found at trace quantities in landfill gas generated at most landfill sites. These compounds may be detected by sense of smell at very low concentrations (i.e. 0.005 ppm and 0.001 ppm respectively). The potential health effects of some of the other trace compounds commonly found in landfill gas are also of concern in the through chronic exposure. In addition to the potential odour, air quality, and health impacts, methane and carbon dioxide are greenhouse gases that contribute to global warming when introduced into the atmosphere.

Gas Generation Estimation Methodology

Assessment of landfill gas for the purpose of designing a control system should be based on a conservatively high estimate of the landfill gas generation expected for the landfill Site in order to ensure that the capacity of piping, blower and flare components is adequate to accommodate the highest rates of gas generation that could be realized at the landfill. Selection of a control technology and sizing of the integral components of the technology is based primarily on the rate of gas generation. LFG generation estimating techniques are applied to develop a potential range of the LFG generation rates based on site-specific characteristics of the subject site and site waste stream. A range of generation estimates is developed by incorporating reasonable variations in the model input parameters to incorporate expected, but unquantifiable, variability within the waste stream and generation processes. The resulting generation range or "envelop" represents the basis for developing the detail design of the LFG management system.

The generation of landfill gas takes place in stages. Following initial placement of the waste in the site, anaerobic methanogenic decomposition begins following depletion of oxygen in the waste mass. This process generally continues until the organic matter has been fully decomposed. As the landfill ages, the rate of landfill gas generation gradually decreases and the character of trace components in the gas may change somewhat until little or no benefit come from extracting the gas. Thus waste that has previously been placed at the landfill is not suitable for producing extractable LFG for savings of air emissions.

The fundamental elements of landfill gas generation estimates include: the landfill gas yield, the unit landfill gas generation rate, and the site landfill gas generation rate. The landfill gas yield is the total volume of landfill gas produced per unit mass of refuse (i.e., m^3/kg or ft^3/lb.). The unit landfill gas generation rate is the volume of landfill gas generated per unit mass of refuse per unit of time (i.e., m^3/kg/yr. or ft^3/lb./yr.). The site landfill gas generation rate is defined as the volume of landfill gas that is produced by the total quantity of refuse in-place in a site per unit of time (i.e., m^3/hr or ft^3/min.).

A number of important site-specific factors contribute to the generation of gases within a landfill, including:

- *Waste Composition:* The amount of landfill gas produced is dependent on the amount of organic matter in the waste, and the distribution of this matter within the landfill.
- *Moisture Content:* water is required for the anaerobic degradation of organic matter. The amount of moisture within a landfill also significantly affects the gas generation rates.
- *Temperature:* Anaerobic digestion is an exothermic process. The growth rates of bacteria tend to increase with temperature until an optimum is reached, which is well above average temperatures in temperate climates. The depth of the waste and presence and composition of the landfill cover will impact the extent to which the process is insulated from cooler ambient temperatures.
- *pH and Buffer Capacity:* The generation of CH_4 in landfills is greatest when neutral pH conditions exist. The activity of methanogenic bacteria is inhibited in acidic environments.
- *Availability of Nutrients:* Nutrients required for anaerobic digestion include carbon, hydrogen, nitrogen, and phosphorus, which are generally in sufficient supply in typical municipal solid waste streams to support methanogenic bacteria.
- *Waste Density and Particle Size:* density of the waste and the proportion of void space also influence gas generation. These both affect the surface area available for degradation and therefore increase the gas production rate. As waste densities increase, the overall porosity is reduces, which in turn reduces the movement of moisture and nutrients

through the waste. Layers of low permeability cover soils (or other materials), will also inhibit the distribution of moisture through the waste.

A number of models are available for estimating rates of generation of landfill gas. Accepted industry standard models are generally first order kinetic models which rely on an idealized mathematical representation of anaerobic decomposition and a number of basic assumptions regarding site specific conditions. These models are used to predict the profile of landfill gas generation rates over time for a typical unit mass of solid waste. A theoretical unit landfill gas generation rate curve is then applied to past filling rate data and estimates of future filling rates at a landfill to produce an estimate of gas generation over time.

It should be recognized that site-specific data for many of the variables that effect landfill gas generation are generally unknown and cannot be easily or readily obtained. Furthermore, all of the accepted modeling techniques rely on idealized representations of the landfill gas generation processes that cannot quantify all of the heterogeneous conditions that exist in a landfill site. These factors introduce uncertainties into the landfill gas generation modeling process. One approach that is applied to better understand the possible accuracy of the estimates is to model a number of scenarios varying the possible input parameters within a reasonable range to attempt to gauge the sensitivity of landfill gas generation to the baseline assumptions. Given these limitations, it is recognized that landfill gas generation modeling merely provides an estimate of the landfill gas generation potential, and a fairly wide range of values need to be considered for decision-making for the design of gas management facilities and systems.

The methodology applied in estimating gas generation rates for the Sandy Hollow landfill is based on what has become know as the Scholl Canyon model, which is a theoretical first-order kinetics method for estimating landfill gas generation rates, and is of the form:

$$G_i = M_i \, kL_0 \exp^{-(k \times t_i)},$$

where:

G_i = emission rate from the *i*th section (kg CH_4/year)

K = CH_4 generation first order kinetic rate constant (year^{-1})

L_0 = CH_4 generation potential (kg CH_4/tonne of refuse)

M_i = mass of refuse in the *i*th section (Mt)

t_i = age of the *i*th section (years)

The first order decay function is applied to a finite element analysis to develop projections of waste mass as input parameters to estimate landfill gas generation over time. Typical values of k range from 0.02/year for dry sites to 0.07/year for very wet sites. The methane generation potential depends on the waste composition and is directly related to the landfill gas yield. A wide range of values is reported for landfill gas yield extending from 125 m^3/tonne to 500 m^3/tonne (2 ft^3/lb to 8ft^3/lb). This variability is due to variations in the composition of waste used in the various studies of empirical values for the rate constant.

The organic content of waste is responsible for the generation of LFG. Given that municipal waste is a heterogeneous mixture of materials with varying concentrations of organic constituents, input values for the Scholl Canyon model encompass an 'average' value to account for the waste's overall composition.

LFG Recovery Estimate Methodology

Landfill sites equipped with landfill gas management systems have limitations with respect to their effectiveness in recovering all gas generated by the decomposition of organic matter, and some portion of the generated landfill gas cannot recovered. Critical influences on recovery efficiency include specifics of the LFG management system design operational status of the Site, the presence and composition of cover materials, waste placement techniques, and leachate distribution within the waste mass. Gas not recovered by the management system may be emitted to the atmosphere through the landfill cap, via lateral migration along porous media in the base liner, or through the drainage media and piping of the leachate collection system.

To account for the proportion of gas generated but not recovered, recovery efficiency is estimated for each year that the system is expected be in operation. The value selected for recovery efficiency is based on the anticipated site conditions and level of development of the LFG management system relative to the estimated LFG generation rate for that given year. In many cases, the efficiency of a system increases as the landfill approaches closure and final capping is undertaken. The development of the site cap provides an effective barrier isolating the waste from the atmosphere, further reducing the portion of the landfill gas generated from being emitted to the atmosphere.

Within exceptionally wet landfill sites, where all the pore spaces in the waste are near saturation or where the accumulation of leachate within the waste mass limits the movement of gas through the landfill, the recovery efficiency can be significantly reduced. The excess moisture effectively floods the pathways for gas movement. While engineered solutions are available to reduce the impact of leachate on LFG recovery, such measures can require significant capital and operating costs. Consideration of the leachate distribution within the site must be incorporated into a conceptual model of the Site.

Management Approach Evaluation

Options available for landfill gas management are summarized in Table C1-1. Descriptions of the management approach options, advantages, and disadvantages of each approach are presented.

TABLE C1-1
LANDFILL GAS MANAGEMENT APPROACH SUMMARIES

Management Approach	Description of Management Approach	Advantages	Disadvantages
No Action	Implement no control measure and allow LFG to passively vent through the landfill cover the Site	Requires no capital investment or operational costs	Will likely result in nuisance odour impacts off-site, potential dangerous concentrations of methane in soils adjacent to the waste footprint, may result in regulatory infractions, does not reduce air emissions. Can not incorporate utilization technology.
Passive venting and flaring	Passive vents installed at specifically designed locations within the waste mass to provide controlled emission points. LFG emission is driven by intrinsic pressure of LFG generation. LFG can be combusted to significantly reduce methane emissions using individual low flow flares with solar igniters installed at passive vents.	Requires less additional infrastructure and operational investment than active collection. Can be retrofitted to incorporate active gas collection.	Passive vents have low recovery efficiencies and are not reliable for long term operation. Preferential pathways from the waste mass to the atmosphere other than the passive vents may result in uncontrolled emissions and continued nuisance odours. Passive flaring systems do not achieve high operating temperatures required to effectively destroy harmful trace organic compounds commonly present in landfill gas. May not produce enough LGF collection to significantly reduce GHG emissions. Can not incorporate LFG utilization technology.
Active collection and flaring	Collection wells installed within the waste mass to allow controlled collection of LFG as it is generated. LFG is destroyed in a high temperature flare system.	Provides the highest level of control and efficiency for LFG management. Provides the highest probability of successfully reducing odours. Effectively destroys harmful organic trace constituents potentially present within the gas. Successfully reduces GHG emissions, and exceeds reduction targets. Capable of incorporating utilization technology into design	Collection system requires the highest capital investment and operation costs.

Given the overriding objectives of the report to reduce GHG emissions, the preferred LFG management approach for the Site is active collection with centralized high temperature flaring. Although there is a large initial cost of implementing the system, the future GHG savings would meet the cities reduction needs by 187% (refer to Table 2).

LFG recovery efficiencies for typical municipal waste landfills are expected to be in the range of 75% to 90% of the total gas generated at the Site. The lowest recovery efficiencies are expected during initial start-up of the system, prior to establishment of final cover on filled portions of the Site. Prior to constructing the final cover, high vacuums cannot be applied to the extraction system mass near the top of the landfill without pulling atmospheric air into the collection system. The introduction of air, and particularly of the oxygen in the air, hampers the operation of the flare system such that high destruction efficiency of the methane and trace organics constituents may not be consistently achieved. If the vacuum is reduced to reduce air infiltration into the waste, the effective zone of influence of extraction wells and/or trenches will be reduced, in turn reducing the overall collection efficiency of the system and increase emissions of landfill gas directly to the atmosphere will likely occur.

The relatively high permeability of the soils in which the Sandy Hollow site is located is expected to facilitate migration of landfill gas out of the site, and low permeability soils used for daily cover and cap construction would also facilitate emissions to the atmosphere. This does not, however, impact the collection efficiency of a landfill gas collection system, since it would require active extraction in order to accommodate flaring of the gas, and the application of a vacuum throughout the waste mass would effectively eliminate migration of the gas through the cover of the landfill or through the base of the Site. Appropriate design and operation of a gas collection system would also prevent the introduction of atmospheric air from above the landfill cover, which could impact the operational effectiveness of a flaring system. Estimating the site-specific collection efficiency for the landfill can be facilitated by performing a pilot extraction test.

The relatively slow filling pace, resulting in a long Site operating life, serves to reduce the recovery efficiency of the collection system. The landfill is not anticipated to experience impacts to collection recovery effectiveness due to excess moisture in the landfill if excessive leachate accumulation within the landfill methods and systems are maintained and operated over the active life of the gas collection system.

As presented in Table C1-2, the yearly GHG reduction is at least 51,000tonnes/year. Securing this amount of reduction, the City of Barrie would meet their needs of GHG cutback by 187%. The peak recovery rates coincide with the peak estimated generation rates.

TABLE C1-2
ESTIMATED LFG ENERGY RECOVERY & CORRESPONDING GHG REDUCTION POTENTIAL

Parameter	YEAR Unit	2007	2008	2009	2010	2011
Est. Landfill Gas Production	m^3/year	10,314,207	10,314,207	10,358,857	10,433,274	10,537,458
Est. Landfill Gas Recovery (70% of production)	m^3/year	7,219,945	7,219,945	7,251,200	7,303,292	7,376,221
Annual Est. Methane Recovery	m^3/year	3,614,938	3,612,852	3,626,931	3,655,682	3,692,980
Est. GHG Reduction (CO2e)	tonne/year	51,469	51,440	51,640	52,050	52,581

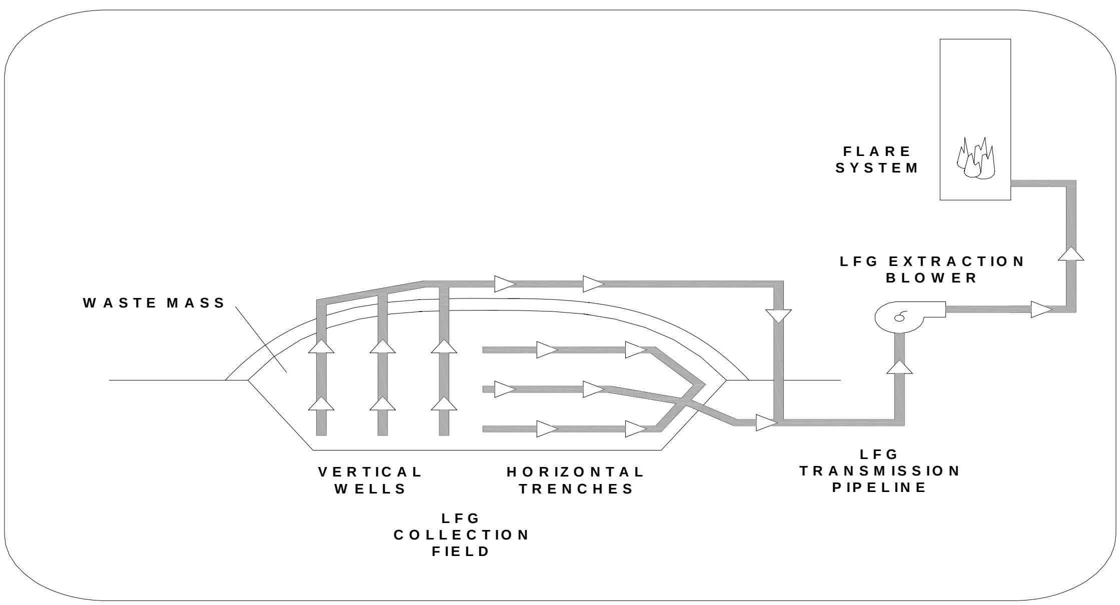
As previously stated, efficiencies of between 75% and 90% of the total LFG generation estimates are normally achieved at landfill locations. Using these common values a conservative value of 70% recovery efficiency can easily be expected at the Sandy Hollow Site. The normal range of recovery efficiencies are based on empirical collection efficiency data typical of active LFG collection systems that are installed and expanded as landfilling progresses. This efficiency range is based on the assumption that vertical wells would be installed in areas of the site that have achieved final grades, and horizontal trenches are installed in the remaining portion of the landfill.

The recovery efficiencies were selected based on a conceptual implementation schedule for a LFG recovery system. Recovery efficiencies are expected to increase as filling progresses and as the final cover is constructed over portions of the landfill that have reached final filling elevations.

Conceptual Design

Figure C1-4 presents a schematic of typical active LFG recovery system components and interconnections.

FIGURE C1-4
ACTIVE LANDFILL GAS RECOVERY SCHEMATIC



Assuming LFG is expected to be generated throughout the operating life of the Site and beyond. The expected LFG generation period is expected to extend more than 20 years. The conceptual design of the LFG collection system includes staged construction and implementation throughout the operating life of the facility. Following closure of the landfill, retrofits may be required to enhance collection of LFG.

The proposed collection system will include both vertical and horizontal collection wells. Incorporating both well types will allow for maximum LFG recovery efficiency and facilitates the integration of the collection system construction with Site operations and for the portion of the site for which filling has been completed, vertical wells are the preferred approach for LFG collection. Vertical wells are installed using conventional rotary auger drilling rigs, commonly used for geotechnical investigations.

Future expansion of the collection field can be accomplished as filling progresses with the installation of horizontal collection trenches. Horizontal collection trenches are typically constructed as filling progresses in actively operated portions of the landfill, eliminating the need to excavate or drill within the waste mass. Horizontal trenches with perforated piping provide high LFG recovery rates and are easily constructed.

LFG Utilization Potential

The methane content of LFG represents a significant potential source of energy. A typical unit quantity of LFG has an energy value of approximately half that of the same quantity of natural gas given that LFG consists of only approximately 50 percent methane. Utilization of the energy content of LFG is currently practiced at numerous landfill sites across Canada. The demand for innovative sources of renewable energy over the past 20 years has been a driving factor in the development and advancement of LFG utilization technologies. However, the potential for LFG utilization is site-specific and very much dependent on the availability of a local end-user that can utilize the gas on a relatively continuous long-term basis, as well as economic factors associated with the capital investment required to extract the LFG and develop and construct the utilization system.

Common full-scale LFG utilization projects in Canada include: generation of electricity, direct use as an industrial process fuel, and direct use as a space-heating fuel. The feasibility and selection of a utilization process must be based on a detailed assessment of the LFG quality, available utilization options, and estimated capital costs versus estimated revenues for the life of the utilization project. Additional factors, unrelated to technical and economic considerations, such as public support or opposition, are also critical factors that may influence the evaluation of available utilization approaches.

Based on the estimated LFG generation rate, utilization may be practicable at the Site. Potential utilization approaches appropriate for the estimated LFG recovery rates may include generation of electricity using reciprocating engines, or direct use of LFG as a heating fuel pending identification of a long-term local user.

Typical 'yard stick' recovery rates required to support the generation of electricity from LFG based on the fuel requirements of current generation reciprocating engine technology are between 300 and 375 cfm per megawatt (MW) of electricity generated. Currently, the smallest available capacity of reciprocating engineer gensets is approximately 1MW. It should be noted that power generation often requires the removal of trace compounds commonly found in raw LFG. Trace compounds such as siloxanes and sulphides can significantly shorten the service life of critical components of reciprocating engine generator sets. Detailed characterization of the LFG is required to determine if gas treatment in addition to moisture removal is required to address the potential damage to the gensets. Gas treatment can represent a significant cost in many small scale generation projects.

The viability of utilization as a heating fuel is largely dependant upon the proximity of the end user to the landfill site and the level of gas conditioning required to meet the demands of the heating process. Minimum LFG recovery rates required to support the capital expenditures of the LFG delivery equipment (i.e., compressor station and pipeline) are determined from the distance to the end user from the Site. As this distance increases, the relative capital cost of the utilization project increases proportionally. Depending on the space heating process (e.g., radiant heaters, boiler, forced air), treatment of the gas may not be required, but in most cases would be less onerous and less costly than treatment of gas for use in reciprocating engine gensets.

An economic assessment of utilization options would require detailed information regarding the energy demand profile of potential local users of the gas for direct use options. To evaluate the economics of utilizing the gas for power generation, an assessment of the local electrical power transmission and distribution systems would be required, as interconnection requirements and power purchase opportunities and pricing. As of March 2006, the Ontario government has agreed to purchase green energy at a base price of 0.11 ¢ per kilowatt-hour from small operations. LFG systems are encouraged sources of green energy and are classified as small operations. Thus, if power is supplied back to the power grid from the Sandy Hollow LFG collection system, the City would be able to offset the cost of LFG production, while still obtaining the desired GHG reductions.

Assumptions:

- landfill continues to be filled until 2023 with no major change of operation
- 70% recovery of landfill gas

Table C1-3 shows the areas of possible GHG reduction for waste management:

TABLE C1-3
POSSIBLE GHG REDUCTIONS

Measure	Estimated GHG Reduction Potential
Increase Waste Diversion	0.48 tonnes CO_2e per tonne waste diverted from landfill
Landfill Gas Flaring	51,000 tonnes CO_2e

PART TWO

Review and Profile of Energy Consumption in Facilities

Landfill Facilities

The landfill profile is presented in Table C2-1.

TABLE C2-1
LANDFILL FACILITIES PROFILE

Location	321 Ferndale Dr.
Operational Profile	9:00AM to 4:00PM, Tuesday to Saturday
Building History	New facilities were built in 2003, which include: a personnel facility, administration office and maintenance garage, dual traffic weigh scales and kiosk and a household hazardous waste/ commodities depot building. A small trailer kiosk has also been installed at the waste segregation checkpoint.
Building Energy Management System	Heating/Cooling in main office is provided by a natural gas furnace located in the mechanical room and supplemented with some electrical heaters in the offices, lunchroom and entrance on the main floor. Natural gas tube heaters provide heating in the garages bays. Electric baseboard heaters and air conditioning units provide heating/cooling for the weigh scale kiosk. The hazardous waste depot building is serviced with electric heaters in the office only. All interior lights are controlled manually while exterior lights are controlled by photocells. Heating is controlled by individual thermostats in the office.
Lighting	
Main Administration Office (main floor, entrance, lunch room and customer service)	Standard fluorescent fixtures (T-8 and T-12) controlled by wall switches.
Main Administration Office (second floor)	Standard fluorescent fixtures (T-8 and T-12) controlled by a wall switches.
Main Administration Office (Maintenance Garages)	Fifteen sodium fixtures with supplemental lighting provided by skylights.
Weigh Scale Kiosk	Standard fluorescent T-12 fixtures controlled by a wall switch.
Hazardous Waste Depot Building	Standard fluorescent fixtures in the office. Sodium fixtures with supplemental lighting provided by skylights (in garage area).
Exterior Lights	Controlled by photocells and timers
Building Heating/Cooling/Air Flow and Ventilation	
Main Administration Office	One natural gas forced air furnace located in the mechanical room services the offices in the main building and supplemented with some electrical heaters in the offices, lunchroom and entrance on the main floor.

TABLE C2-1
LANDFILL FACILITIES PROFILE

Location	321 Ferndale Dr.
Main Administration Office (Maintenance Garages)	Five natural gas tube heaters service the six bay garage.
Weigh Scale Kiosk	Electric baseboard heaters and air conditioning units service the Scale Kiosk
Hazardous Waste Depot Building	The offices are heated with electric baseboard units. The garage area is not heated.
Other Equipment	
Methane Gas Detection System	A methane detection system has been installed for the new facilities since they are located within the landfill attenuation zone. Primary element sensors and relaying transmitters are located throughout all of the building facilities.
Wash Bay Water Heater	A wash bay water heater, powered by natural gas, instantly heats water for the wash bay
Exhaust Fans	NOx and COx detectors monitor levels in the garages and interlocked with exhaust fans to turn fans on and off when required (vents have freely moving louvers).
Appliances and Power Tools	Some power tools are used in the garage. Fridge, stove, microwave and vending machines in the lunch rooms
Bug zappers	Bug zapping fixtures have been installed at numerous locations through the building to help control the number of flies and other bugs. Normally the flies are worse in the summer; however, the lights are left on year around.
Hot Water Heater	A natural gas hot water heater (with a reserve tank) provides hot water for domestic use in the main building. One small electric water heater is located in the weigh scale kiosk and the hazardous waste depot building.
Building Envelope	
Windows	For the most part, windows are sealed double paned glass in the buildings. Most exterior office windows were equipped with blinds and can be opened. Staff have noted apparent cold areas around windows in a few offices on severe winter days. Window sills at the weigh scale kiosk have a few leaks which are being corrected under the general contractors guaranteed maintenance program.
Doorways	The main public entrance vestibule for the administration offices has a double set of doors
Garage Bay Doors	New garage doors are insulated; however, some of the doors do not fully seal when closed. if there is debris near the base of the doors.
Walls and Roof	All of the new facilities have a sheet metal exterior. All pre engineered building areas are insulated.
Meterage	
Natural Gas	One meter for the entire facility. Note: The main personnel facility and maintenance garages are the only facilities on site with natural gas service.
Electricity	One meter for the entire facility

The City of Barrie Landfill is located at 321 Ferndale Drive. New facilities at the landfill were built in 2003, which include: a personnel/administration office and maintenance garage, dual traffic weigh scales/kiosk and a household hazardous waste/commodities depot building. There are between eight and twelve people working out of the main office and sub-offices. The main office consists of two levels with an adjoining six bay garage. The main floor has a customer service office, lunchroom, washrooms and other offices. The second floor has more administrative offices as well as the mechanical and electrical room. The weigh scale kiosk is a smaller building located between the in bound and outbound weigh scales and consists of one larger control room for scale operators with full glass frontage on approaching traffic and client service windows adjacent to the scale. The remainder of the building houses a small kitchen galley, washroom, storage area and a mechanical room. The household hazardous waste depot and the commodities depot are separated by a covered open air thruway for vehicle passage. The household hazardous waste depot consists of a garage area with a blocked in office, washroom and utility room within. The commodities depot consists of a garage area with a blocked in utility room and washroom for public access from the exterior. The public entrance in the main administrative office has a double door vestibule, while the other buildings have single doors. The administrative offices and hazardous waste building office also have some exterior windows that are double paned glass which can be opened. The garage and storage area of the hazardous waste depot storage facility have several sealed skylights, which supplement the lighting in the garage. Since the facilities were completed in August 2003, the contractor is still addressing various issues in the buildings, such as cold drafts in the offices and garage bay doors not sealing properly when closed. However, it should be noted that the facility is located at higher point of elevation relative to the local area and is subject to high prevailing winds.

One natural gas forced air furnace services the main office and is supplemented with some electrical heaters in some offices, lunchroom and entrance on the main floor. Currently, thermostats control the furnace and airflow and no programmable controls are available. Some employees have complained of cold drafts in various offices and have been using electric space heaters in their work areas (Customer Service). Electric heaters are also located at the exit doors and the lunchroom. Natural gas tube heaters provide heating in the garages and washbay and are controlled by individual thermostats (set to 22 degrees Celsius). Two electric baseboard heaters and an air conditioning unit provide heating and cooling in the weigh substation. The hazardous waste building is serviced with electric heaters in the office only. A small waste segregation trailer also has one electric heater and one roof top air conditioning unit.

The offices and common areas have standard fluorescent fixtures (T-8s and T-12s) controlled by wall switches in each room. The garages and hazardous waste building have sodium fixtures with supplemental light from skylights. Employees are instructed to turn off lights at the end of the day. Exterior building lights are controlled by a photocell while the street lights are operated by a timer.

Other major equipment includes a pollution control system for the garage. When NOx and COx monitors detect hazardous concentrations in the ambient air, exhaust fans automatically start. The exhaust fans can also be operated manually to control odours or heat during the summer. The wash bay is equipped with a water heater/compressor

(Natural Gas), which heats the water and provides a high pressure wash for vehicles. A natural gas hot water heater (with a reservoir tank) provides hot water for domestic use in the main building. One small electric water heater is located in the weigh substation and the hazardous waste building. Other appliances located in the lunch room include a fridge, microwave and stove. Bug zapping fixtures have been installed at numerous locations through the building to help control the number of flies and other bugs. Normally the flies are worse in the summer; however, the lights are left on year-round.

Overall Recommendations

Based on the large quantity of GHG reduction potential it is recommended that a LFG collection system be seriously considered. With the implementation of a LFG collection system the City would not only exceed their reduction targets, but would also have the opportunity to receive economic benefit from the production of green electricity. These positive aspects of a LFG collection should provide a basis for further investigation. Additional recommendations for the landfill buildings are as follows:

- Wrap Hot Water Heaters
- Turn off bug zappers during winter months

APPENDIX D

MODULE 4

CITY OF BARRIE WATER AND WASTEWATER SYSTEMS

City of Barrie Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module 4:
Water and Wastewater Systems

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Figures

List of Tables

PART ONE

Review and Profile of Energy Consumption in Facilities

Background

This audit is intended as a sub component to Barrie's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its energy and greenhouse gas reduction commitments.

The objective of this audit is to provide a high level review of water and wastewater facility energy use and identify target areas where opportunities for improved energy use may exist. The facilities in this module include: The Barrie Water Pollution Control Centre (Sewage Treatment Plant); various water storage facilities, such as, towers and reservoirs (here after referred to as Reservoirs) and various water pumping stations that include both groundwater well extraction pumping stations and booster stations (here after referred to as Pumping Stations). Note that even though some facilities share multiple functions, each facility was separated into a single function category.

Overall Energy Consumption

Figure D1-1 provides an historical trend of overall energy use in the City of Barrie's facilities listed in this module. Due to lack of data for some facilities (pumping stations and reservoirs) those facilities with electricity usage documented prior to 2000 were used to represent the historical trend of CO_2 emissions. The trend line within the graph indicates the wastewater throughput in cubic metres from 1994 to 2000. The energy use for these facilities has increased 51.7% in 2000 since 1994, whereas the wastewater throughput has only increased 23%. A rise in energy consumption over 1994 to 2000 can be attributed primarily to the addition of new water supply related facilities. The total electricity usage by water related facilities in 2000 was approximately 13,500 MWh, which translates to approximately 5,800 tonnes of CO_2e emissions for 44,543 m^3 of wastewater. This is also compounded by the increase in carbon emissions intensity for electricity purchased off the Ontario grid, as a greater reliance on coal derived electricity increased during this period. The emissions intensity for wastewater changed from 0.019 t CO_2e/m^3 of wastewater in 1994 to 0.030 t CO_2e/m^3 of wastewater in 2000.

FIGURE D1-1
OVERALL CO_2 EMISSIONS (TONNES) DERIVED FROM ELECTRICITY USE

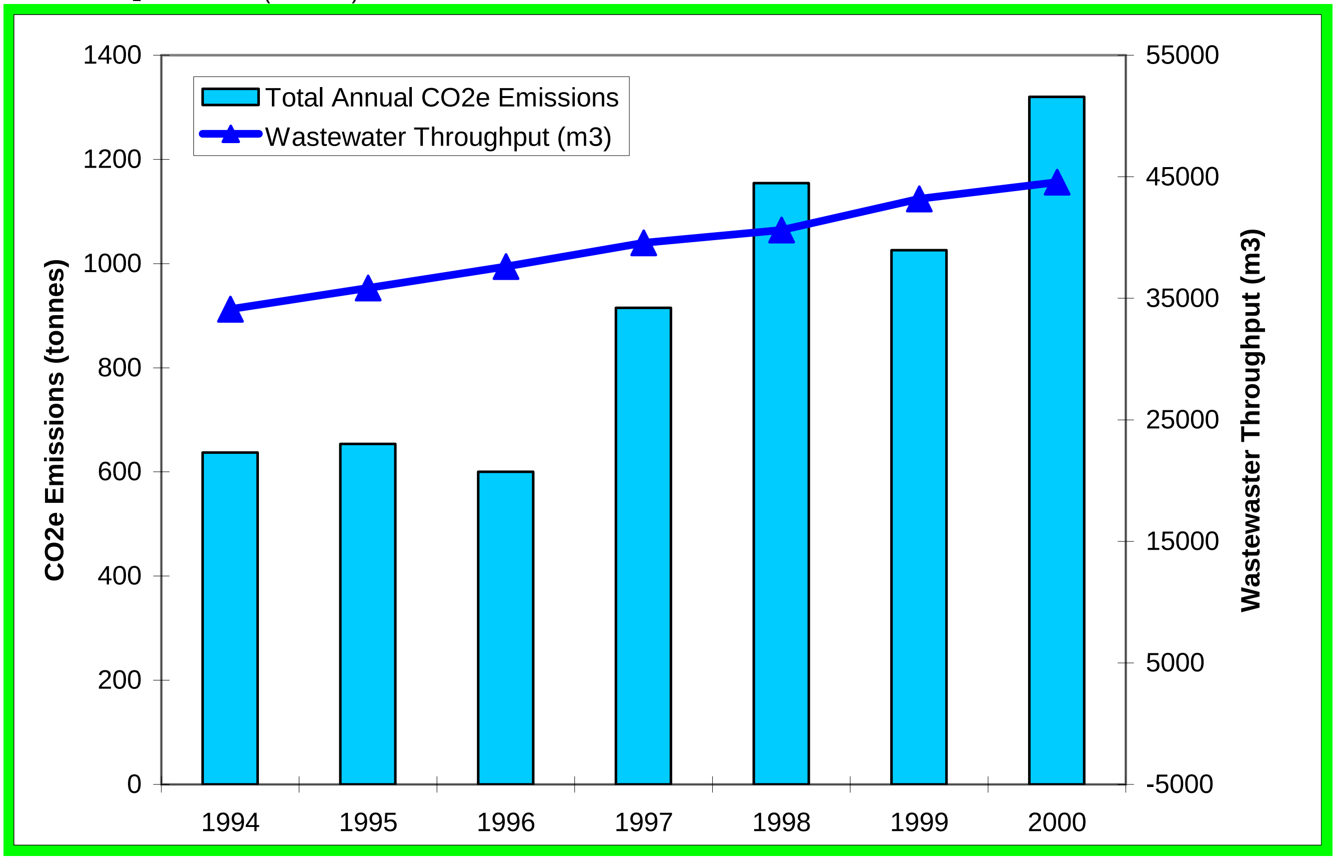


Table D1-1 presents the CO_2e emission reduction targets to 1995 levels on a facility class basis for Barrie's facilities.

TABLE D1-1
CO_2E REDUCTION TARGETS (DERIVED FROM ELECTRICITY USE)

Facility Class	1994 Electricity Use (MWhs)	1994 CO_2e (tonnes)	2000 Electricity Use (MWhs)	2000 CO_2e (tonnes)	Difference in MWh	Difference in CO_2e (tonnes)
Sewage Treatment Plant	5,016	596	4,474	1,407	-542	811
Reservoir[1]	N/A	N/A	304	96	N/A	N/A
Pumping Station[1]	413	49	1,320 (8,689)[2]	389	+907	+340
Totals	**5,429**	**645**	**6,098 (13,467)[2]**	**1,892**	**+669**	**+1,247**

Note:

[1] Incomplete information available for Reservoir and Pumping Station facilities prior to 2000.

[2] Pumping Stations with electricity data prior to 2000 represented a total of 1320 MWhs in 2000 which was used to determine a representative difference in CO_2e emissions. The total electricity use for all pumping stations in 2000 was determined to be 8,689 CO_2e.

As indicated in Table D1-1, a total reduction of approximately 1,247 tonnes of CO_2e is required to reduce year 2000 energy use to 1994 levels. It is important to note that the sewage treatment plant's calculated CO_2e emissions increased from 1995 to 2000, while there was a net decrease in electrical demand. This increase is a result of the increased use of carbon in the Ontario Electricity Grid (coal fired generation) during that period. The use of a cogeneration plant at the sewage treatment plant has helped reduce electrical demand by producing 250 kWh (approximately one third of the sewage treatment plant's needs) from digester gases (methane) or natural gas when digester gases are not available. In Table 1.0, calculated CO_2e emissions are based only on the power grid's emission factors and is a reflection of Ontario's increased reliance on coal fire stations. The sewage treatment plant's total CO_2 and greenhouse gas emissions should be further refined to reflect the carbon emissions from natural gas and methane consumption at the cogeneration plant rather than from grid factors. Furthermore the digester gas combustion of methane to carbon dioxide should be factored in as a net reduction of CO_2e, by comparing the values combusted in 1994 versus 2000.

Energy Use Trending and Benchmarking Performance

Table D1-2 lists the buildings represented in this module; however, only a selection of these facilities were toured during this audit.

TABLE D1-2
WATER SYSTEM FACILITY NAME, ADDRESS, AND FUNCTION CATEGORY

Facility Name	Address	Function
Barrie Water Pollution Control Centre	249 Bradford	Sewage Treatment Plant *
Harvie Road Reservoir	90 Harvie Rd	Reservoir*
Mapleview Drive Water Tower	65 Mapleview Dr W	Reservoir*
Bayfield Street Water Tower	444 Bayfield St	Reservoir*
Bayview Reservoir	157 Dunlop St E	Reservoir*
Lismer Blvd. Sewage P.S.	2 Lismer	Pumping Station
Penetanguishene Rd. Sewage P.S.	238 Penetanguishene	Pumping Station
Codrington Street	64 Codrington St	Pumping Station*
John Street Well #5	217 John St	Well
Tiffin Street Well #7	44 Sarjeant Dr	Well
Wood Street Well	12 Wood Street	Pumping Station
Huronia Road Well #10	294 Huronia Rd	Well
Big Bay Point Road	20 Big Bay Point Rd	Pumping Station*
Centennial Park Well #12	85 Lakeshore Dr	Well*
Leacock Drive Booster PS	319 Leacock Dr	Pumping Station*
Johnson Street Well #13	168 Johnson St	Well*
Huronia Rd. Sewage P.S.	644 Huronia	Pumping Station

TABLE D1-2
WATER SYSTEM FACILITY NAME, ADDRESS, AND FUNCTION CATEGORY

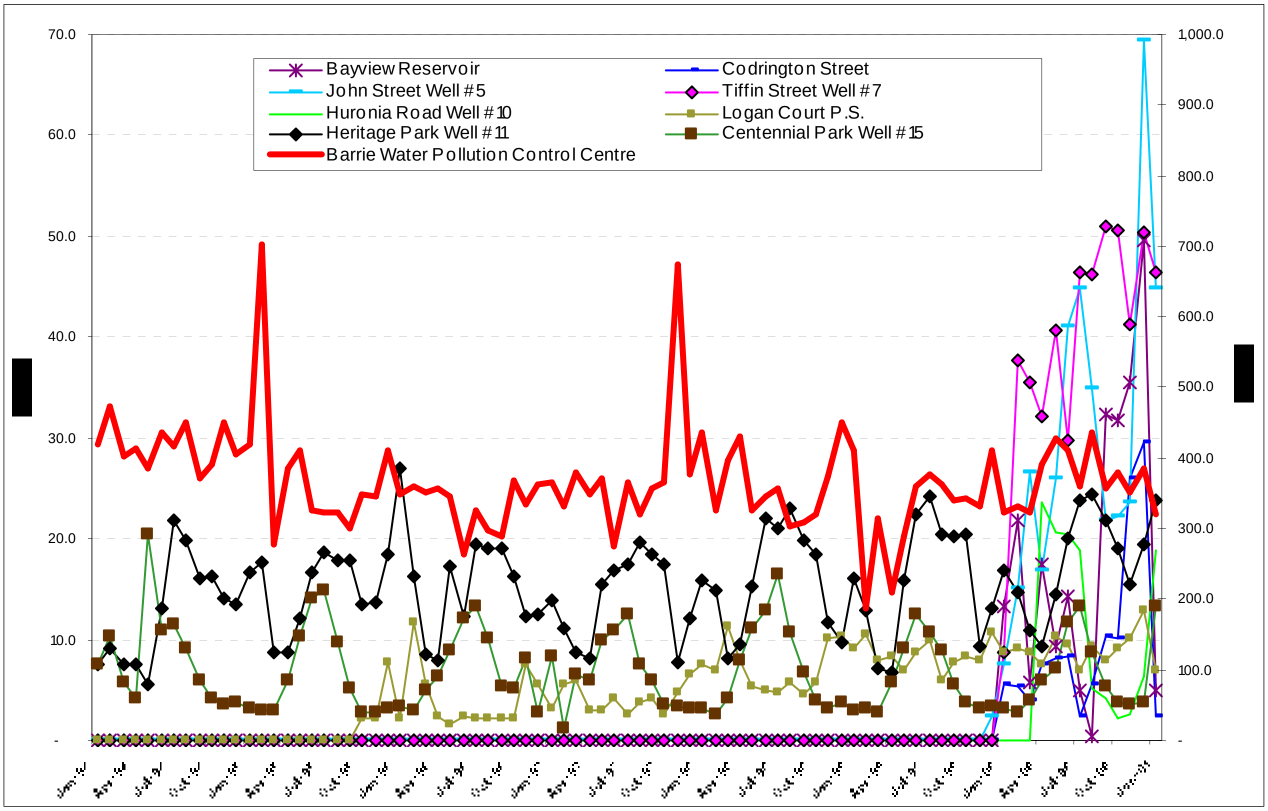
Facility Name	Address	Function
Heritage Park Well #14	15 Lakeshore Dr	Well*
Marina	55 Lakeshore Dr	Pumping Station
Logan Court P.S.	65 Logan Court Pump Stn	Pumping Station
Anne Street Well #3	54 Anne	Well*
Anne Street Booster Pumping Station	164 Anne St N	Pumping Station*
Innisfil Street Booster Pumping Station	380 Innisfil St	Pumping Station*
Perry Street Well #4	83 Perry	Well*
Logan Court Sewage P.S.	65 Logan Ct	Pumping Station
Bayview Dr. Sewage P.S.	799 Bayview	Pumping Station
Duckworth Street Sewage P.S.	510 Duckworth St	Pumping Station
Heritage Park Well #11	5 Lakeshore Drive	Well*
Centennial Park Well #15	55 Lakeshore Rd	Well*
Bayfield St. Sewage P.S.	509 Bayfield New	Pumping Station
Bayfield St. Sewage P.S.	509 Bayfield	Pumping Station
Brownwood Drive Well #16	101 Brown Wood Dr	Well

* indicates that a site visit to the facility was conducted.

Historical Energy Use Patterns

A review of available historical energy use patterns can provide insight into the changes in operational patterns or significant load additions at each facility. Figures D1-2 and D1-3 provides an historical perspective of electricity use from 1994 to January 2001.

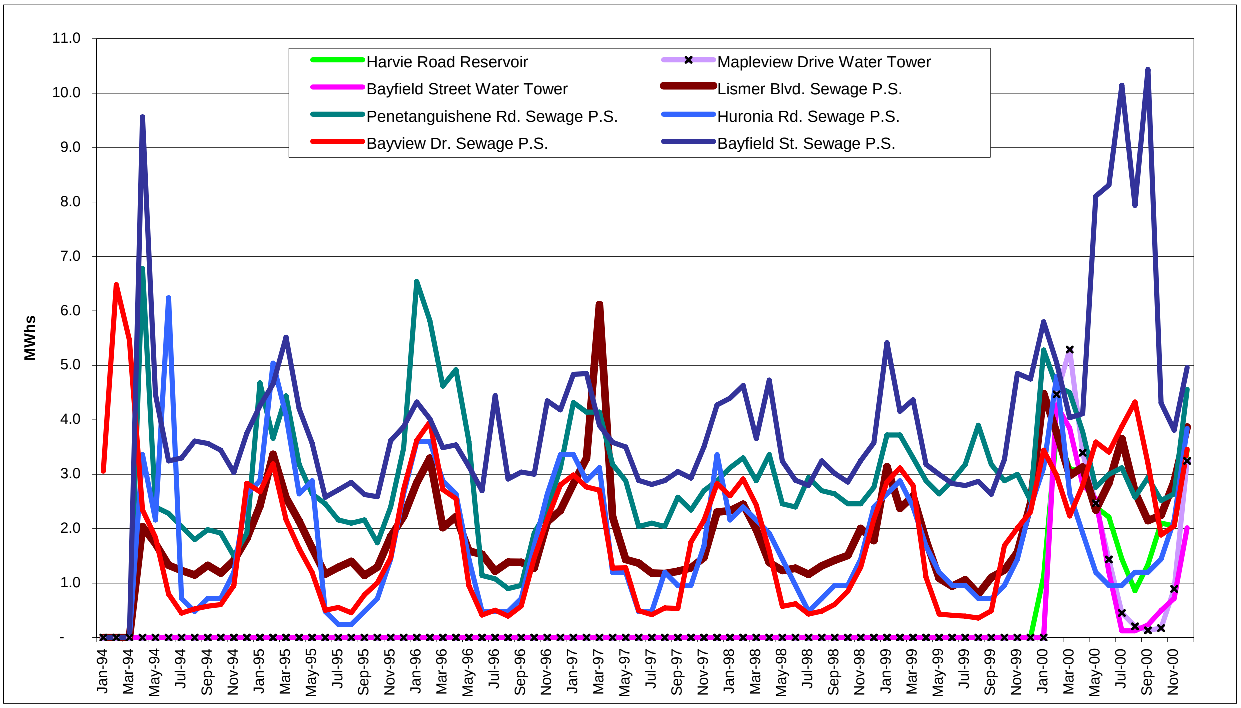
FIGURE D1- 2.
HISTORICAL ELECTRICITY USE BY FACILITY: 1994 - JANUARY 2001 (HEAVY USERS)



Note:
[1] Barrie's Water Pollution Control Centre was plotted on the secondary (right) y-axis while the other facilities were plotted on the primary y (left) y-axis

[2] Water facilities with no data available were removed

FIGURE D1-3
HISTORICAL ELECTRICITY USE BY FACILITY: 1994 - JANUARY 2001 (LIGHT USERS)



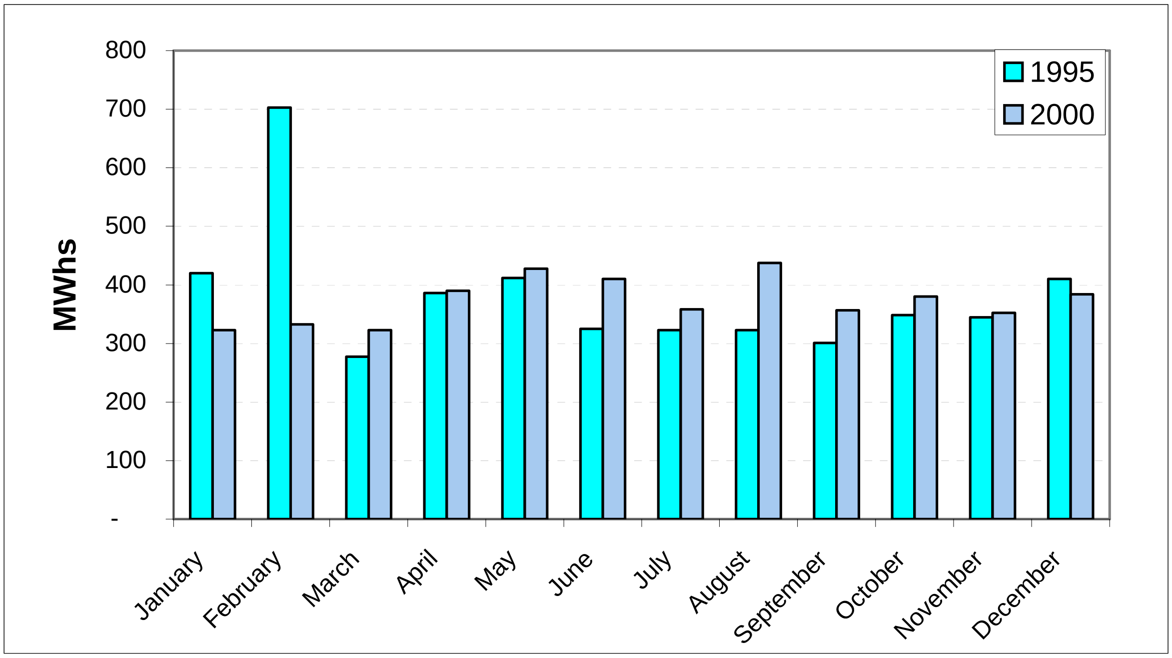
Note:

[1] Water facilities with no data available were removed

Upon review of the sewage treatment plant's electricity usage, the overall usage appears to be relatively constant or slightly declining. Two significant spikes in demand are apparent in February 1995 and November 1997. These peaks may be attributed to repairs being conducted at the cogeneration plant. Electrical demand at pumping stations and reservoirs appear to increase during the summer and late fall and decline during the winters. While electric heaters and lighting are present at most facilities, the main electrical demand appears to be a function of population shifts. Seasonal increases in population may be increasing the demand on water and wastewater facilities.

Figure D1-4 illustrates the electricity use profile for the sewage treatment plant for 1995 and 2000. The sewage treatment plant is the largest single consumer of electricity in this module.

FIGURE D1-4
SEWAGE TREATMENT PLANT ELECTRICITY USE



Figures D1-5 and D1-6 illustrate the electricity use profile for facilities classified as reservoirs and pumping stations, respectively, for 1995 and 2000.

FIGURE D1-5
RESERVOIR ELECTRICITY USE

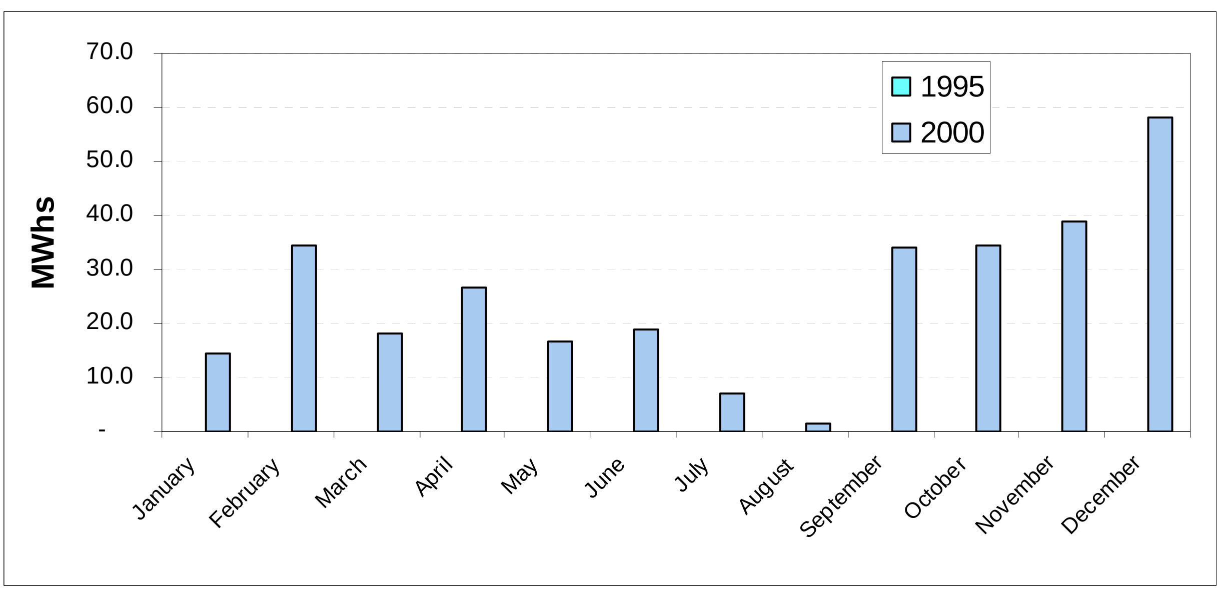
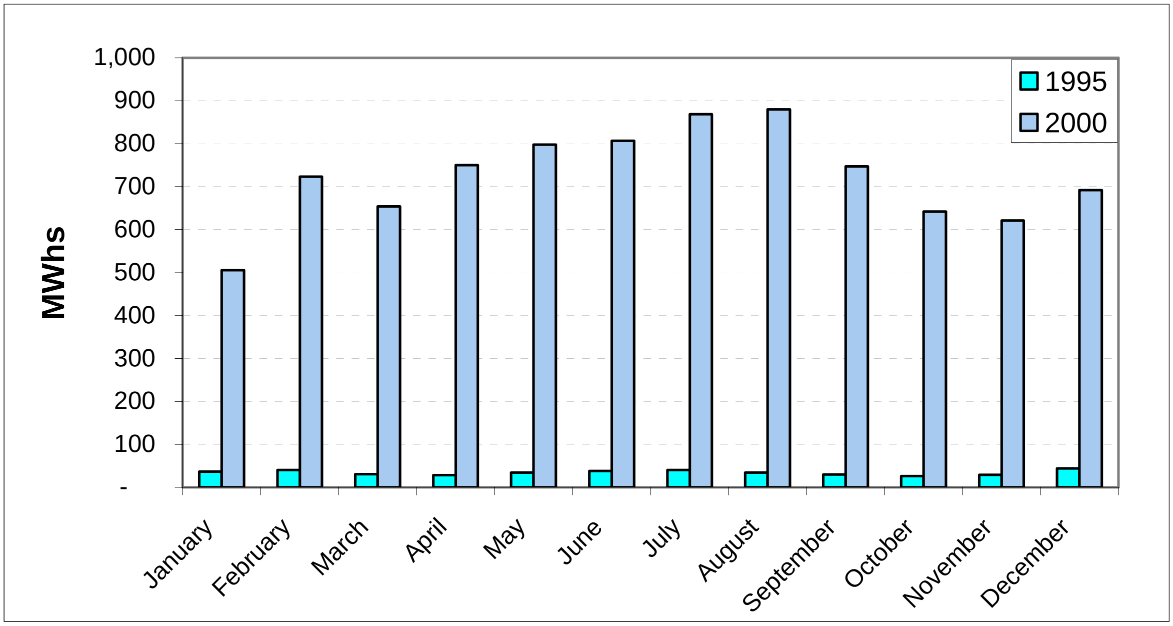


FIGURE D1-6
PUMPING STATIONS ELECTRICITY USE



General Recommendations

Water and Wastewater treatment produces high energy demands as a result of aeration and pumping requirements. There are some minor recommendations with respect to energy conservation at the treatment and pumping buildings, but the majority of the energy demand is from high service pumps that convey water for treatment. The primary route to energy reduction is through water use reduction within the community thereby reducing the volume of water requiring treatment and accordingly, less energy is used. Significant reductions in water use have been implemented by various municipalities by implementing water use programs and by-laws for outside water use; low-flush toilet rebate programs; industrial capacity buy back programs; sewer discharge metering and associated sewer surcharges to water bills; and Community general awareness campaigns.

With respect to water supply, water loss through the distribution system creates additional pumping demands and energy use. Undertaking a distribution system water balance audit would identify volumetric losses and potential sources of leakage.

Information related to each of the facilities toured during the energy audit are included in the following section.

PART TWO

Potential Opportunities for Improved Energy Efficiency

Sewage Treatment Plant

The Sewage Treatment Plant profile is listed in Table D2-1.

TABLE D2-1
SEWAGE TREATMENT PLANT PROFILE

Location	249 Bradford
Operational Profile	Continual Operation
Building History	The original facility was built in the 1950s/ 1960s and has undergone many additions and renovations. Many parts of the facility are underground or partially underground and linked with service tunnels. The facility includes a cogeneration building, a digester building, a chemical storage building, a diesel generator building, primary and secondary clarifier buildings, a UV treatment building, underground basements and connecting tunnels as well as an administration building.
Building Energy Management System	Barrie's sewage treatment facility is among the most integrated and innovative plants in operation. A cogeneration building at the facility is capable of producing up to two thirds of the plant's electrical needs (with available digestion gas and/or natural gas.) on gases (methane) or natural gas that are extracted from the sewage solids. Generators operate on natural gas when methane is not available. Waste heat from the generators in the cogeneration building are used to power hot water boilers and a hot water circuit that heats most buildings and tunnels at the facility. Supplemental heating is supplied by electrical baseboards and electric roof top units.
Lighting	
Main Administration Office (offices, meeting room, laboratory, control room and equipment bay and storage)	Standard fluorescent fixtures (T-8 and T-12) controlled by wall switches in the office. Low pressure sodium light fixtures, which is most efficient, are present in the equipment bays and storage areas. Many inside lights go on and off automatically with motion control switches.
Cogeneration building	Standard fluorescent T-8 fixtures controlled by wall switches (upper level and office). In some locations (lower level) there are intrinsically safe lights installed in areas where a gas leak is possible.
Digester building	Intrinsically safe lights are installed in the gas capture room. Low pressure sodium, controlled by wall switches in the control room.
Tunnels	All tunnels are controlled by motion sensors.
Chemical storage building	Standard fluorescent T-8 fixtures controlled by wall switches and motion sensors.
Diesel generator building	Standard fluorescent T-12 fixtures controlled by a wall switches
Primary Clarifier building	Service tunnels have a limited number of fluorescent intrinsically safe lights.

TABLE D2-1
SEWAGE TREATMENT PLANT PROFILE

Secondary Clarifier building	Service tunnels have a limited number of fluorescent intrinsically safe lights. Sodium wall light fixtures.
UV Treatment building	UV lights are in enclosed tanks and are used for water treatment. Sodium light fixtures along both walls.
Underground basements and tunnels	Service tunnels have a limited number of fluorescent intrinsically safe lights.
Exterior Lights	Controlled by photocells and/or timers
Building Heating/Cooling/Ventilation	
Main Administration Office	Hot water space heaters with supplemental electric baseboard heaters.
Cogeneration building	Two electric heaters and an air conditioning unit in the control office. Three hot water in the Boiler room and one hot water heater in the Heat Exchange room.
Digester building	Hot water radiator in the control room. There is no space heater. And the area has an air conditioning system.
Chemical storage building	Hot water radiator, hot water tank and an electric portable 240 v heater.
Diesel generator building	Hot water radiator.
Primary Clarifier building	Service tunnels heated by hot water radiators. Cont. room electric heat.
Secondary Clarifier building	Service tunnels heated by hot water radiators. One electric heater in the Pump room and two electric heaters in the Control room.
UV Treatment and Tertiary Filter building	Hot water radiators and air-conditioned office.
Underground basements and tunnels	Service tunnels heated by hot water radiators.
Cooling	Most of the buildings lack air conditioning. Some control rooms and offices such as the Digestor Control room and the maintenance office have electric air conditioning.
Other equipment	
Generators/Transformers	Two generators in the cogeneration building operate continuously on digester gas or natural gas, One backup diesel generator in a separate building. Several transformers of various size throughout the facility.
Heat Exchangers /Boilers	In the cogeneration building, heat exchangers use waste heat to produce hot water which then circulates in a loop and heats various buildings and tunnels in the facility. Excess digester gas is also used to produce hot water from buildings and process heat. Plus two boilers can add heat.
Exhaust Fans	Present in almost every building, controlled by gas detectors, thermostats or manual switches.
Pumps	There is a multitude of pumps that exist in the treatment facility. All pumps are electric and vary in both size and function. For example, the pumping of digester sludge, hot water heating system or simply moving sewage or water through the various stages of treatment.
Hot Water Heater	Four electric hot water heaters – one each for the administration office, maintenance shop (wash up area), diesel generator building washroom, and one tertiary washroom and custodial area.

TABLE D2-1
SEWAGE TREATMENT PLANT PROFILE

Building Envelope	
Windows	For the most part, windows are sealed double paned glass in the buildings that can be opened. Several parts of the facility are currently under construction/renovation and are partially open to the outside.
Doorways	The main public entrance into the administration offices have a double set of doors.
Meterage	
Gas	One meter for the entire facility
Electricity	One meter for the entire facility

The original facility was built in the 1950s - 60s and has since undergone many additions to accommodate population growth in Barrie. Many parts of the facility are underground or partially underground and linked with service tunnels. The facility includes a cogeneration building, a digester building, a chemical storage building, a diesel generator building, treatment tertiary clarifiers, a UV treatment building, underground basements, connecting tunnels as well as an administration building. Many of the buildings and infrastructure have been renovated, retrofitted or are currently under construction and consist of red brick veneer walls. Most of the exterior windows are double paned glass which is often opened in the summer to improve ventilation and cooling (most of the buildings lack air conditioning). Many doors have gaps in their weather-stripping. The main administration building has double doors at the main public entrance. A few skylights are present, above the effluent pumps and in the new addition being constructed in the administration building.

The administration building has one main floor with offices, a new office addition (currently under construction), washrooms, a control room, a laboratory, equipment bays (vehicles), and maintenance shop. The cogeneration and digester building has two levels and are part of the original infrastructure that has been renovated within the last six years. In the cogeneration building, the upper level has two generators, control panels and switches while the lower level has various pumps and piping, a heat exchanger, and boilers. The cogeneration building's main purpose is to receive gases from the digester building and produce electricity and hot water to meet the needs, in part, of the rest of the facility. The digester building also has two levels and includes a gas capture room, four digesters, four pumps, two sludge heaters, and a control room. The chemical storage building is a single story structure that is used primarily for sodium hypochloride. The diesel building houses the backup generator and is also used to store various equipment parts. The primary and secondary clarifiers are underground for the most part and consist of concrete tanks. A UV treatment building with tertiary filters form the final phase of water treatment before water is pumped into the bay by five electric pumps at the effluent pump station.

Two co-generator engines in the cogeneration building provides heat for the plant building and processes as well as some of the facility's electrical needs. Gases (Methane) captured from the sewage (at the digester) are used to power two engines located on the second floor of the cogeneration building, producing 250 kWh or approximately one third of the plant's electrical needs. Electricity produced at the facility is synchronized with outside electricity through control panels and boilers produce hot water for a heating loop that circulates the tunnels and buildings. Pumps on the lower level help circulate hot water through the loops. Waste heat from the system is exchanged with effluent and discharged to the Ellen Street sanitary sewer. When the digester is down and no sewage gases are being collected, the engines are switched to natural gas.

Natural gas space heaters, hot water radiators and/or hot water space heaters are used to heat most buildings at the treatment facility. A limited number of electrical baseboard heaters were found in the administration building and main control room. The natural gas space heaters are typically used to provide supplemental heat, especially in control rooms and other commonly occupied rooms. For example, the digester building control room was heated by a natural gas space heater controlled by a thermostat.

Some automatic controls have been implemented at the facility to varying success. Most offices and control rooms have standard fluorescent T-8 or T-12 fixtures controlled by a light switch. Equipment bays and storage areas in the administration building, the UV building among others also have sodium light fixtures. Intrinsically safe light fixtures have been installed in certain areas where there is a potential for a hazardous atmosphere (Cogeneration and Digester buildings). Light fixtures in the service tunnels are controlled by motion sensors. There have been reports that several sensors and lights have been malfunctioning. Employees typically turn out lights at the end of the day in their respective work areas. Lights in several buildings, including the digester building and the chemical storage building are also controlled by motion sensors. Some buildings also have skylights, which provide supplementary lighting during the day.

Innisfill Booster Station

The Innisfill Booster Station profile is presented in Table D2-2

TABLE D2-2
INNISFILL BOOSTER STATION BUILDING PROFILE

Location	380 Innisfill Road
Operational Profile	Continual operation
Building History	A small red brick building that is shared with Ontario Hydro which was renovated and retrofitted and now is approximately 300 square feet.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Control panels operate pumps and communicate with central control. Inside lights are controlled manually.
Lighting	
Main pump room	6 Fluorescent T-8 fixtures controlled by one manual switch.
Exterior lights	Controlled by a photocell

TABLE D2-2
INNISFILL BOOSTER STATION BUILDING PROFILE

Building Heating/Cooling/Air Flow and Ventilation	
Heating	One electric spacer heater/fan controlled by a manual switch
Cooling	No cooling system present / not required
Ventilation	Vents are covered by freely moving louvers
Other Equipment	
Booster Pumps	Three 100 hp electric booster pumps
MCC Control Panel	Communication and control equipment
Building Envelope	
Windows	Double thermo paned glass in main hall, original single paned glass windows in older part of the building
Doors	Double door vestibule at the main entrance, Garage Doors in the lower level
Meterage	
Electricity	One main meter for the building

The Innisfill Booster Station is a small red brick building that is shared between the City of Barrie and Ontario Hydro. The building's main operational function is to receive water from the water network and boost water pressure for the local distribution area. Equipment housed in the building includes 3 booster pumps, an MCC control panel and a chlorine analyzer.

The building has two service levels with some insulation (roof), a sealed double paned window, steel doors and vents. The doors have some weather stripping; however, the doors do not seal and require maintenance. The vents are covered by louvers which are freely moving and prone to opening with prevailing winds.

The building is only occupied for short periods of time for routine checks unless maintenance is required. The space heater runs continuously until the room reaches a certain temperature and then the heater turns off automatically. The heater has a manual switch to adjust temperature settings. Employees turn on the units in the late fall and turn off the units in the summer. Internal lights are only turned on when employees are present.

Recommendations

- Install a blind on the window
- Install devices that limit or control louver movement
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Harvey Reservoir

The Harvey Reservoir profile is presented in Table D2-3.

TABLE D2-3
HARVEY RESERVOIR BUILDING PROFILE

Location	90 Harvey Road (Harvey and Veterans Lane)
Operational Profile	Continual operation
Building History	A concrete structure inside the reservoir embankment. Constructed at the same time as the reservoir. Protected by a barbwire fence. Recent renovations include the expansion of the reservoir, the addition of a Chlorine room and a new roof with insulation. Inside lights are controlled manually.
Building Energy Management System	Heating provided by three electric heaters (two with manual controls and one on a thermostat). The building maintained near room temperature. A separate vent house also has one electric heater
Lighting	
Main room	10 Fluorescent T-12 fixtures controlled by manual switches
Exterior lights	Controlled by a photocell
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Three electric spacer heaters/fan. One electric heater in the vent house
Cooling	No cooling system present / not required
Ventilation	Two exhaust fans (one for the main room and one for the chlorine room)
Other Equipment	
Injection Controls	Chlorine injection control equipment
MCC Control Panel	Communication and control equipment
Water Heater	One small electric hot water heater
Pumps	There are no pumps at this facility
Meterage	
Electric	One meter for the building

The Harvey Reservoir building is built into the side of the reservoir embankment and is located near Harvey Street and Veterans Lane. The building houses a chlorine/chemical injection system as well as check valves that are used to open/close various cells in the reservoir. The building was recently expanded and retrofitted to include the addition of a chlorine room and accommodate the expansion of the reservoir. The chlorine room is separated from the rest of the building and has its own exhaust/ventilation system. The main valve room has two service levels. The lower service level provides access to the check valves and hot water tank. The upper level provides access to control and communication equipment. A separate vent house is also present on the property; however, the building was not toured due to accessibility issues (snow).

The building does not have any windows. The main steel entrance door lacks weather stripping and a round hole above the door (approximately three inches in diameter) has been left open to the outside. The walls are solid concrete and roof was recently insulated.

Heating is provided by three electric space heaters. Two of the space heaters have manual controls while the third heater is controlled via a thermostat. The building is usually maintained at a constant 25 degrees Celsius. The vent house was also reported to have an electric heater. Lighting in the building consists of ten fluorescent T-12 fixtures in the main valve room. External lights are controlled by a photocell.

The building is only occupied for short periods of time for routine checks unless maintenance is required. The space heater runs continuously until the room reaches a certain temperature and then the heater turns off automatically. The heater has a manual switch to adjust temperature settings. Employees turn the units on in the late fall and turn the units off in the summer. Internal lights are only turned on when employees are present.

Recommendations

- Repair weather stripping and patch the hole above the door.
- Add thermostats to all electric heaters (if possible).
- Cover/insulate the small electric hot water tank.
- Reduce average temperature of the building to 21 degrees Celsius.

Mapleview Elevated Tower

The Mapleview Elevated Tower profile is presented in Table D2-4.

TABLE D2-4
MAPLEVIEW ELEVATED TOWER BUILDING PROFILE

Location	65 Mapleview (Bryne and Mapleview)
Operational Profile	Continual operation
Building History	An elevated concrete tower (tank)
Building Energy Management System	One electric space heater, controlled by a thermostat, heats a small control room located inside at the base of the water tower. Heat tracers run along the water riser pipes inside the tower. The rest of the tower is not heated or insulated and remains cool all year round. The city and communication controls electrical demands are metered separately. Inside lights are controlled manually.
Lighting	
Control room	3 Fluorescent T-12 fixtures controlled by a manual switch
Tower	A few incandescent lights are present at the top of the tower
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	One electric space heater in the control room
Cooling	No cooling system present / not required

TABLE D2-4
MAPLEVIEW ELEVATED TOWER BUILDING PROFILE

Riser Pipes	Riser pipes (Inlet and Outlet water pipes) have a heat tracer attached to the outside of the pipe.
Other Equipment	
Pumps	There are no pumps within this building
Meterage	
Electric	Two meters for the building (City and Point to Point Communications Equipment)

The Mapleview facility is a large elevated tower (tank) that helps maintain water pressure for the surrounding water distribution network. The tower is also used as a communications tower by Point to Point Communications Inc. Communication equipment located inside and outside the tower are owned and operated by the communications company and are metered separately.

A small enclosed control room located inside at the base of the tower houses control valves, electric meters and switches. The control room is heated with a small electric space heater that is controlled by a thermostat (set at 20 degrees Celsius). The rest of the tower building is not insulated or heated with the exception of heat tracers that run along the outside of the riser pipes (Intake and Outflow).

Lighting consists of three T-12 fixtures located in the control room. Several incandescent service lights are present inside the tower.

The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Big Bay Booster Station

The Big Bay Booster Station profile is presented in Table D2-5.

TABLE D2-5
BIG BAY BOOSTER STATION BUILDING PROFILE

Location	20 Big Bay Road (Big Bay and Point Road)
Operational Profile	Continual operation
Building History	Red brick building with some insulation later retrofitted with new pumps.
Building Energy Management System	Two electric space heaters, controlled by a thermostat, heat the entire building. Two air handling units used to reduce humidity for older pumps that have since been removed, are still in operation. Control panel operates four pumps located inside the building. Manual lighting controls.
Lighting	
Main Pump room	10 Fluorescent T-12 fixtures controlled by a manual switch

TABLE D2-5
BIG BAY BOOSTER STATION BUILDING PROFILE

Exterior lights	Controlled by a photocell
Building Heating/Cooling/Ventilation	
Heating	Two electric space heater in the main pump room
Cooling	No cooling system present / not required
Other Equipment	
Booster Pumps	4 (125 hp) electric pumps
MCC Control Panel	Communication and control equipment
Air Handling Units	2 Carrier Air Handling Units
Meterage	
Electric	One electric meter for the building

The Big Bay Booster Station is a small red brick building located at 20 Big Bay Road. The building's main operational function is to receive water from the water network and boost water pressure for the local distribution area. Equipment housed in the building includes 4 booster pumps (125 hp), an MCC control panel, switches, valves, two air handling units, two electric heaters and a chlorine analyzer.

The main pump room is heated with two small electric space heaters that are controlled by thermostats. The building has three doors and no windows. The doors have some weather stripping; however, the doors do not fully seal when closed. The amount of insulation in the building was unknown. A vent with louvers was visible in the ceiling.

Two operating air handling units (Carrier) were observed at one end of the building. City staff indicated that the air handling units were installed to control humidity levels for the variable speed pumps. These variable speed pumps were later replaced with new pumps; however, the air handling units were left in place and are still operating.

Lighting consisted of ten T-12 fixtures located in the main pump room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Re-evaluate the need for the two air handling units
- Install devices that limit or control louver movement
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #12

The Well # 12 Building profile is presented in Table D2-6.

TABLE D2-6
WELL #12 BUILDING PROFILE

Location	85 Lakeshore (in Centennial Park)
Operational Profile	Continual operation
Building History	Small building with exterior wood veneer panelling. The pump and backup generator are located in one room while the chlorine injection equipment and chlorine tanks are located in a separate small interior room.
Building Energy Management System	Two electric space heaters, controlled by internal thermostats, heat the entire building until it reaches a temperature set by the manual switch. Manual lighting controls. Backup Generator.
Lighting	
Main Pump room	9 Fluorescent T-12 fixtures controlled by a manual switch
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	One electric space heater located in the main pump room, the second electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required
Other Equipment	
Well Pump	Electric well pump - 250 Hp and treatment pumps – 3 Hp total
MCC Control Panel	Communication and control equipment
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fan	Exhaust fan operates when the generator is running
Meterage	
Electric	One electric meter for the building

The Well #12 building is a small building with exterior wood panelling. The building is located at 85 Lakeshore along the water front. The building's main operational function is to extract water from Well #12, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building includes one pump, a backup generator and diesel tank, chlorine injection equipment, an MCC control panel, switches, exhaust fan, two electric space heaters and a sodium silica tank(with injection equipment).

The main pump room is heated with one electric space heater that is controlled by an internal thermostat and manual switch. A smaller chlorine room inside the building (separate entrance) has a smaller electric space heater which is also controlled by an internal thermostat and manual switch. The building has two doors, two vents, no windows and one skylight. The doors have weather stripping; however, some of the louvers associated with the exhaust fan do not fully seal. One set louvers on the other vent are operated by a mechanical device that opens the louvers in the event that the backup generator starts. The skylight, located above the pump, was installed to provide access to the well when service is required. The building is insulated; however, the amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water. A transformer is also located outside the building.

Lighting consisted of seven fluorescent T-12 fixtures located in the main pump room and two fluorescent T-12 fixtures in the chlorine room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #15

The Well # 15 Building profile is presented in Table D2-7.

TABLE D2-7
WELL #15 BUILDING PROFILE

Location	55 Centennial (in Centennial Park)
Operational Profile	Continual operation
Building History	Small building with exterior wood veneer panelling. The pump and backup generator are located in one room while the chlorine injection equipment and chlorine tanks are located in a separate small interior room.
Building Energy Management System	Three electric space heaters, controlled by internal thermostats, heat the entire building until it reaches a temperature set by the manual switch. Manual lighting controls. Backup Generator.
Lighting	
Main Pump room	9 Fluorescent T-12 fixtures controlled by a manual switch
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	Two electric space heaters are located in the main pump room, the third electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required

TABLE D2-7
WELL #15 BUILDING PROFILE

Other Equipment	
Well Pump	Electric well pump - 250 Hp and treatment pumps – 3 Hp total
MCC Control Panel	Communication and control equipment
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fan	Exhaust fan operates when the generator is running
Meterage	
Electric	One electric meter for the building

The Well #15 building is a small building with exterior wood panelling. The building is located at 55 Centennial along the water front. The building's main operational function is to extract water from Well #15, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building includes one pump, a backup generator and diesel tank, chlorine injection equipment, an MCC control panel, switches, exhaust fan, three electric space heaters and a sodium silica tank(with injection equipment).

The main pump room is heated with two electric space heaters that are controlled by an internal thermostat and manual switch. A smaller chlorine room inside the building (separate entrance) has a smaller electric space heater which is also controlled by an internal thermostat and manual switch. The building has two doors, two vents, no windows and one skylight. The doors have weather stripping; however, small gaps could be observed when the door was closed. One set of louvers on the room vent are operated by a mechanical device that opens the louvers in the event that the backup generator starts. An exhaust fan unit has been installed on the other vent with louvers. The skylight, located above the pump, was installed to provide access to the well when service is required. The building is insulated; however, the amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water. A transformer is also located outside the building.

Lighting consisted of seven fluorescent T-12 fixtures located in the main pump room and two fluorescent T-12 fixtures in the chlorine room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #14

The Well # 14 Building profile is presented in Table D2-8.

TABLE D2-8
WELL #14 BUILDING PROFILE

Location	15 Lakeshore Dr.
Operational Profile	Continual operation
Building History	Small building with exterior wood veneer panelling. The pump and backup generator are located in separate adjoining rooms while the chlorine injection equipment and chlorine tanks are located in a separate small interior room. The building is also shared by the Parks and Recreation department and is use for public washrooms and storage.
Building Energy Management System	A total of four electric space heaters, controlled by internal thermostats, heat the entire building (on the water supply side) until it reaches a temperature set by the manual switch. Manual lighting controls. Backup Generator.
Lighting	
Main Pump Room and Generator Room	10 Fluorescent T-12 fixtures controlled by a manual switch
Chlorine Room	One Incandescent Light
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	Three electric space heaters are located in the main pump room and generator room, the fourth electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required
Other Equipment	
Well Pump	Electric well pump - 200 Hp and treatment pumps – 3 Hp total
MCC Control Panel	Communication and control equipment
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fan	Exhaust fan operates when the generator is running
Meterage	
Electric	Two electric meters for the building, One for water supply side and one for parks and recreation department.

The Well #14 building is shared with the Parks and Recreation department and has exterior wood panelling. The building is located at 15 Lakeshore Dr. along the water front. The water supply side of the building had a chlorine room, the main pump room and a backup generator room. The parks and recreation side of the building has public washrooms and storage. Each side of the building is metered separately for electricity.

The building's main operational function is to extract water from Well #14, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building include one pump (with a sand separator), a backup generator and diesel tank, chlorine injection equipment, an MCC control panel, switches, exhaust fan, three electric space heaters and a sodium silica tank(with injection equipment).

The main pump room and the chlorine are both heated with their own electric space heaters that are controlled by an internal thermostat and manual switch. The backup generator room has two electric space heaters that are controlled by an internal thermostat and manual switch. On the water supply side, the building has two doors, two vents, no windows and one skylight. The doors have weather stripping; however, small gaps could be observed when the door was closed. One set of louvers in the pump room are operated by a mechanical device that opens the louvers in the event that the backup generator starts. An exhaust fan unit has been installed on the other vent inside the generator room which also has louvers. The skylight, located above the pump, was installed to provide access to the well when service is required. The building is insulated; however, the amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water.

Lighting consisted of ten fluorescent T-12 fixtures located in the main pump room and generator room and one incandescent fixture in the chlorine room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight opening with blind.
- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #11

The Well # 11 Building profile is presented in Table D2-9.

TABLE D2-9
WELL #11 BUILDING PROFILE

Location	5 Lakeshore Dr. (in Centennial Park near Well #14)
Operational Profile	Continual operation
Building History	Small building with exterior wood veneer panelling with two levels. The pump is located in the main room while the chlorine injection equipment and chlorine tanks are located in a separate small interior room. This building shares the backup generator located in Well #14. The building is also shared by the Parks and Recreation department who use the building for cold storage.

TABLE D2-9
WELL #11 BUILDING PROFILE

Building Energy Management System	A total of three electric space heaters, controlled by thermostats and an over-ride timer, heat the entire building. Manual lighting controls. Lights in the Chlorine room also control the exhaust fan. Backup Generator.
Lighting	
Main Pump Room	Three Fluorescent T-12 fixtures controlled by a manual switch
Chlorine Room	One Fluorescent T-12 fixture
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	Two electric space heaters are located in the main pump and generator room, the third electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required
Other Equipment	
Well Pump	Electric well pump - 100 Hp and treatment pumps – 3 Hp total
Control Panel	Controls and electrical switches
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Meterage	
Electric	One electric meter for the building

The Well #11 building is a small building with two levels with exterior wood panelling. The building is located at 5 Lakeshore Dr. along the water front. The building's main operational function is to extract water from Well #11, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building includes one pump, chlorine injection equipment, switches, exhaust fan, three electric space heaters and a sodium silica tank (with injection equipment). The building shares the backup generator located in the Well#14 building.

The main pump room is heated with two electric space heaters that are controlled by separate thermostats that are connected to an over-ride timer switch. The thermostats were set at 12 and 22 degrees Celsius at the time of the building tour. Employees working in the building for an extended period of time can set the timer for more heat, if required. A smaller chlorine room inside the building (separate entrance) has a smaller electric space heater which is controlled by an internal thermostat and manual switch. The building has two doors, two vents (chlorine room), no windows and one skylight. The doors have weather stripping; however, small gaps could be observed when the door was closed. Exhaust fans are installed on the vents in the chlorine room and are operated with the main light switch. The skylight, located above the pump, was installed to provide access to the well when service is required. The building is insulated; however, the amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water.

Lighting consists of three fluorescent T-12 fixtures located in the main pump room and one fluorescent T-12 fixture in the chlorine room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight opening with blind.
- Repair weather stripping around doors
- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Bayview Park Booster Station

The Bayview Park Booster Station Building profile is presented in Table D2-10.

TABLE D2-10
BAYVIEW PARK BOOSTER STATION BUILDING PROFILE

Location	157 Dunlop (near the water front)
Operational Profile	Continual operation
Building History	Old grey stone building with no insulation and three single paned glass windows, one steel door and double glass doors. The building has two levels and used to service a well (located in a separate building nearby). The well has been abandoned and the station has been converted to a booster (high lift) station for Well #11. No renovations have been completed on the building.
Building Energy Management System	Four radiant electric heaters, controlled by thermostats, heat the entire building. Control panel operates two pumps located inside the building. A redundant transformer located in the basement is no longer connected. A former backup generator on the upper level is dismantled and no longer in operation. Manual lighting controls.
Lighting	
Main Pump room (Upper Level)	1 Fluorescent T-12 fixture controlled by a manual switch
Main Pump room (Lower Level)	2 Incandescent fixtures retrofitted with new energy efficient bulbs controlled by a manual switch.
Exterior lights	Controlled by a photocell
Building Heating/Cooling / Ventilation	
Heating	Three electric space heater in the main pump room on the upper level and one electric space heater in the lower level
Cooling	No cooling system present / not required

TABLE D2-10
BAYVIEW PARK BOOSTER STATION BUILDING PROFILE

Other Equipment	
Pumps	2 x 75 Hp Highlift pumps
Control Panel	pump control equipment
Injection Equipment	Chlorine injection equipment located on the lower level
Exhaust Fans	Exhaust Fans, located on the lower level, operate continuously to prevent the build up of chlorine gas in the basement.
Meterage	
Electric	One electric meter for the building

The Bayview Park Booster Station is a small grey stone building located at 157 Dunlop Road near the water front. A smaller building, located nearby, houses an abandoned well. The main building has two levels. The lower level has chlorine injection equipment, an exhaust fan, an electric radiant heater and a redundant transformer which is no longer in service. The upper level has two booster pumps, control equipment, electrical switches, a decommissioned generator and three electric radiant heaters. The station used to service the well in the adjacent building and later retrofitted to act as a booster (high lift) station for Well #11.

The upper and lower levels are heated with old electric radiant heaters that are controlled by thermostats. Upper level thermostats were set at 23 degrees Celsius while the lower level was set at 27 degrees Celsius. These heaters are very inefficient and poor at distributing heat in the building. During the building tour, these radiant heaters were found to be extremely hot. Moreover, the building has three large single paned windows and one set of double glass doors. Large gaps were observed around the glass doors and no weather stripping was observed. The amount of insulation in the building is either minimal or non-existent. Only one vent was noted in the ceiling.

Lighting consisted of one fluorescent T-12 fixture located on the upper level, controlled manually with a switch. The lower level had two incandescent fixtures that were retrofitted with energy efficient bulbs. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Other equipment included an exhaust fan in the basement which operates continuously to prevent the build up of chlorine gas from the chlorine injection system.

Recommendations

- The building requires major renovation (unless decommissioning is being considered in the future). Major improvements in insulating, ventilating and securing the building are required.
- Replace electric heaters with new heaters
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening

Codrington Street Booster Station

The Codrington Street Booster Station Building profile is presented in Table D2-11.

TABLE D2-11
CODRINGTON STREET BOOSTER STATION BUILDING PROFILE

Location	64 Codrington Street
Operational Profile	Continual operation
Building History	Old red brick building with minimal insulation and four single paned glass windows, a vent/ exhaust fan above one window and one steel door. The building has two levels. No renovations have been completed on the building.
Building Energy Management System	Two electric radiant heaters (Upper level only), controlled by thermostats, heat the entire building. One exhaust fan controlled by a thermostat. Control panels operate three pumps located inside the building. Manual lighting controls.
Lighting	
Main Pump room (Upper Level)	2 Fluorescent T-12 fixtures controlled by a manual switch
Lower Level	2 Fluorescent T-12 fixtures controlled by a manual switch.
Exterior lights	Controlled by a photocell
Building Heating/Cooling/Ventilation	
Heating	Two electric radiant heaters on the upper level. No heaters on the lower level.
Cooling	No cooling system present / not required
Other Equipment	
Pumps	2 x 60 Hp Highlift pumps
Control Panel	pump control equipment
Exhaust Fan	Located on the upper level above one of the windows, operates on a thermostat
Meterage	
Electric	One electric meter for the building

The Codrington Street Booster Station is a small red brick building with minimal insulation. The building's main operational function is to receive water from the water network and boost water pressure for the local distribution area. The station typically operates in the summer during peak demands. Equipment housed in the building (upper level) includes 3 booster pumps (60 hp), an MCC control panel and a chlorine analyzer. The lower level does not have any equipment.

The upper level is heated with two old electric radiant heaters that are controlled by thermostats. The thermostats were set at 23 and 27 degrees Celsius. These heaters are very inefficient and poor at distributing heat in the building. Moreover, the building has several older single paned windows which can be opened. In the summer, the building becomes very hot and the windows are opened to help dissipate heat. An exhaust fan, controlled by a thermostat, has been installed in one of the windows to help ventilate the building. The amount of insulation in the building is either minimal (roof) or non-existent.

The building is only occupied for short periods of time for routine checks unless maintenance is required. Employees turn the units on in the late fall and turn the units off in the summer. Internal lights are only turned on when employees are present.

Recommendations:

- Cover window openings with blind.
- Install fans to help distribute heat in the summer and winter.
- Upgrade radiant heaters with new heaters
- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Wells #9 and 13

Well # 9 and Well #13 Building profile is presented in Table D2-12.

TABLE D2-12
WELL #9 AND #13 BUILDINGS PROFILE

Location	168 Johnson St.
Operational Profile	Continual operation
Building History	Well #9 building is a new building currently under construction while Well #13 is housed in a separate smaller building. The Well#13 building is a pre-existing building whose exterior has recently been refaced. Both buildings have red brick veneers and are insulated with steel doors. Well #9 building has three skylights, no windows and wall vents while the Well#13 has one skylight, one double paned window and a ceiling vent. The Well #9 building has one well pump and two high lift pumps while the Well #13 building houses one well pump (which feeds into the Well #9 building) and one backup generator. Each high lift pump works in tandem with a well pump. The old chlorine room in the Well #13 building is now redundant and no longer in use. The chlorine room in Well #9 services both wells. A Contact (retention) tank below Well#9 building ensure that new water has at least 15 minutes of contact time before it enters the system.
Building Energy Management System	The Well #9 building has four electric space heaters controlled by thermostats (set at 20 degrees Celsius). The Well #13 building has three electric space heaters that are controlled with manual switches and internal thermostats. Manual internal lighting controls in both buildings and exterior lights are controlled with a photocell. Backup Generator located in Well #13 building.
Lighting	
Main Pump Room (Well 9)	Sixteen Fluorescent T-8 fixtures controlled by a manual switch
Main Pump Room (Well 13)	Two Fluorescent T-12 fixtures controlled by a manual switch
Chlorine Room (Well 9)	Two Fluorescent T-8 fixtures controlled by a manual switch

TABLE D2-12
WELL #9 AND #13 BUILDINGS PROFILE

Chlorine Room (Well 13)	No longer in use – One Fluorescent T-12 fixture controlled by a manual switch.
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	Three electric space heaters are located in the main pump room and the fourth electric space heater is located in the chlorine room of Well #9. Two electric space heaters are in the main pump room of Well #13.
Cooling	No cooling system present / not required
Ventilation	Two wall vents with louvers are present in the Well#9 building. An exhaust fan in the Well#13 building is controlled with a thermostat. A ceiling vent with louvers are located in the Well#13 building and are opened upon the start of the backup generator.
Other Equipment	
Well Pumps	One well and two high lift pumps located in Well#9 building, One well pump located in Well#13. Well pumps have sand separators.
Control Panel	Controls and electrical switches in both buildings
Exhaust Fan	Control by a thermostat, located in Well#9 building
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment located in the Well#13 building.
Meterage	
Electric	One electric meter for both buildings

The Well#9 and #13 buildings are located at 168 Johnson St. The Well #9 building is a new building currently under construction while Well #13 is housed in a separate smaller building. The Well#13 building was a pre-existing building whose exterior has recently been refaced. Both buildings have red brick veneers and are insulated with steel doors. The Well #9 building also has one well pump and two high lift pumps while the Well #13 building houses one well pump (which feeds into the Well #9 building) and one backup generator. Each high lift pump works in tandem with a well pump. The old chlorine room in the Well #13 building is now redundant and no longer in use. The chlorine room in Well #9 services both wells. A Contact (retention) tank below Well#9 building ensures that new water has at least 15 minutes of contact time before it enters the water distribution system. Both wells share the backup generator located in the Well#13 building.

The main pump room in the Well#9 building is heated with three electric space heaters that are controlled by thermostats (set at 20 degrees Celsius). A fourth electric heater is located in the separate chlorine room of the Well#9 building. The Well #13 building has three electric space heaters that are controlled with manual switches and internal thermostats. The Well #9 building has three skylights, no windows and wall vents while the Well#13 has one skylight, one double paned window and a ceiling vent. Although the Well#9 building is still under construction, gaps underneath the steel doors were visible. Contractors present during the building tour mentioned that a common problem for well stations is high winds that blow vent louvers open. Freely moving louvers attached to vents are prone to flapping or left open when prevailing winds are strong. Wall vents were present in the Well#9 building as well as an exhaust fan that was controlled by a thermostat. A ceiling vent and exhaust fan was present in the Well#13 building which starts and opens the vent louvers automatically when the backup generator starts. The buildings are insulated; however, the amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required) in the Well#9 building. A sodium silica tank and injection system located in the Well#9 building are use to help remove suspended material in the water.

Lighting consists of eighteen fluorescent T-8 fixtures located in the Well#9 building and two fluorescent T-12 fixtures in the Well#13 building. All internal lights are controlled manually with a switch. The buildings will be only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight openings and windows with blind
- Repair/Install weather stripping around doors
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #16

The Well # 16 Building profile is presented in Table D2-13.

TABLE D2-13
WELL #16 BUILDING PROFILE

Location	101 Brownwood Dr.
Operational Profile	Continual operation
Building History	Small building with exterior red brick veneer. Since the building is located in a residential neighbourhood, the building has been constructed to resemble a house. The pump and backup generator are located in the same room while the chlorine injection system is located in a separate room. Two skylights are present, on above each pump. A retention tank (15 minute contact time) is located underneath the building.
Building Energy Management System	Two electric space heaters, controlled by thermostats, heat the pump room. A smaller electric space heater operates in the chlorine room. Manual lighting controls. Backup generator.
Lighting	
Main Pump Room and Generator Room	Ten fluorescent T-8 fixtures controlled by a manual switch
Chlorine Room	One fluorescent T-8 fixture controlled by a manual switch
Exterior lights	Controlled by a photocell

TABLE D2-13
WELL #16 BUILDING PROFILE

Building Heating/Cooling/Ventilation	
Heating	Three electric space heaters are located in the main pump room and generator room, the fourth electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required
Ventilation	One wall vent controlled with mechanical louvers. Two additional vents with exhaust fans are located on the opposite wall.
Other Equipment	
Pump	Well pump – 60 Hp, Highlift pump – 100Hp, Treatment pump – 1 Hp
MCC Control Panel	Communication and control equipment
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fans	Exhaust fans operate when the generator is running
Transformer	One transformer located outside the building
Meterage	
Electric	One meter for the building

The Well #16 building is small red brick veneer building that constructed to resemble a house. The building is located at 101 Brownwood Dr. in a subdivision. The building consists of the main pump and generator room as well as a separate chlorine room. A contact tank underneath the building has been designed to allow a minimum of 15 minutes contact time before the treated water enters the distribution system.

The building's main operational function is to extract water from Well #16, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building include two pumps (with a sand separator), a backup generator and diesel tank, chlorine injection equipment, an MCC control panel, switches, exhaust fans, three electric space heaters and a sodium silica tank (with injection equipment).

The pump and backup generator room has two electric space heaters that are controlled by an external thermostat while the chlorine room has a smaller heater controlled by an internal thermostat. The building has two doors, two vents, no windows and two skylights. The doors have weather stripping, however, small gaps could be observed when the door was closed. Vent louvers in the pump room are operated by a mechanical device that opens the louvers in the event that the backup generator starts. Exhaust fans have been installed on the vent on the other side of the building. Skylights, located above the pumps, were installed to provide access to the well when service is required. The building is insulated; however, the amount of insulation in the walls and ceiling are unknown. At the time of the building tour, large icicles were hanging from the roof.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water.

Lighting consisted of ten fluorescent T-8 fixtures located in the main pump room and generator room and one fluorescent T-8 fixture in the chlorine room. All inside lights are controlled manually with a wall switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight opening with blind.
- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Bayfield Elevated Tower

The Bayfield Elevated Tower Building profile is presented in Table D2-14.

TABLE D2-14
BAYFIELD ELEVATED TOWER BUILDING PROFILE

Location	444 Bayfield
Operational Profile	Continual operation
Building History	An elevated concrete tower (tank)
Building Energy Management System	One electric space heater, controlled by a manual switch, heats a small enclosed control (valve) room located inside at the base of the water tower. Another enclosed room houses communication equipment and is heated by a small space heater that is plugged into the wall. Heat Tracers run along the water riser pipes inside the tower. The rest of the tower is not heated or insulated and remains cool all year round. Inside lights are controlled manually.
Lighting	
Control room	Two fluorescent T-12 fixtures controlled by a manual switch
Tower	A few incandescent lights are present at the top of the tower
Exterior lights	Controlled by a photocell
Building Heating/Cooling	
Heating	One electric space heater in the control room, another small space heater plugged into the wall is located in the communications room.
Cooling	No cooling system present / not required
Riser Pipes	Riser pipes (Inlet and Outlet water pipes) have a heat tracer attached to the outside of the pipe.
Other Equipment	
Pump	There are no pumps at this facility.
Meterage	
Electric	One meter for the main building and the city's communication equipment. One meter for Clearnet™ communications.

The Bayfield facility is a large elevated tower (tank) that helps maintain water pressure for the surrounding water distribution network. The tower is also used as a communications tower by the City's Fire Department. Some ClearnetTM communication equipment is also present and metered separately.

A small enclosed control room located inside at the base of the tower houses control valves, electric meters and switches. The control room is heated with an electric space heater that is controlled by a thermostat. A separate communications room is heated with a small electric space heater that is plugged into the wall. The rest of the tower building is not insulated or heated with the exception of heat tracers that run along the outside of the riser pipes (Intake and Outflow).

Lighting consists of two fluorescent T-12 fixtures located in the control room and one fluorescent T-12 fixture in the communications room. Several incandescent service lights are present inside the tower.

The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Connect the second space heater to a thermostat if possible

Anne Street Booster Station and Reservoir

The Anne Street Booster Station Building and Reservoir profile is presented in Table D2-15.

TABLE D2-15
ANNE STREET BOOSTER STATION BUILDING (AND RESERVOIR) PROFILE

Location	164 Anne Street
Operational Profile	Continual operation
Building History	Red brick building with some insulation (amount of insulation unknown). Building operates as a booster station and controls the reservoir. The pump and backup generator are located in the separate rooms. One skylight is present above the pumps.
Building Energy Management System	Three electric wall heaters, controlled by individual thermostats, heat the entire building. Control panel operates the three pumps located inside the building. Manual lighting controls. Backup generator present.
Lighting	
Main Pump room	2 fluorescent T-12 fixtures controlled by a manual switch
Exterior lights	No exterior lights present
Building Heating/Cooling / Ventilation	
Heating	Three electric wall heaters in the main pump room
Cooling	No cooling system present / not required

TABLE D2-15
ANNE STREET BOOSTER STATION BUILDING (AND RESERVOIR) PROFILE

Ventilation	Three vents (two with mechanical controls and one fitted with an exhaust fan) are opened when the generator is in operation.
Other Equipment	
Pumps	2 x 75 Hp, 1 x 100 Hp
MCC Control Panel	Communication and control equipment
Exhaust Fan	Exhaust fans operate upon generator start-up
Transformer	One transformer located outside
Meterage	
Electric	One electric meter for the building

The Anne Street Booster Station is a small red brick building located at 164 Anne Street. The building's main operational function is to receive water from the water network and boost water pressure for the local distribution area as well as operate the adjacent reservoir. Equipment housed in the building includes 3 booster pumps, an MCC control panel, switches, valves, three electric heaters, an exhaust fan and a chlorine analyzer.

The main pump room is heated with three (old) electric wall heaters that are controlled by thermostats (set at 25 to 27 degrees Celsius). The building has two doors and two windows. The doors have some weather stripping; however, the doors do not fully seal when closed. The windows are single paned sealed glass units. The amount of insulation in the building was unknown. Two wall vents with mechanical louvers and an exhaust fan open when the generator starts up.

Lighting consists of 2 fluorescent T-12 fixtures that are located in the main pump room and controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present.

Recommendations

- Replace old heaters with new ones
- Lower overall internal temperature of the building
- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Leacock Booster Station and Reservoir

The Leacock Booster Station Building and Reservoir profile is presented in Table D2-16.

TABLE D2-16
LEACOCK BOOSTER STATION BUILDING PROFILE

Location	319 Leacock
Operational Profile	Continual operation
Building History	Red brick building with some insulation (amount of insulation unknown). Building operates as a booster station to increase water pressure for the local area. Since the building is located in a residential neighbourhood, the building has been constructed to resemble a house. The building has two doors and a garage door as well as three sealed window units and a skylight.
Building Energy Management System	Three electric space heaters, controlled by individual thermostats, heat the entire building. Control panel operates three pumps located inside the building. Manual lighting controls. Backup generator present in the garage.
Lighting	
Main Pump room	6 fluorescent T-12 fixtures controlled by a manual switch
Generator room	4 fluorescent T-12 fixtures controlled by a manual switch
Exterior lights	Controlled by a photocell
Building Heating/Cooling / Ventilation	
Heating	Two electric space heaters in the main pump room, and one electric space heater in the generator room.
Cooling	No cooling system present / not required
Ventilation	An exhaust fan is located in the generator room.
Other Equipment	
Pumps	1 x 30 Hp, 1 x 75 Hp, 2 x 125 Hp booster pumps
MCC Control Panel	Communication and control equipment
Exhaust Fan	Operates upon generator startup
Transformer	A small transformer is located inside the building
Meterage	
Electric	One electric meter for the building

The Leacock Booster Station is a small red brick building located at 164 Anne Street. Since the building is located in a residential subdivision, the exterior resembles a house. The building's main operational function is to receive water from the water network and boost water pressure for the local distribution area as well as operate the adjacent reservoir. Equipment housed in the building includes 4 booster pumps, an MCC control panel, switches, valves, three electric heaters, an exhaust fan and a chlorine analyzer.

The main pump room is heated with two electric space heaters that are controlled by thermostats (set between 25 and 27 degrees Celsius). The building has two doors, a garage door, three sealed windows and a skylight. The doors have some weather stripping, however, the doors do not fully seal when closed. The windows are double paned with an exterior thermo glass and an interior frosted plastic (Lexan). The skylights are sealed units that can be opened when the wells require servicing. The amount of insulation in the building was unknown. An exhaust fan in the generator room starts automatically when the generator starts.

Lighting consists of 10 fluorescent T-12 fixtures that are located in the main pump room and generator room and are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by a photocell.

Recommendations

- Repair or install weather stripping around doors to receive full seal when closed
- Lower overall internal temperature of the building

Well #3A

The Well #3A (Anne Street Well) Building profile is presented in Table D2-17.

TABLE D2-17
WELL #3A (ANNE STREET WELL) BUILDING PROFILE

Location	54 Anne Street
Operational Profile	Continual operation
Building History	The building is constructed of concrete blocks with exterior metal sheeting. The pump is located in the main room while the chlorine injection equipment and chlorine tanks are located in a separate small interior room. The building has two doors, no windows and two skylights. The building likely has minimal insulation.
Building Energy Management System	A total of three electric space heaters, controlled by individual thermostats, heat the entire building. Two heaters are located in the main pump room while one smaller heater is located in the chlorine room. Manual lighting controls.
Lighting	
Main Pump Room	Five fluorescent T-8 fixtures controlled by a manual switch
Chlorine Room	One fluorescent T-12 fixture controlled by a manual switch
Exterior lights	Controlled by a photocell
Building Heating/Cooling / Ventilation	
Heating	Two electric space heaters are located in the main pump and generator room, the third electric space heater is located in the chlorine room.
Cooling	No cooling system present / not required

TABLE D2-17
WELL #3A (ANNE STREET WELL) BUILDING PROFILE

Ventilation	Two vents, one with mechanical louvers and one fan with freely moving louvers in the main room. The chlorine room also has one exhaust fan.
Other Equipment	
Pumps	Well pump – 60 Hp, Highlift – 100 Hp, Treatment pump – 1 Hp
Control Panel	Controls and electrical switches
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fans	One in the main room, one in the chlorine room
Meterage	
Electric	One electric meter for the building

The Well #3A (Anne St Well) building is located at 54 Anne street and is constructed of concrete blocks with exterior metal sheeting. The pump is located in the main room while the chlorine injection equipment and chlorine tanks are located in a separate small interior room. The building's main operational function is to extract water from Well #3A, inject/treat the water with chlorine and deliver water into the municipal water network. Equipment housed in the building includes two pumps, chlorine injection equipment, switches, exhaust fans, three electric space heaters and a sodium silica tank (with injection equipment).

The main pump room is heated with two electric space heaters that are controlled by thermostats (set between 17 and 19 degrees Celsius). The building has two doors, no windows and two skylights. The doors have some weather stripping; however, the doors do not fully seal when closed. The skylights are sealed units that can be opened when the wells require servicing. The amount of insulation in the building was unknown. An exhaust fan is present in each room and is controlled by a thermostat (main pump room) or switch (in the chlorine room). The skylight, located above the pump, was installed to provide access to the well when service is required. The building likely has minimal insulation. The amount of insulation in the walls and ceiling are unknown.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water.

Lighting consists of five fluorescent T-8 fixtures located in the main pump room and one fluorescent T-12 fixture in the chlorine room that are controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight openings with blinds
- Repair weather stripping around doors

- Install devices that limit or control louver movement / inspect and repair louvers
- Evaluate the need for exterior building protection from winds. For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

Well #4

The Well#4 (Perry Street Well) Building and Reservoir profile is presented in Table D2-18.

TABLE D2-18
WELL #4 (PERRY STREET WELL) BUILDING PROFILE

Location	83 Perry Street
Operational Profile	Continual operation
Building History	The Perry Street facility consists of two buildings. One of the buildings, the last of the original buildings, is a small older white building constructed of metal siding (no insulation) and houses a high lift pump. The other building is newer and constructed of concrete with red brick veneer. The red brick building houses the main Well#4 extraction/inject pumps. An underground retention tank between the two buildings ensure that treated water has a minimum of 15 minutes contact time before being discharged into the system. The small metal building has one door and one window. The larger brick building has two doors, no windows and one skylight.
Building Energy Management System	Two electric baseboard heaters, controlled by individual thermostats, heat the smaller metal building. Another two electric space heaters are used to heat the main brick building. The chlorine room in the brick building has a small electric baseboard heater. Manual lighting controls.
Lighting	
Main Pump Room	Eight fluorescent T-12 fixtures controlled by a manual switch
Chlorine Room	One fluorescent T-12 fixture controlled by a manual switch
Lift station building	One fluorescent T-12 fixture controlled by a manual switch
Exterior lights	Controlled by a photocell
Building Heating/Cooling/Ventilation	
Heating	Two electric space heaters, controlled by individual thermostats, are located in the main pump room. A third electric baseboard heater with manual settings is located in the chlorine room. The older building has two electric wall heaters that are controlled by a thermostats.
Cooling	No cooling system present / not required
Ventilation	Two vents are controlled by mechanical louvers in the main pump room. Two other vents have fans installed (controlled by thermostats). The chlorine room also has one exhaust fan.
Other Equipment	
Pumps	Well pump – 40 Hp, Highlift pump – 75 Hp
Control Panel	Controls and electrical switches
Injection Equipment	Chlorine and sodium silica injection and monitoring equipment
Exhaust Fans	Two fans in the main room (controlled by thermostats), one in the chlorine room

TABLE D2-18
WELL #4 (PERRY STREET WELL) BUILDING PROFILE

Location	83 Perry Street
Meterage	
Electric	One electric meter for both buildings (located in the metal building).

The Well #4 (Perry St Well) facility consists of two buildings located at 83 Perry St. One of the buildings, which is also the last of the original pump buildings, is a small older white building constructed of metal siding (no insulation) and houses a high lift pump. The other building is newer and constructed of concrete with red brick veneer. At the time of the building tour, the building was under renovation. The red brick building houses the main Well#4 extraction/inject pumps. An underground retention tank between the two buildings ensures that treated water has a minimum of 15 minutes contact time before being discharged into the system. The building's main operational function is to extract water from Well #4, inject/treat the water with chlorine and deliver water into the municipal water network. The equipment housed in the main building includes a well pump, chlorine injection equipment, switches, exhaust fans, three electric heaters and a sodium silica tank (with injection equipment). The equipment housed in the smaller metal building includes a high lift pump, two electric heaters and a fan.

The main pump room is heated with two electric space heaters that are controlled by thermostats (set at 17 degrees Celsius). A baseboard heater controlled by a manual switch services the separate chlorine room. Two wall heaters, controlled by thermostats, heat the smaller metal building. The metal building has one door and one window. The larger brick building has two doors, no windows and one skylight. The doors have some weather stripping; however, the doors do not fully seal when closed. The skylights are sealed units that can be opened when the wells require servicing. There is no insulation in the metal building and the amount of insulation in the brick building was unknown. The exhaust fans present in the main pump room, the chlorine room and the metal building are controlled by a thermostat. The skylight, located above the pump, was installed to provide access to the well when service is required.

Additional equipment includes a chlorine injection system that operates under a vacuum (no additional venting required). A sodium silica tank and injection system located in the building are use to help remove suspended material in the water.

Lighting consists of eight fluorescent T-12 fixtures located in the main pump room and one fluorescent T-12 fixture in the chlorine room that are controlled manually with a switch. The metal building had one fluorescent T-12 fixture. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present. Exterior lights are controlled by photocells.

Recommendations

- Cover the skylight openings with blinds
- Repair weather stripping around doors
- Install devices that limit or control louver movement / inspect and repair louvers

- Evaluate the need for exterior building protection from winds (wind break). For example, planting shrubs near the side of the building with the louvers to prevent them from opening.

APPENDIX E

MODULE 5

CITY OF BARRIE FLEET OPERATIONS

City of Barrie Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module 5:
Fleet Operations

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Figures

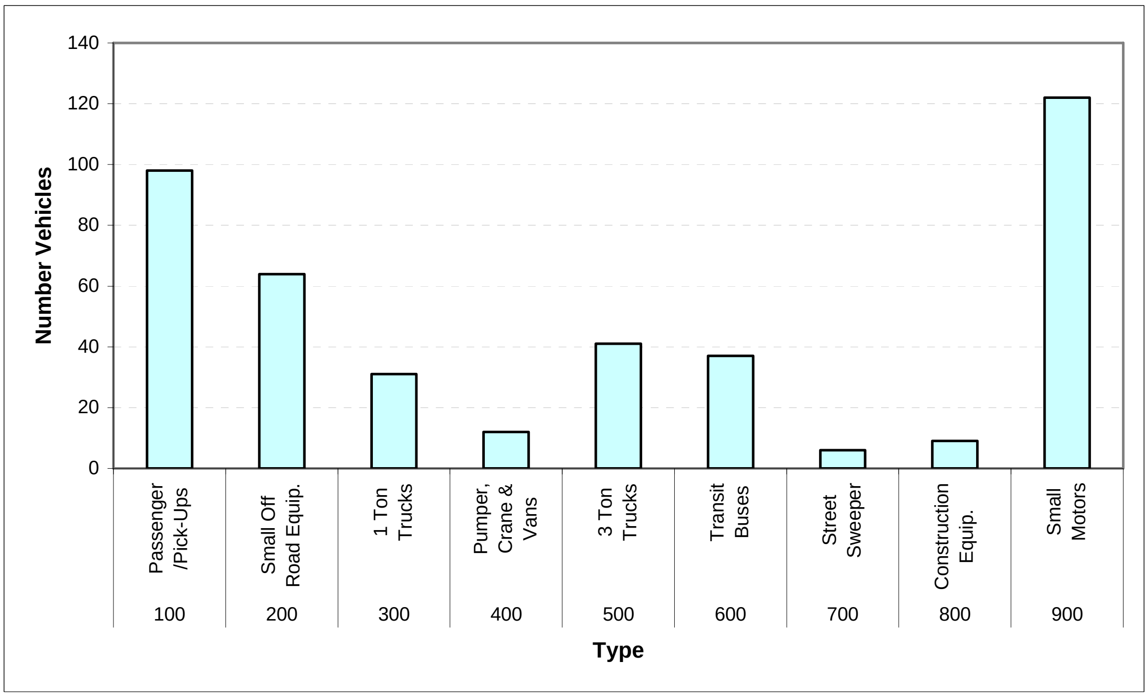
List of Tables

PART ONE

Review and Profile of Fleet Energy Consumption

The City of Barrie operates and maintains approximately 210 fleet vehicles ranging in size from passenger and light duty trucks to heavy diesel equipment. The various types of vehicles are identified in Figure E1-1.

FIGURE E1-1
NUMBER OF VEHICLES BY CLASSIFICATION



The Fleet department also carries small motors and police vehicles as part of their asset inventory. The Barrie Transit system is operated and maintained by PMCL so fuel consumption and energy efficiency opportunities are evaluated separately.

Classification Description

100 – 1000 Series

The 100 Series includes all passenger vehicles and pick-up trucks. Approximately 90 percent of the stock in this class is pick-up trucks and small vans (e.g., Ford F-150, Dodge 1500). The majority of passenger vehicle usage is conducted under employee owned vehicles through a mileage reimbursement program. Vehicles in this class are used for a wide range of utility purposes for the works crews throughout the City. (Police Service vehicles are also included in this fleet asset class but are excluded from the scope of this report since fuel is managed directly by the police department.)

200 – 2000 Series

The 200 series is primarily represents various off-road tractors used by the City. Examples of equipment in this class include: Bobcats, larger lawn mowers, lawn aerators and forklifts.

300 – 3000 Series

1 Tonne Trucks are classed in the 300 Series (e.g., Ford F-350, GMC 3500). 1 Tonnes are generally purchased for specific applications such as: traffic bucket for street light change-out, garbage compactor and sewer inspection/maintenance.

400 – 4000 Series

The 400 Series includes the pumper and crane trucks. The Police motor home which is used as a command post and for community events is also included in this category. (Note that police cruisers are not included in this report as their fuel use is managed outside of fleet operations.)

500 – 5000 Series

5 Tonne Diesel Trucks are classed in the 500 Series. Truck in this category include: fire trucks, snow plows, sanders, snow melter and sewer vactor trucks.

600 – 6000 Series

The 600 Series represents the city transit buses. The transit fleet is maintained and operated by PMCL. Fuel for the transit buses is not purchased through the City.

700 – 7000 Series

The 700 Series includes street sweepers and other antique vehicles.

800 – 8000 Series

All heavy diesel equipment is classed in the 800 Series. This would include road graders, back hoes, bulldozers and compactors.

900 -9000 Series

The 900 Series is reserved for all small gasoline engines. This would include push mowers, weed wackers, small pumps etc.

Garbage collection is outsourced to a private company and not include in this report.

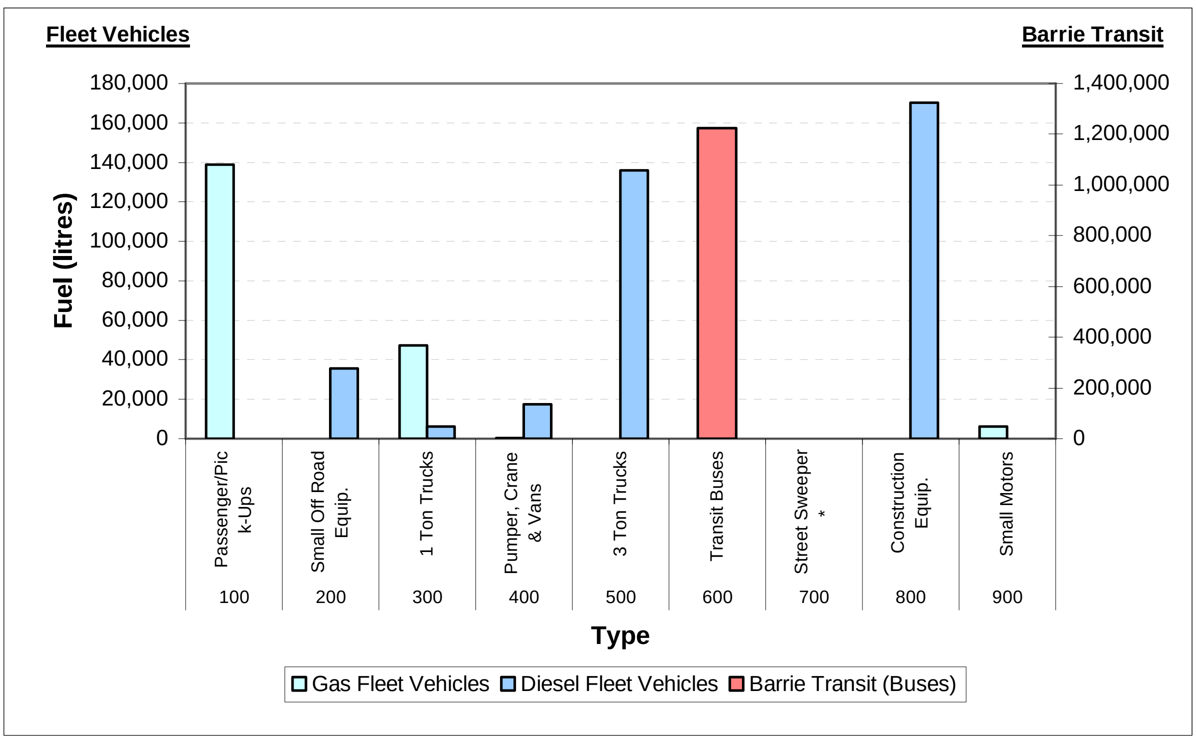
Fuel Type and Consumption by Vehicle Class

The primary decision factors for selecting engine fuel type is first cost, engine availability and durability under expected operating conditions. For smaller vehicles in the 100 and 300 Series (equal to or less than 1 ton) the City predominantly selects gasoline engines. In the 5 tonne size range diesel is selected for durability and reduced maintenance cost. Above 5 tonnes gasoline power plants are not available and all equipment is diesel.

The City has experimented with Alternate Fuel Vehicles (AFV) by purchasing some Compressed Natural Gas (CNG) passenger vehicles. This program has not expanded due to fuel cost and refueling capabilities as discussed in more detail in later sections. At present, only the Zambonis for ice resurfacing are operating on natural gas.

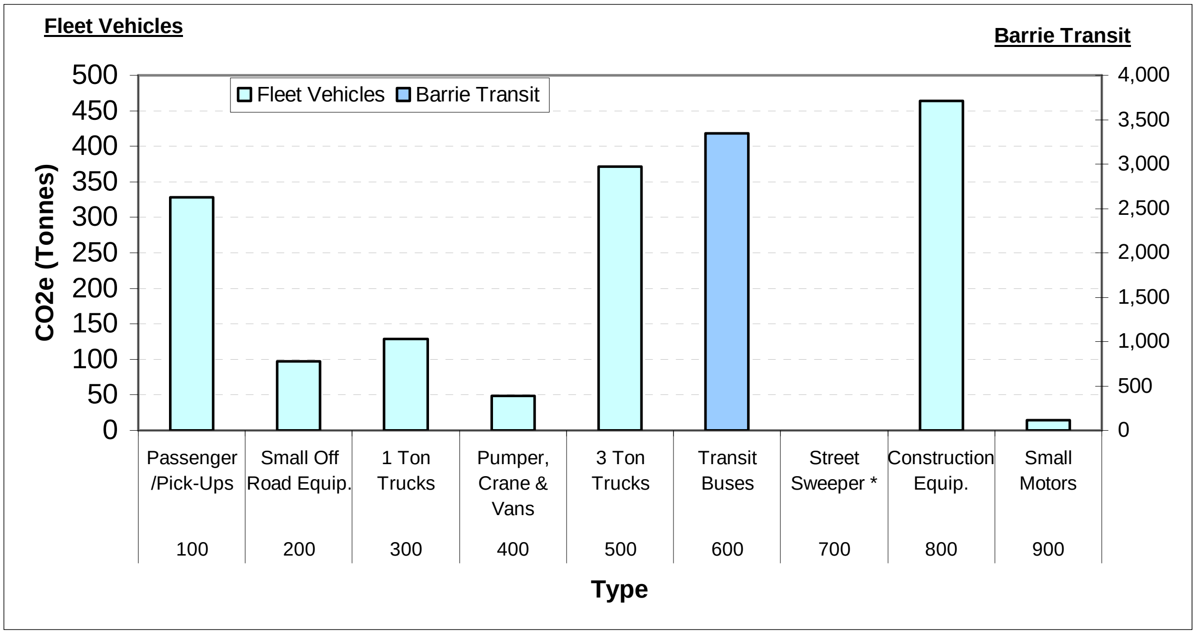
Figure E1-2 illustrates the annual fuel use by classification series. Figure E1-2 and the following Figures E1-3 and E1-4 on CO_2e emissions should be prefaced with a caution that they potentially have significant errors due to the current fuel use administration system. City vehicles refuel at the Mayes-Martin refueling depot where employees are required to enter the vehicle ID number and the mileage. At present this information is routinely entered incorrectly resulting in erroneous fuel consumption data. As such, it is currently not possible to determine base efficiency parameters such as average fuel efficiency and total vehicle kilometres driven. At this point the following figures will only serve as an indication of the relative energy use in each class.

FIGURE E1-2
ANNUAL FUEL CONSUMPTION BY CLASS



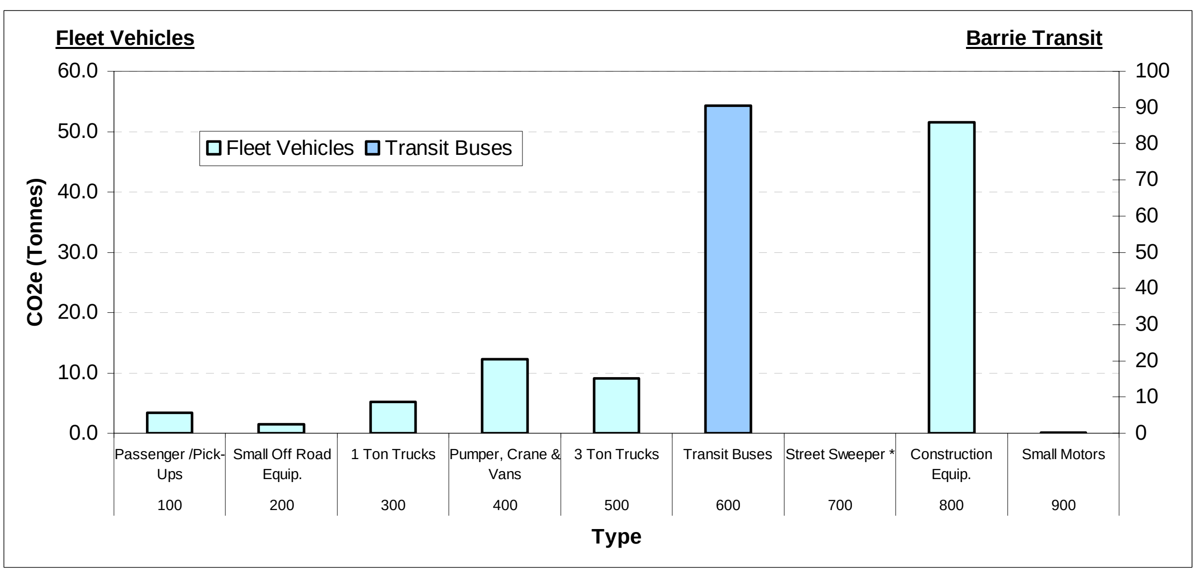
*No data available at time of report

FIGURE E1-3
ANNUAL VEHICLE EMISSIONS CO_2E



*No data available at time of report

FIGURE E1-4
AVERAGE ANNUAL VEHICLE EMISSIONS CO_2E



*No data available at time of report

While the above Figures E1-3 and E1-4 cannot be taken as exact, they do illustrate some trends that support the development of a more rigorous fuel monitoring system. Points of consideration include:

- Although 400, 500 and 800 Series equipment represent a smaller number of vehicles, their annual per vehicle fuel usage is greater than all other classes. This is particularly relevant to Series 800 heavy diesel equipment that operates at the landfill. Usage patterns and idling times of this equipment need to be further monitored to identify any energy use reduction opportunities. Since 800 Series represents so few vehicles they are not necessary perceived as a significant energy consumer relative to bulk of vehicles in Series 100 and 300.
- Transit buses represent the highest per vehicle energy usage and are not under direct control of the City, as they are contracted out.
- Series 400 vehicles have a relatively low contribution to overall annual fuel usage, but their individual vehicle fuel usage is in excess of most other vehicles including similarly sized 3 tonne trucks.
- The Series 100 pick-up trucks and small vans have a relatively low per vehicle fuel usage but represent the greatest number of vehicles operated and maintained by the City. As such, small energy efficiency improvements in each vehicle could result in significant energy savings.

Fuel Type Considerations

In terms of price, natural gas traditionally costs less than propane. Environmentally, natural gas is the cleanest burning fossil fuel. The analysis of natural gas versus propane combustion in terms of GHG impact represent emissions from the total fuel cycle--from resource recovery through energy transformation (e.g., refining) through end-use consumption. Emission estimates for each portion of the fuel cycle are shown in the report. Notable facts involving total fuel cycle emissions include the following: [1]

- CNG produces the lowest level of carbon dioxide emission across the total fuel cycle, followed by LPG and ethanol from corn.
- CNG produces the largest methane emissions.

Carbon dioxide emissions coefficients for non-electric fuels are based upon the carbon content of the fuel and percent oxidized. These are coefficients recommended for use by the Energy Information Administration.[2]

Fuel Type	CO2 Emissions [lb/Mbtu]
Gasoline	156.4
Diesel	161.4
LPG	139.0
Natural Gas	117.1

[1] U.S. Energy Information Administration *Alternatives to Traditional Transportation Fuels 1994 Volume 2 Greenhouse Gas Emissions* http://www.eia.doe.gov/cneaf/alternate/page/environment/exec2.html

[2] U.S. Energy Information Administration "*Guidelines for Voluntary Reporting of Greenhouse Gases*". Form EIA-1605.

Fuel Consumption and GHG Emission Reduction Targets

As Table E1-1 indicates, the overall increase in fuel consumption for the City has been dramatic making the PCP 20% target reduction a significant challenge.

TABLE E1-1
ANNUAL FUEL CONSUMPTION AND REDUCTION TARGETS FOR FLEET SERVICES

Fuel Type	Annual Fuel Consumption		Percent Increase	2001 CO_{2e} Tonnes	20% Reduction
	1994	2001			
Total Unleaded	228,875	329,404	144%	778	156
Total Diesel	95,100	435,043	457%	1,188	238
Barrie Transit	799,640	1,225,000	153%	3,345	669
TOTAL	1,123,615	1,989,447		5,311	1063

If a reduction target of 20% is assumed then the new CO_{2e} reduction goal would be 394 tonnes for City managed vehicles and 1063 tonnes including Barrie Transit.

PART TWO

Review of Fleet Operations and Energy Efficiency Opportunities

The review of energy efficiency opportunities will be divided into the following categories for this report:

Behavioural Opportunities

- Monitoring/Accounting/Benchmarking
- Education/Driver Habits
- Usage/Route Optimization

Equipment Based Opportunities

- Vehicle Type and Size
- Fuel Type
- Maintenance
- Energy Efficiency Devices
- Energy Efficiency Rebate Programs

Behavioural Opportunities

Fleet Monitoring, Accounting and Benchmarking

Fleet Services has two key management tools with respect to monitoring and auditing energy usage within the city's vehicles. The primary administrative tool is called Computerized Fleet Analysis (CFA). This is a multi-faceted PC based software tool that can track all aspects of a vehicles operation including: scheduled maintenance, capital and maintenance costs, fuel usage, mileage, vehicle utilization and overall life cycle costs. CFA is currently used extensively to manage vehicle maintenance and is also used for vehicle use optimization and life cycle cost control. As an example, the annual cost of operating various vehicle types relative to the duty tasks being performed is evaluated to select the most cost effective vehicle for the task. Also, vehicles of low annual usage are identified as potential opportunities for fleet reduction through periodic rental or leasing of stock.

The second key administrative tool for managing fuel usage in Barrie's fleet is a card lock system that exists at the main private refuelling depot managed by Mayes-Martin. This system requires that city personnel enter the vehicle ID and mileage at each refuelling. As noted previously, however, this system is currently fraught with errors due to incorrect entry of vehicle ID numbers and mileage is not always entered. Fuel consumption data from the Mayes-Martin system must be manually downloaded into CFA each month as the systems operate independently.

The integration of the card lock system and CFA is currently a weak point in the management of fuel usage. In addition, while the CFA is a very powerful analysis tool it does require initial creation of data transfer protocols and report format generation. At present there is no reliable reports indicating fuel use for individual vehicles and fuel efficiency for each vehicle. (As noted above, CFA is currently tracking vehicle life cycle cost – but independent of fuel costs.) Temporary or permanent administrative staff is needed to support the update and on-going maintenance of CFA.

Another key aspect of managing fuel usage is accountability. At present, fuel cost components are spread throughout city departments but the fuel use is managed by Fleet Services. Future plans are to streamline administration and have all fuel use managed and budgeted under the Fleet Services account. Overall operating costs will be allocated by Fleet Services to various departments – of which fuel will be a component. This trend to simplify energy use accounting has been seen in various departments throughout the city and tends to move accountability for energy use away from the personnel directly responsible for the fuel use. Energy use accountability and end-user awareness need to be re-emphasized in the administrative culture within the City.

Education and Driver Habits

The City currently has a dedicated staff member to conduct driver training programs for vehicle operators. At present, these training programs are primarily directed at improving road safety and increasing driver qualifications to operate the larger 5 tonne diesel vehicles.

The federal government under the FleetSmart program has introduced the SmartDriver training programs which educates vehicle operators on driving techniques to reduce energy consumption. This would include techniques such as: the reduction of idling time, anticipating lights and controlling acceleration and braking

These programs have been very successful and have helped fleet operators reduce fuel consumption by up to 15% percent with no capital investment. There are general programs and well as specialized SmartDriver workshops for transit bus operators. Feedback from the training has also indicated the students of the training tend to carry the new driving practices to the personal vehicles as well.

Smart Driver Training for Transit Bus Drivers

A new Smart Driver training program has been implemented for transit bus operators. BC Transit is implementing a monitoring program to measure the potential savings this fall. Edmonton Transit completed benchmark and post training fuel consumption and has found a 12-16% reduction in fuel consumption which includes a 24% reduction in idling time.

An education program consisting of SmartDriver training as well as the need for better data entry at the Mayes-Martin refuelling depot could potentially provide fuel savings in the order of 10 percent.

Vehicle Usage and Route Optimization

The City currently has two GPS route tracking systems that can be used for route optimization and monitoring of various parameters such as speed graphs, hard braking and idling time. The first system called Grey Island is a real time internet based tracking system that has its greatest functionality during the winter for tracking snow plough and sander locations. This tool enables dispatchers to know the time to clear a section of road and also manages liability issues since it provides a record that the City had cleared and sanded each section of roadway. During the summer, the GPS transponders are transferred to the sewer maintenance vactor trucks.

The second system, called GeoTab, is a passive system that requires information download from vehicles. The system does not provide real time information but is more versatile in the type of information that can be collected.

These GPS systems are currently only used in vehicles where route timing and location records are critical to operations. These systems are potentially very complementary to the SmartDriver training programs. Many fleets have used EMC or GPS systems to track vehicle usage prior to the SmartDriver training program to monitor parameters such as acceleration, hard braking, idling time and per km fuel usage. The same parameters are measured after the SmartDriver training to demonstrate to operators the significant impact that their driving habits can have on annual fuel consumption.

Vehicle Idling

Vehicle idling can be a huge operating cost for fleet operators. Some fleet operators participating in the federal FleetSmart program found that vehicles were idling up to 54% of total operating hours and during the idling period the PTO was operating 80% of the time. Additional data from the FleetSmart program found that 20 percent of idling generally occurs within a fleets own facility. For a large diesel engine, idling can consume up to 4 litres of fuel per hour. In addition, idling creates increased wear on the engine resulting in the requirement for more frequent oil changes.

Idling is often done in winter for cab heating. Barrie's Fleet Services noted that they do not like separate cab heaters for safety reasons. With respect to snow removal equipment, engines are left idling to power lights for safety reasons and to keep the cab warm to prevent snow build-up on the windows (it is felt that defogging windows and clearing snow during restart may use more fuel). Aside from on-site idling, consideration should be given to reducing any potential idling at the Fleet Operations Centre.

Aside from snow removal equipment, minimization of idling will like provide for opportunities to reduce fuel consumption. One key target area for investigation would be the landfill and Series 800 heavy diesel equipment that has the high per vehicle energy usage. At present, the GPS transponders are being placed in Vactor Cleanout trucks during the summer. It may be worthwhile to put the GeoTab system in the Series 800 equipment to better understand the nature of the fuel consumption of these vehicles.

Equipment Based Opportunities

Vehicle Type and Size

With respect to vehicle usage in general, Fleet Services uses the CFA program to purchase the smallest vehicle with the smallest engine (at lowest capital cost) necessary to meet the operational duty of the vehicle. To minimize trips, the city is also endeavouring to purchase King Cab pick-ups so that work crews can attend a jobsite in one vehicle instead of two.

Fuel Type

As noted earlier, the majority of light duty vehicles are gasoline as they are generally lower in capital cost. Mid-sized vehicles are a mix of gasoline and diesel depending up on the expected duty. Diesel is preferred for higher duty applications because it offers lower long term maintenance and operating costs. Heavy duty vehicles are all diesel since existing gasoline engines do not have sufficient power.

Alternate fuels have been evaluated by Fleet Services but higher maintenance costs and fuel availability have plagued the expanded use of fuels such as CNG, LPG, ethanol and biodiesel. In general, CNG is best suited to conversion of small gasoline trucks and passenger vehicles while fuels such as biodiesel offer the simplest fuel alternative for mid-sized and larger diesel vehicles.

Compressed Natural Gas (CNG)

CNG currently represents the greatest economically viable opportunity to significantly reduce GHG emissions from Barrie's fleet vehicles. An equivalent litre of CNG produces 16 percent the GHG emissions of gasoline and 14 percent the GHG emissions of diesel. This reduction is achieved since natural gas is a saturated fuel – put another way, the carbon atoms in natural gas have the maximum number of hydrogen atoms attached resulting in the highest percentage of energy coming from the production of water as opposed to CO_2.

GHG Reduction Potential of CNG

If 50 percent of Barrie's Class 100 Vehicles were converted to natural gas and it is assumed 50 percent of gasoline consumption would be converted natural gas - an overall reduction of 17 percent in the fleet's total GHG emissions would be realized. (This reduction includes all diesel and gasoline emissions – excluding transit.)

For CNG to be economically viable three main factors must be addressed: refuelling infrastructure, vehicle conversion cost and fuel and maintenance costs.

Enbridge used to have partnerships with three gas stations in Barrie where fast fill CNG compressors were installed. Unfortunately the partnering petrochemical company raised the price of CNG to a price point above that of regular unleaded gasoline. This has driven several private fleet operators in Barrie to revert back to gasoline greatly weakening the CNG infrastructure in Barrie. Enbridge is currently working to secure a new relationship with an alternate petrochemical company that will price CNG well below that of gasoline to encourage the CNG market. In general, public refuelling stations typically offer CNG at a savings of 20% over regular unleaded gasoline – based on current vehicle conversion costs and available rebates the payback for converting to natural gas is approximately 4 years. On-site refuelling for fleets generally offers a 40% savings over regular gasoline resulting in vehicle conversion paybacks of less than 2 years.

To date, three CNG passenger vehicles have been purchased by the City but only one currently remains in operation. Although, pick-up trucks and vans (the majority of the 98 vehicles in Class 100) would be ideal candidates for conversion, all currently run on gasoline. There exists a poor perception of natural gas within Fleet Operations due to the poor refuelling infrastructure, perceived maintenance problems with compressors and the belief that compressor electricity negates any potential GHG savings.

Electrical Compressor Energy for CNG Refuelling

A 100 HP compressor generates 5.66 m3/min of CNG
1m^3 of CNG is equivalent to 1.07 litres of gasoline
Therefore 5.66m^3/min ÷ 1.07 litre/m^3 = 5.28 litres/min of gasoline equivalent
100 HP operating for 1 min = 1.26 kWh
1.26 kWh = 6.4 x 10^{-5} Tonnes CO_2e
Based on Ontario's current electricity mix compressor energy results in less than a 1% change in the GHG emission reduction benefit between natural gas and gasoline.

While past difficulties have existed with natural gas vehicles, the industry has made significant advances both in vehicle conversion technology and refuelling systems. Enbridge has indicated they would work with the City of Barrie to develop a flexible on-site refuelling system that could be leased as an embedded fuel cost. Compressor options could range from a fast fill system, individual vehicle refuelling appliances (slow fill) or a hybrid system offering accelerated refuelling times. The compressor of choice could be continually upgraded depending upon the number of vehicles converted to natural gas.

Over the last several years significant research and development has been conducted on natural gas conversion kits for passenger vehicles, pick-up and vans. New fuel injected conversion kits allow for highly reliable operation of dual-fuel vehicles. Of course the dual fuel capability eliminates any issues with respect to vehicle range.

Canadian Natural Gas Vehicle Alliance – Federal Grant Program

Typical Conversion Cost $5,500.00 including tanks
Federal Rebate Program $3,000.00 (on new & used vehicles)
Provincial Rebate Program – PST Rebate on New Vehicles

Typical Fuel Savings for On-Site Refuelling are ~ 30 ¢/litre
Typical Payback Period for On-Site Refuelling ≤ 2 years
Based on Ontario's current electricity mix compressor energy results in less than a 1% change in the GHG emission reduction benefit between natural gas and gasoline.

The Canadian Natural Gas Vehicle Alliance actively pursues the federal government to continue grant programs for NGV vehicle conversions. These programs have been approved (starting in 2004) and with existing provincial grants, conversion costs can have paybacks of less than one year. The new federal grant program is vehicle specific but includes a number of cars, vans and trucks. Various conversion packages exist for these different vehicles to minimize functional space requirements for the natural gas tanks.

Bio-Fuels – Ethanol Blends

Ethanol is produced from renewable biological feedstocks, such as agricultural crops and forestry by-products. It acts as an oxygenate in fuel improving combustion and reducing overall emissions.

Ethanol-blended fuels as E10 (10% ethanol and 90% gasoline) reduces greenhouse gases by up to 3.9%. Ethanol blends are available through many retailers throughout southern Ontario including all Sunoco outlets, Pioneer Petroleum, Mr. Gas, Sunys and UPI Inc. Setting a purchasing policy based on the use of ethanol blended gasoline would automatically generate a GHG reduction credit of 4 percent of all gasoline emissions.

Bio-Fuels – Biodiesel

Biodiesel is a produced from a chemical reaction between methanol and oil from soybeans and or from food waste products such as animal fat. Biodiesel can be used directly or as a blend with petroleum based diesel fuel. Typical mixtures are an 80/20 mix (80% petroleum based and 20% biodiesel fuel), or a 50/50 mix (50% petroleum based and 50% biodiesel fuel).

Biodiesel produces less harmful emissions of most air pollutants and also has the benefit of being biodegradable. While biodiesel has more lubricating ability than petroleum diesel and can reduce engine wear, it also has a higher viscosity and can clog fuel lines during cold weather operation. The City of Toronto has done extensive testing on the operation of vehicles with 100% biodiesel during summer months and has found very positive results. Biodiesel vendors will typically offer special blends for fuel supply during colder months. There are select public outlets selling biodiesel, but in general the fuel is purchased and stored on-site – vendors will also supply on-site storage containers. Vendors have advanced the consistency of their blends to optimize vehicle operation.

According to emission factors developed with Natural Resources Canada, the Canadian Agricultural New Uses Council (CANUC) has published the following greenhouse gas emission rates for biodiesel from different sources based on CO_2e/L listed in Table E2-1.

TABLE E2-1
BIODIESEL EMISSION FACTORS

Biodiesel Emission Factors	
Regular Diesel	3.12 kg
Soybean Based	1.27 kg
Canola Based	1.25 kg
Recycled Cooking Oil	0.71 kg
Animal Fats	0.29 kg

Based on Life Cycle – not tailpipe emissions

As indicated by the above table, the application of 100% biodiesel can reduce GHG emissions by 60% or greater.

GHG Reduction Potential of Biodiesel

If Barrie operated summer months on a 20 percent biodiesel blend and on a 5 percent blend during winter months this would result in a 10 percent reduction in GHG emissions attributable to diesel fuel usage. This would represent a net reduction in CO2e emissions of 119 tonnes which is 30 percent of the fleets PCP target of 394 tonnes.

It should be highlighted, that unlike CNG, biodiesel does have a slight fuel cost premium. However the Provincial Government has eliminated the fuel tax on biodiesel (14.3 ¢/litre) and the federal excise tax of 4 cents per liter was eliminated in the 2003 federal budget – thus reducing the fuel cost premium to about 1-2¢/litre. Biodiesel cost can be subject to fluctuations based on agricultural commodity prices and inventories – especially for soybean based biodiesel. Companies such as Biodiesel Canada manufacture the fuel in Canada from recycled cooking oils and animal fats allowing for a more stable price regime. (Biodiesel Canada offers a 5 percent biodiesel blend for the winter and a 20 percent blend for the summer months.)

Fuel Options for Barrie Transit

Most major bus fleets across North America are now adopting CNG as a major portion of their new fleet stock – in fact 25-30 percent of all new bus purchases are CNG dedicated. New engine and compressor technologies have made these buses very reliable and an environmentally friendly alternative to diesel. For the City of Barrie, however, two major challenges impede that adoption of natural gas buses. First, the bus fleet has a relatively low turn-over rate and second, the operation and maintenance is contracted out which results in greater price sensitivity. There is generally a minimum number of buses that must be dedicated to natural gas before the lease of a compressor system can be economically justified. The payback for this type of investment typically runs longer than the City's contract term for operation of the bus fleet. For CNG to be a viable option the City would need to incorporate the requirement to operate CNG buses in it tender documents.

As an alternative, biodiesel offers a viable alternative for bus fleets that will reduce GHG emissions as well as other hazardous emissions such as diesel particulates. The City of Brampton is currently running its fleet on biodiesel and the City of Toronto is planning testing on biodiesel this fall with plans to convert the entire fleet by 2005. A comprehensive test of biodiesel was conducted by Société de Transport de Montréal (STM) and the Canadian Renewable Fuels Association. The results of this testing are available online at www.stm.info.

Blending Low Sulphur Diesel Fuels

Sulphur acts as a lubricant in diesel fuels and low sulphur fuels can tend to accelerate engine wear. Testing has found that the lubricity of biodiesel enhances engine lubrication and has been proven to increase mileage.

Biodiesel offers a low capital cost option for the City of Barrie to significantly reduce emissions from its entire diesel fleet. Operating on a 20% blend would reduce GHG diesel emissions by 16 percent as compared to running straight petroleum based diesel.

Maintenance

Fleet Services has a very rigorous maintenance program that ensures all vehicles are operating at peak efficiency. The fleet service operation is a certified emissions testing centre for both gasoline and diesel engines which allows all vehicles to be routinely tested to verify peak operating performance.

In addition to engine tuning, other routine maintenance such as regular checks on tire pressure and alignment also helps to ensure maximum vehicle mileage per litre of fuel.

Enhanced Combustion Technologies

Various enhanced combustion technologies have been tested by fleets in Ontario. The City of Toronto evaluated the Halo spark plug that purports to enhance fuel burn by its ring shaped electrode that is designed to provide a more direct path for fuel and air to reach the spark. The benefits of this technology are highly dependant upon engine type so the city tested the plugs on a 1991 Ford F350 and a 2002 Fort F250. While the manufacturer claims 10-30 percent fuel savings, the city's test found savings in the range of 3 percent.

The City of Barrie tested a fuel mixing device from the Tadger Group. The device costs $450 and is supposed to break up the fuel thereby enhancing combustion. Fleet Services felt that the unit did increase fuel efficiency but was unable to quantify the savings.

Building Heating in Fleet Service Bays

Fleet Services has identified an opportunity to reduce fuel consumption by improving the insulation and door seals on the fleet service bays at Ferndale. In addition, during storm events, the doors may be left open for excessive periods causing the unit heaters to work overtime to try and maintain building temperature. Increased attention to open doors and the retrofit of new doors that provide a better seal and insulation will reduce building heating costs.

Summary of Measures

Based on the preceding behavioural and equipment based measures, a 20 percent reduction in GHG emissions for Barrie's Fleet Services should be attainable. It is interesting to note that CNG is currently the only measure that offers greater than 20% reduction in GHG emissions on its own. To achieve the overall target of 20% reduction by 2011 the City will need to implement both behavioural and equipment based measures to meet the target.

Tables E2-2 and E2-3 provide a summary of goals and potential measures that would need to be achieved to meet the reduction target of 1062 tonnes CO_2e.

TABLE E2-2
SUMMARY OF GHG EMISSION REDUCTION GOALS

Vehicles Managed by Fleet Services (excluding Police)	394 tonnes CO_2e
Barrie Transit	669 tonnes CO_2e
Total	1062 tonnes CO_2e

TABLE E2-3
SUMMARY OF GHG EMISSION REDUCTION MEASURES

	Fleet Services Behavioural Factors	CO_{2e} Reduction
1.	Smart Driver Training Program This measure encompasses all aspects of Smart Driver training including minimization of idling, trip optimization and better fuel use accountability. Current experience from this program has demonstrated that 8-10% fuel reduction is achievable if awards recognition programs are in place. This measure is applicable to all fuel usage.	197 tonnes
Fleet Services Equipment and Fuel Use Factors		
2.	Conversion of 50 Percent of Series 100 Vehicles From Gasoline to Natural Gas CNG offers an 84% reduction in GHG emissions as compared to an equivalent amount of gasoline. Conversion to CNG offers the highest percentage reduction option currently available to Fleet Services.	321 tonnes
3.	Use Ethanol Blended Gasoline for Remaining 50% of Series 100 Vehicles Running of Gasoline Ethanol blended gasoline can reduce GHG emissions by approximately 4%.	23 tonnes
4.	Switch to Blended Biodiesel Significant test data is now available on the operation of biodiesel in various types of vehicles ranging from pick-up trucks to garbage collection vehicles and transit buses. Suppliers indicated a confidence level in converting fleets to a 20% summer blend and 5% winter blend of biodiesel. The GHG emission reduction presented in this measure assumes a yearly blended average of 12.5% biodiesel.	118 tonnes
5.	Retrofit Fleet Service Bay Doors at Ferndale Assume a 5 percent reduction in building heating fuel is possible.	27 tonnes
Subtotal of GHG Reduction Potential for Fleet Services		**686 tonnes**
Barrie Transit Behavioural and Equipment Factors		
6.	Smart Driver Training Program FleetSmart will be implementing a specialized Smart Driver training program for transit bus operators starting fall 2004. Preliminary results from this program have demonstrated that 10% reduction in fuel consumption is readily attainable.	334.5 tonnes
7.	Switch Transit Buses to Biodiesel Comprehensive test data is now available from testing completed by Société de Transport de Montréal (STM) and the Canadian Renewable Fuels Association. As noted in the fleet section, a blended fuel average of 12.5% annually provides the opportunity to reduce equivalent diesel emissions by approximately 10%	334.5 tonnes

TABLE E2-3
SUMMARY OF GHG EMISSION REDUCTION MEASURES

Fleet Services Behavioural Factors	CO_{2e} Reduction
Subtotal of GHG Reduction Potential for Fleet Services	**669 tonnes**
Grand Total CO_{2e} Emission Reduction Potential for Fleet Services	**1300 tonnes**

Note:
The measures in Table 3 are considered mutually exclusive for illustration and are not considered in combination. That is, behavioral factors reducing overall fuel use will affect the potential of equipment based measures.

It is noted that an outsourcing of services for fleet emissions removes the ownership of the emissions from the City, but not the control of those emissions. Work performed for the City would be associated with the City's emission profile in terms of indirect emissions, if the equipment is not directly owned. The intent of the PCP commitment is to reduce global greenhouse gas emissions.

APPENDIX F
MODULE 6
STREET LIGHTING

City of Barrie Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module 6:
Street Lighting

Prepared for

City of Barrie

Prepared by

CH2MHILL

Contents

List of Tables

PART ONE

Review and Profile of Street Lighting

Street lighting and traffic control is generally accomplished by a mix of different lighting technologies including: incandescent, fluorescent, and high intensity discharge (HID).

For street lighting, the current standard is HID Lamps which the family of: Mercury Vapour, Metal Halide, High Pressure Sodium, and Low Pressure Sodium lamps. The standard for traffic signals has been incandescent lamps but a strong transition in being made toward LED for new installations.

In considering different lamp technologies, the following lamp characteristics must be taken into consideration:

Light Output (Luminous Flux)

The quantity of light that flows out of a light is measured in lumens (lm). The amount of light hitting the road surface is measured in Lux (lx). Lux = total lumens ÷ area (m^2).

Efficacy

Efficacy is the measurement of the ability of a lamp to turn electricity into lumens. It is generally measured in lumens/watt. Overall efficacy includes both power consumed by the lamp the control ballast.

Colour Rendering Index

Color Rendering Index (CRI) is expressed as a rating from 0 to 100. It describes how a light source makes the color of an object appear to human eyes and how well subtle variations in color shades are revealed. The higher the CRI rating is, the better its color rendering ability. CRI may be applied to specific colors or to an average of eight colors. The notation for average CRI is Ra.

Lamp Life

Rated average life for high intensity discharge lamps is defined as: A value of lamp life expectancy based on laboratory tests of representative lamps, burning at rated volts, on an approved system, operating with a burning cycle of 10 hours per start. The "average life" is determined when 50% of the lamps initially installed are still operating.

Table F1-1 provides a general summary of different lamp types:

TABLE F1-1
LAMP TYPES

Lamp Type *Nominal wattage and International Type Descriptor are shown.*	**Circuit Watts** *(Lamp and control gear total power draw)*	**Light output (lumens)**	**Efficacy (lumens/ watt)**	**Colour Rendering Index, R_a**	**Lamp Life (hours)**
Mercury Vapour					
250 watt HME	271.0	12,700	46.8	40 - 60	22,000
400 watt HME	424.0	22,000	51.8	40 - 60	
High Pressure Sodium					
250 watt HST	276.0	27,500	99.6	≤40	25,000
400 watt HSE	434.0	49,000	112.9	≤40	
Metal Halide – Probe Start					
250 watt HIT	269.5	19,500	72.3	75 - 85	6,000
400 watt HIT	437.0	31,750	72.6	80 - 90	
Metal Halide – Pulse Start					
300 watt (LLRPSL)	324	30,500	94.1	70	20,000
450 watt (LLRPSL)	485	50,000	103.1		
Low Pressure Sodium					
18 watt	25.5	3,825	Typically 140 – 160 lumens/ watt	0	Typically 14,000 - 18,000 hours
35 watt	45.0	6,750		0	
90 watt	102.5	15,375		0	
Fluorescent					
36 watt triphosphor (Compact)	45.0	2800	62.2	80 - 85	10,000
36 watt triphosphor (Linear, 26mm diameter)	42.0	3350	79.7	80 - 85	7,000
LED					
18 volt Amber (590nm)[3]	31.9	650	20.3	0	100,000
18 volt White (4,500K)	31.9	325	10.2	70	100,000
Incandescent	100 *(lamp only, no ballast required)*	1,000 – 1,500	Typical range: 10 – 15	99	Typically 750 - 1000

The original HID technology used for street lighting was the mercury vapour lamp. While these lamps had a reasonable colour rendering index, their efficiency was relatively low. Subsequently, metal halide and high pressure sodium lamps were introduced to the market place and have now become the accepted standard. As noted on the table, low pressure sodium lamps have the highest efficacy, but also the lowest color rendering index. During the early 1990's, Toronto installed low pressure sodium lamps on the Don Valley Parkway, and received many complaints about the lighting quality. The City has since replaced these lamps with high pressure sodium.

In general, the two primary lamps types used for street lighting are now high pressure sodium and metal halide. High pressure sodium produces an acceptable light quality and has the advantage of high efficiency and very long lamp life. Metal halide has a slightly lower efficacy but produces more of a "white light" and is used in applications where colour rendition is important to the area.

For traffic control signals, LED light technology is sweeping the market place. LED's use 85 to 90 percent less electricity than comparable incandescent lamps and have an operating life up to 50 times longer. LEDs currently have an efficiency of approximately 20 lumens per watt – manufacturers expect to push this figure to 50 lumens per watt by 2005.

City of Barrie Street Lighting Inventory

The City of Barrie converted all of the existing fluorescent and most mercury vapour lamps to high pressure sodium and metal halide in the early 1990's. The current lighting inventory is indicated on Table 2.

TABLE F1-2
LAMP TYPES

Lamp Type	Wattage (Excluding Control Circuit)	Number of Lamps	Connected Load (including ballast control)
High Pressure Sodium	70W	288	22.2 kW
	100W	4,150	456.5 kW
	150W	3,193	526.8 kW
	200W	409	90.0 kW
	250W	896	246.4 kW
	400W	217	95.5 kW
Mercury Vapour	150W	16	2.6 kW
	250W	15	4.1 kW
Metal Halide	100W	56	6.2 kW
Totals		**9,240**	**1,450.3 kW**

The hours of operation of the street lights is controlled by cadmium sulphide photo sensors that automatically turn each light on and off and dusk and dawn. Of the total 9,240 street lights, 2,900 photocells have been upgraded to electronic photocells and all new lighting installation are using electronic photocells.

Energy consumption and billing by Barrie Hydro is currently based on 4016.16 operating hours per year (334.68 hours per month). All billing is based on a flat rate tariff by Barrie Hydro.

City staff indicated that there were no active steps taken to review tariffs based on energy efficiency measures taken by the City.

The City currently has 167 intersections which equate to approximately 120 full light set equivalent intersections. Intersections use incandescent lighting for traffic control. The standard amount of power consumed for a full intersection is 1177 kWh/month. All new intersections are equipped with LED lighting systems that use 193 kWh/month. There are plans to retrofit all intersections to LED lighting but funding allocation has not yet been confirmed.

PART TWO

Review of Street Lighting Energy Efficiency Opportunities

Change to More Efficient Lamp Types

Barrie has already converted all of the fluorescent and most mercury vapour lamps to high pressure sodium and metal halide. There are still 31 mercury vapour lamps in operation. Converting from mercury vapour to metal halide (similar CRI), an energy savings of approximately 37% can be realized. Based on 4,016 operating hours per year, the potential electrical savings would be 9,138 kWh/year.

Where probe start metal halide lamps are utilized, there is the potential to change out these lamps to pulse start metal halide lamps. Pulse start lamps have an improved arc tube design and increased fill pressure that allows for higher lumen output and greater efficiency as compared to probe start lamps. If all 56 probe start lamps were converted to pulse start, the energy savings would be approximately 5,400 kWh per year.

As noted above, an intersection utilizing incandescent lamps for traffic control will consume approximately 1,177 kWh/month, whereas LED lamps would only consume 193 kWh/month – a net energy savings of 984 kWh/month or 11,808 kWh/year. Since the City has 120 equivalent full light intersections, the total potential energy savings is:

11,808 kWh/intersection x 120 intersection = 1,416,960 kWh

Reduce Number of Lamps Operating

For street lighting operations, Barrie has a Light Uniformity Code based on different road classifications. The Uniformity Code dictates the required lighting levels so lamp reduction is not practical.

Reduce Lamp Operating Hours

Since Barrie utilizes photocell technology to control lamp on/off cycles, it is important to understand the implications of dusk to dawn cycle timing. The City still has 6840 lamps operating on cadmium sulphide photo cells. The switch-off illuminance of these devices can be three to five times the switch-on illuminance, which is around 30-60 lux. The implication is that this can add an additional 30 minutes daily operating time of each lamp. Due to instability, switch times can drift up to 10 percent per year. Additionally, cadmium sulphide photo-switches have a low but constant power draw – up to 2 watts per switch when the lamp is off.

Replacing the existing photocells with newer more reliable electronic types could reduce lamp operating time by up to 30 minutes per day. For all 9,240 lamps, this would represent a savings of approximately:

1,450.3 kW (connected load) x 0.5 hours/day x 365 days/year = 264,679 kWh/year

Now to address the "tiny" 2 watt load of the cadmium sulphide photo cells controlling each lamp. New generation photocells utilize phototransistors and can have power consumption as low as 0.4 watts. This represents a savings of 1.6 watts per street lamp. While this may not seem very much, consider the savings over one year:

0.0016 kW/sensor x 9,240 lamps x 8760 hours/year = 129,507 kWh/year

Since cadmium sulphide photocells have a service life of about 7 years, an accelerated upgrade program could be initiated based normal photocell replacement.

Introduce Data Management Software

At present, the number and type of lamps is tracked manually on a map of the City. To audit the street lighting system, it is necessary to manually count each lamp type on the map. Adoption of commercially available street lighting software would allow for automated tracking of lamp inventory and history of lighting upgrades.

In addition, data management software would also act as a tool to reconcile how much is being paid to Barrie Hydro and how the energy bills are being calculated. At present, there is organized activity within the City whereby energy efficiency initiatives are recorded and presented to the electric utility as a justification for rate reduction. (It should be noted, however, that Barrie Hydro is updating its billing practices – for example, Barrie Hydro will be installing a new photocell on their roof to provide a more accurate calculation of operating hours.)

Solar Street Lighting

There are now several Canadian and U.S. based companies marketing solar street lighting systems. While solar lighting has a significantly higher capital cost, it may be a viable option in areas where hydro is not readily available or as green technology promotion in public areas. Solar systems can be completed stand-alone or grid interconnected for back-up power supply.

To give an idea of the solar panel sizing required, the National Renewable Energy Laboratory estimates the solar radiation available in the Great Lakes area to be 2-3 kWh/m^2 of collector/day. A 50-W lamp operating for 10 hours would consume 0.5 kWhs. Solar panel and battery sizing is usually designed to accommodate 2-3 relatively dark days so a 1 m^2 panel would be required.

Solar street lighting systems typically use fluorescent or low pressure sodium lamps in the 18 to 50 W range. One company in particular Sunlight Solar Technologies (www.sunlightsolar.com) has recently introduced LED based street lighting.