City of Whitehorse – Energy Management Plan
Final Report

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Submitted to:
City of Whitehorse

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Executive Summary

Introduction

In 2008, the City of Whitehorse made an official commitment to sustainability with the adoption of its Strategic Sustainability Plan. This plan is the City's guide to becoming a more sustainable community, and aims to incorporate sustainability into all municipal operations and decision-making.

In this context, the City commissioned an Energy Management Plan (Plan) to serve as a roadmap for achieving deep energy and cost reductions and improving the overall energy performance of its facilities. The Plan will support decision making for the implementation of energy management initiatives in alignment with the City's objectives, regulations, and social obligations.

This Plan provides the business case and action plan for the implementation of cost-effective energy management opportunities including technical measures, operating and maintenance (O&M) practices, and corporate-level energy management systems. The development of the Plan was informed by energy performance benchmarking, detailed energy assessments, best practices in energy management, energy management system protocols, stakeholder workshops, the collective experience of the ICF Marbek consulting team, and the vision and leadership of the City.

The Plan provides an actionable and comprehensive roadmap for achieving energy, peak demand, and cost savings in the City's portfolio of buildings; and will serve as a framework for achieving continual improvement of energy performance in support of long-term energy and cost reduction goals.

Work Plan

The work plan undertaken to develop the plan involved three main task areas:

Task Area 1: PRELIMARY ENERGY ASSESSMENTS

In this initial phase, ICF Marbek conducted preliminary energy assessments of each building as a first step in identifying the potential opportunities for energy savings. The specific assessments included a baseline energy use assessment, site assessment and interviews, facility energy performance benchmarking including energy use, technical best practices, and corporate-level organizational best practices assessments. An initial stakeholder workshop was then held to review all the assessment results including initial findings, energy savings potential, and opportunity areas; and, to seek guidance from the Project Steering Committee to focus the next phase of the plan development.

Task Area 2: BUSINESS CASE & ACTION PLAN

For the second phase, ICF Marbek carried out a series of business case assessments of the energy management opportunities identified in the previous task area including corporate-level initiatives. For each energy management opportunity (EMOs and retrofit/upgrades) such as lighting, water conservation, HVAC and controls upgrades, building envelope measures, O&M practices, etc., the business case assessment included an estimate of the expected energy savings and calculation of GHG impacts, simple payback, return on investment (ROI) and project net present value (NPV).

Task Area 3: PREPARATION OF THE PLAN REPORT

In this final phase of plan development, ICF Marbek prepared and assembled a draft Energy Management Plan and presented the preliminary findings at a second stakeholder workshop. The goal of the workshop was to review and approve the energy management actions, implementation scenarios, and schedule. ICF Marbek incorporated the City's comments and then submitted a final report to the City for approval.

Recommended Energy Management Opportunities

Exhibit 1 presents a summary of the business case assessments for the five recommended energy management opportunities that would form the basis of a comprehensive Energy Management Program. As shown, the five major opportunity areas are:

- Lighting Retrofit
- Heating, Ventilating and Air-Conditioning (HVAC) and Refrigeration Upgrades
- Re-commissioning and Controls Optimization
- Operating and Maintenance Practices
- Water-Efficient Plumbing Fixtures

The total annual cost savings for the recommended opportunities are estimated to be $313,000, with an estimated implementation cost of $1,200,000. The resulting simple payback period is 3.9 years and the GHG emissions reductions are 384 tonnes of eCO_2 per year These savings represent a 12% overall reduction in energy use; including a 12% reduction in electricity, a 9% reduction in fuel oil, a 38% reduction in propane, and a 16% reduction in water use. Using a discount rate of 6%, these projects result in a net present value (NPV) of $998,000, indicating the overall project is financially attractive.

Exhibit 1 Summary of Recommended Energy Management Opportunities

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	107	664,840	$95,018	-12,131	-$12,009	-3,214	-$2,838	0	$0	$80,171	$510,239	6.4	$79,637	9%	8.5
Refrigeration and HVAC	0	21,783	$2,801	13,500	$13,365	23,300	$20,574	0	$0	$36,740	$125,625	3.4	$65,920	26%	73.6
RCx and Controls Optimization	0	468,269	$60,219	59,415	$58,821	8,026	$7,087	0	$0	$126,127	$446,108	3.5	$474,426	25%	207.4
Operations and Maintenance	0	215,980	$27,775	16,074	$15,913	1,360	$1,201	3,144	$5,282	$50,171	$78,311	1.6	$286,157	64%	61.1
Water Efficient Fixtures	0	8,644	$1,112	11,297	$11,184	1,229	$1,086	4,246	$7,134	$20,515	$58,896	2.9	$92,007	33%	33.4
Total	**107**	**1,379,516**	**$186,925**	**88,156**	**$87,274**	**30,701**	**$27,109**	**7,390**	**$12,415**	**$313,724**	**$1,219,179**	**3.9**	**$998,147**		**384.0**
Baseline Consumption		10,168,638	$1,575,552	958,367	$955,290	118,763	$71,486	45,033	$75,405	$2,677,734					3,512
Estimated Savings			12%		9%		38%		16%	12%					11%
Post-Retrofit Target		8,789,121	$1,388,627	870,211	$868,016	88,062	$44,377	37,642	$62,990	$2,364,010					3,128

Organizational Action Plan

The Plan presents a number of recommendations for improving the City's organizational capacity for long-term continual improvement of energy performance. The recommendations are informed by the results of the energy performance benchmarking assessment of organizational and management best practices as well as the outcomes of two stakeholder workshops. The specific recommendations are organized under the following six organizational competency areas:

- Commitment to Energy Management
- Planning Processes
- Organization and Accountability
- Energy Management Financing
- Developing Energy Management Projects
- Monitoring and Communication

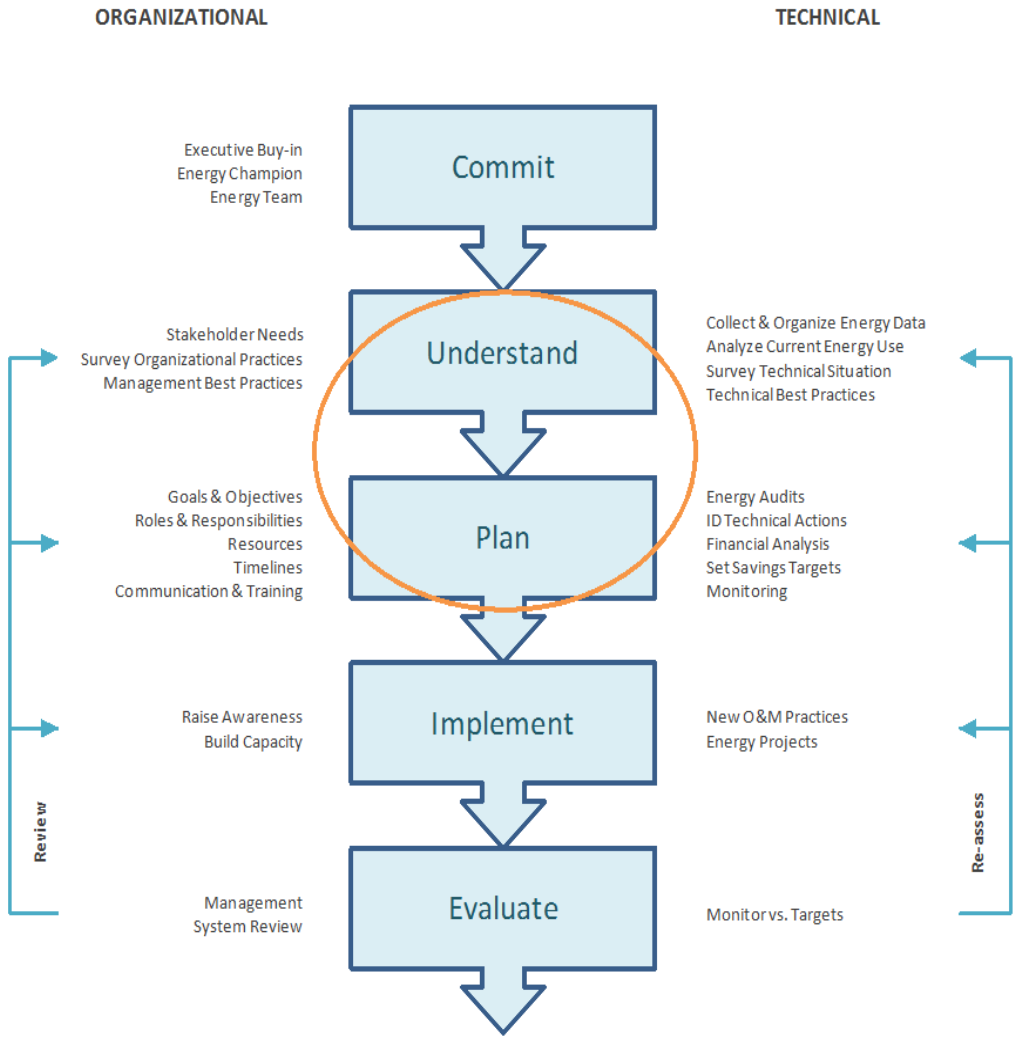
Overall Goal*:* The overall goal is to integrate energy management into all organizational and management practices, at all levels of the organization; from the strategic management of energy, to operating and maintenance practices and occupant behaviours. Specific measurable goals include:

- Top Management Support
- Designated Energy Management Resources
- Action Framework and Energy Management Plan
- Tracking and Reporting of Energy Use
- Communication and Sharing of Results
- Integration of Energy Management into the Organizational/Management Processes and O&M Practices
- Employee Engagement, Awareness & Training

Implementation Plan

The Plan also provides a framework for the implementation of a comprehensive Energy Management Program as shown in Exhibit 2 below:

Exhibit 2 Energy Management Program Framework



As shown, there are five phases in the evolution of an Energy Management Program: Commit, Understand, Plan, Implement and Evaluate (the development of this Plan addresses the Understanding and Planning phases). Each phase integrates both Organizational and Technical actions. The Organizational stream outlines the steps for developing effective management systems; while the Technical stream outlines the steps for identifying, implementing and monitoring technical measures. Together, the two streams provide an integrated process for achieving continual improvement of energy performance.

The key aspects of this framework that are relevant to the approach used for this plan include:

- The integration of the technical and organizational/management elements
- A continual improvement process in which the organizational elements are continuously reviewed and the technical elements are revised for optimal results
- The implicit importance of people and processes throughout the cycle

Overall Goal: The overall goal of the Energy Management Program is to continuously improve the energy performance of the City's facilities towards the following three-year energy reduction targets.

- 12% energy savings from 2011 levels by the year 2016
- 16% water savings from 2011 levels by the year 2016

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List of Exhibits

1 Introduction

ICF Marbek is pleased to submit this report to the City of Whitehorse (City) entitled:

City of Whitehorse Energy Management Plan

This Plan was developed under the terms of a Request For Proposal entitled: Energy Assessments and Analysis, April 2012; and was made possible by funding from the Yukon Energy Corporation, and the Federal Gas Tax.

This report provides an actionable and comprehensive Energy Management Plan (Plan) for achieving energy, peak demand, and cost savings in the City's portfolio of buildings.

The development of the Plan was informed by energy performance benchmarking, detailed energy assessments, best practices in energy management, energy management system protocols, stakeholder workshops, the collective experience of the ICF Marbek consulting team, and the vision and leadership of the City. The Plan provides the business case and action plan for the implementation of cost-effective energy management opportunities including technical measures, operating and maintenance (O&M) practices, and corporate-level energy management systems.

The Plan will serve as a roadmap for achieving continual improvement of energy performance in support of long-term energy and cost reduction goals.

1.1 Background and Objectives

Incorporated in 1950, the City of Whitehorse is the largest Canadian municipality north of the 60th parallel, with nearly 25,000 citizens. The City of Whitehorse aims to achieve excellence in providing municipal services in a remote northern city in a severe climate.

In 2008, the City made an official commitment to sustainability with the adoption of its Strategic Sustainability Plan. This plan is the City's guide to becoming a more sustainable community, and aims to incorporate sustainability into all municipal operations and decision-making.

In this context, the City requires an Energy Management Plan to serve as a roadmap for achieving deep energy and cost reductions and improving the overall energy performance of its facilities. The Plan will support decision making for the implementation of energy management initiatives in alignment with the City's objectives, regulations, and social obligations. In particular, the Plan will support key City objectives including:

- Understand how and where energy is used by the City as a corporation
- Identify energy and cost saving opportunities, including no- and low-cost opportunities
- Identify peak management opportunities to reduce demand charges
- Identify peak management opportunities to reduce the load on Yukon Energy Corporation's diesel generators at peak times
- Identify opportunities to reduce the City's greenhouse gas emissions
- Improve energy management overall and at key facilities.

1.2 Scope of Study

The development of the Plan involved undertaking a portfolio-level assessment of the twenty-three largest energy consuming facilities in the City's portfolio of buildings, representing approximately 45,000 m^2 of floor space; or approximately 90% of the total floor area occupied by City operations. The list of facilities is presented below in Exhibit 3.

Exhibit 3 List of Facilities

No.	Facility Name	Address	Facility Type	Floor Area (m^2)
1	Canada Games Centre	200 Hamilton Blvd	Multi-Use Recreation Centre	21,696
2	Takhini Arena	345 Range Road	Arena	4,093
3	Mount MacIntyre Rec Centre	1 Sumanik Drive	Curling Arena	3,940
4	Municipal Services Building	4210 Fourth Avenue	Office/Garage	3,873
5	Public Safety Building	305 Range Road	Office/Garage	3,212
6	City Hall/Fire Hall #1	2121 Second Avenue	Office/Garage	2,073
7	Transit Garage	110 Tlingit Street	Public Works	1,516
8	Frank Slim Building	2nd and Ogilvie	Community Centre	345
9	Robert Service Campground Office	120 Robert Service Way	Parks	27
10	Crestview Pumphouse	Azure Road	Water/Wastewater Infrastructure	67
11	Lift Station #1	2nd and Ogilvie	Water/Wastewater Infrastructure	152
12	Lift Station #3	Lewes Blvd	Water/Wastewater Infrastructure	128
13	Hamilton Blvd Pumphouse	Hamilton Blvd near Mallard Way	Water/Wastewater Infrastructure	139
14	Selkirk Station	Selkirk Street	Water/Wastewater Infrastructure	167
15	Animal Shelter	9032 Quartz Road	Public Works	264
16	Stores Warehouse	9000 Quartz Road	Public Works	346
17	Copper Ridge Pumphouse	Falcon Drive	Water/Wastewater Infrastructure	361
18	Marwell Lift Station	Gypsum Road	Water/Wastewater Infrastructure	446
19	Two Mile Hill Booster Stn	Two Mile Hill at Industrial	Water/Wastewater Infrastructure	523
20	Strickland Lift Station	Strickland at First Avenue	Water/Wastewater Infrastructure	52
21	McIntyre Creek Pump Station	Mountain View Drive	Water/Wastewater Infrastructure	117
22	Parks Warehouse	9043 Quartz Road	Parks	557
23	Historic Buildings (@ Frank Slim)	2nd and Ogilvie	Parks	Unknown

The scope of energy management opportunities considered in the development of the Plan included:

- Re-commissioning
- Energy Retrofits
- Capital Replacements and Major Renovations
- Renewable Energy Technologies
- Organizational and Management Practices
- Operating and Maintenance Practices
- Occupant Awareness

1.3 Approach and Work Plan

The Plan is informed by benchmarking results, energy assessments, best practices in energy management, energy management system protocols, stakeholder workshops, the collective experience of the ICF Marbek consulting team, and the vision and leadership of the City of Whitehorse. The Plan provides the business case and action plan for the implementation of energy management opportunities including the prioritization and implementation of identified technical measures, operating and maintenance (O&M) practices, occupant engagement, and corporate-level energy management systems.

Working closely with the City, our approach built on the specific plan requirements as outlined in the original RFP to include additional elements such as stakeholder workshops and the assessment of organizational and corporate-level initiatives. Our intention was to facilitate the development of a comprehensive energy management plan to address both the implementation of technical actions, and the organizational processes required for continual improvement of energy performance.

The key elements of the work plan are organized into three main task areas as follows:

- Task Area 1: Preliminary Energy Assessments
- Task Area 2: Business Case and Action Plan
- Task Area 3: Preparation of the Energy Management Plan Report.

1.3.1 Task Area 1: PRELIMARY ENERGY ASSESSMENTS

In this initial phase, ICF Marbek conducted preliminary energy assessments of each building as a first step in identifying the potential opportunities for energy savings. The specific assessments included a baseline energy use assessment, site assessment and interviews, facility energy performance benchmarking including energy use, technical best practices, and corporate-level organizational best practices assessments. An initial stakeholder workshop was then held to review all the assessment results including initial findings, energy savings potential, and opportunity areas; and, to seek guidance from the Project Steering Committee to focus the next phase of the plan development.

1.3.2 Task Area 2: BUSINESS CASE & ACTION PLAN

For the second phase, ICF Marbek carried out a series of business case assessments of the energy management opportunities identified in the previous task area including corporate-level initiatives. For each energy management opportunity (EMOs and retrofit/upgrades) such as lighting, water conservation, HVAC and controls upgrades, building envelope measures, O&M practices, etc., the business case assessment included an estimate of the expected energy savings and calculation of GHG impacts, simple payback, return on investment (ROI) and project net present value (NPV).

1.3.3 Task Area 3: PREPARATION OF THE PLAN REPORT

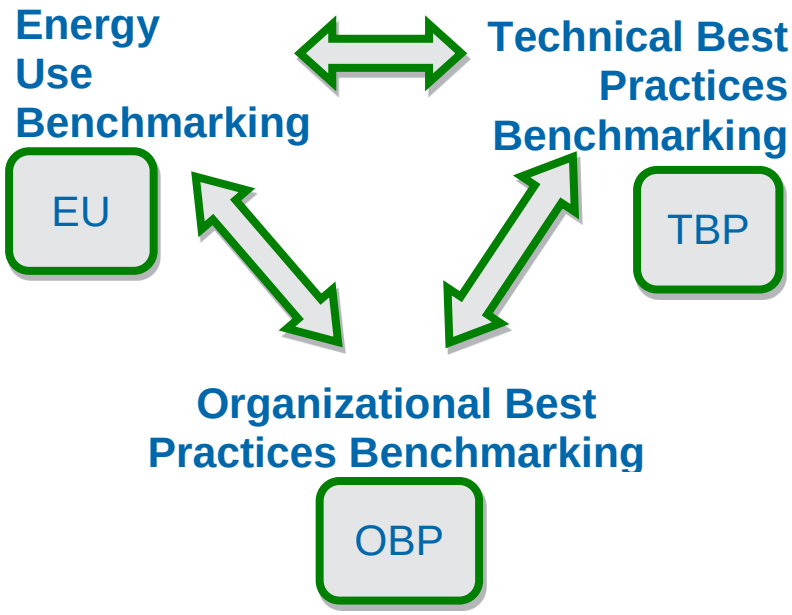
In this final phase of plan development, ICF Marbek prepared and assembled a draft Energy Management Plan and presented the preliminary findings at a second stakeholder workshop. The goal of the workshop was to review and approve the energy management actions, implementation scenarios, and schedule. ICF Marbek incorporated the City's comments and then submitted a final report to the City for approval.

2 Overall Assessment of Energy Performance

This initial section presents the results of the energy performance benchmarking assessment that was undertaken as a first step in understanding the current state of energy management in the City's facility operations, as well as the technical opportunities and organizational barriers to improving performance.

As shown in Exhibit 4, our approach encompassed three dimensions: i) energy use; ii) technical best practices; and, iii) organizational best practices.

Exhibit 4 Three Dimensions of Energy Performance



This integrated approach extends traditional whole-building energy benchmarking to address additional questions:

- What are the technical opportunities to improve energy performance?
- How do I establish the organizational and management competencies required for long-term continual improvement of energy performance?

2.1 Energy Use

2.1.1 Baseline Energy Use, Cost and GHG Profile

The baseline period is January 2011 to December 2011 inclusive. This period was selected based on the availability of utility information and the need to generate a full baseline in a concurrent period. The baseline is used for benchmarking purposes and as a reference case for calculating energy savings.

Exhibit 5 overleaf presents a profile of the base year in terms of energy use, cost and GHG emissions[1] for the 23 facilities considered in this study. The key findings are summarized as follows:

- The total energy costs are approximately $2.56 million. Electricity accounts for $1,539,157, or 60% of the total costs; oil accounts for $955,290, or 37% of total costs; propane accounts for the remaining 3% at $71,486.

- The total energy use is approximately 80,048 gigajoules (GJ). Electricity accounts for 36,634 GJ or, 46%; oil accounts for 40,374 GJ, or 50%; propane comprises the remaining 4% at 3,040 GJ.

- The total GHG emissions are 3,516 tonnes of CO_2 equivalent. Oil accounts for the largest portion at 2,624 tonnes, or 75%; electricity accounts for 712 tonnes, or 20%; propane accounts for the remaining 5% at 179 tonnes.

[1] The GHG emissions factors used in this study are: Electricity –19.4 kg eCO_2/GJ; Oil – 64.9 kg eCO_2/GJ; Propane – 59.0 kg eCO_2/GJ; based on Environment Canada's National GHG Inventory Report, 2008

Exhibit 5 Baseline Energy Use, Cost and GHG Profile[23]

No.	Facility Name	Floor Area	Electricity				Heating Fuel				Total			
			Consumption	Intensity	GHG Emissions	Cost	Consumption	Intensity	GHG Emissions	Cost	Consumption	Intensity	GHG Emissions	Cost
		[m^2]	[GJ]	[MJ/m^2]	[tonnes CO_2e]	[$]	[GJ]	[MJ/m^2]	[tonnes CO_2e]	[$]	[GJ]	[MJ/m^2]	[tonnes CO_2e]	[$]
1	Canada Games Centre	21,696	15,301	705	298	$670,968	21,917	1,010	1,424	$521,687	37,219	1,715	1,721	$1,192,655
2	Takhini Arena	4,093	3,474	849	68	$160,950	1,744	426	103	$41,015	5,219	1,275	170	$201,965
3	Mount MacIntyre Rec Centre	3,940	2,408	611	47	$86,029	3,357	852	218	$79,162	5,765	1,463	265	$165,191
4	Municipal Services Building	3,873	1,593	411	31	$69,127	6,041	1,560	393	$142,736	7,634	1,971	424	$211,862
5	Public Safety Building	3,212	1,280	399	25	$10,975	1,115	347	66	$26,268	2,395	746	91	$37,243
6	City Hall/Fire Hall #1	2,073	919	443	18	$32,839	2,264	1,092	147	$53,508	3,183	1,535	165	$86,347
7	Transit Garage	1,516	548	361	11	$23,559	1,878	1,239	122	$44,068	2,426	1,600	133	$67,627
8	Frank Slim Building	345	167	484	3	$7,748	552	1,603	36	$12,989	719	2,086	39	$20,737
9	Robert Service Campground Office	27	27	989	1	$965	42	1,541	3	$0	69	2,529	3	$965
10	Crestview Pumphouse	67	579	8,592	11	$18,052	0	0	0	$0	579	8,592	11	$18,052
11	Lift Station #1	152	484	3,174	9	$20,843	0	0	0	$0	484	3,174	9	$20,843
12	Lift Station #3	128	198	1,546	4	$6,759	0	0	0	$0	198	1,546	4	$6,759
13	Hamilton Blvd Pumphouse	139	845	6,084	16	$30,207	0	0	0	$0	845	6,084	16	$30,207
14	Selkirk Station	167	27	160	1	$1,725	0	0	0	$0	27	160	1	$1,725
15	Animal Shelter	264	100	380	2	$3,825	439	1,665	29	$10,394	540	2,045	31	$14,219
16	Stores Warehouse	346	113	326	2	$5,579	366	1,056	24	$8,641	479	1,382	26	$14,220
17	Copper Ridge Pumphouse	361	805	2,232	16	$36,688	528	1,465	34	$12,809	1,333	3,697	50	$49,497
18	Marwell Lift Station	446	3,699	8,291	72	$167,116	958	2,147	62	$21,346	4,657	10,439	134	$188,462
19	Two Mile Hill Booster Stn	523	3,162	6,049	61	$143,921	1,240	2,372	81	$27,584	4,402	8,421	142	$171,505
20	Strickland Lift Station	52	85	1,636	2	$5,656	0	0	0	$0	85	1,636	2	$5,656
21	McIntyre Creek Pump Station	117	679	5,784	13	$30,621	347	2,953	23	$9,917	1,026	8,737	36	$40,537
22	Parks Warehouse	557	140	251	3	$5,005	626	1,123	41	$14,655	766	1,374	43	$19,660
	Total	**44,096**	**36,634**	**831**	**712**	**$1,539,157**	**43,414**	**985**	**2,803**	**$1,026,776**	**80,048**	**1,815**	**3,516**	**$2,565,934**

[2] Propane and Fuel Oil combined for display purposes

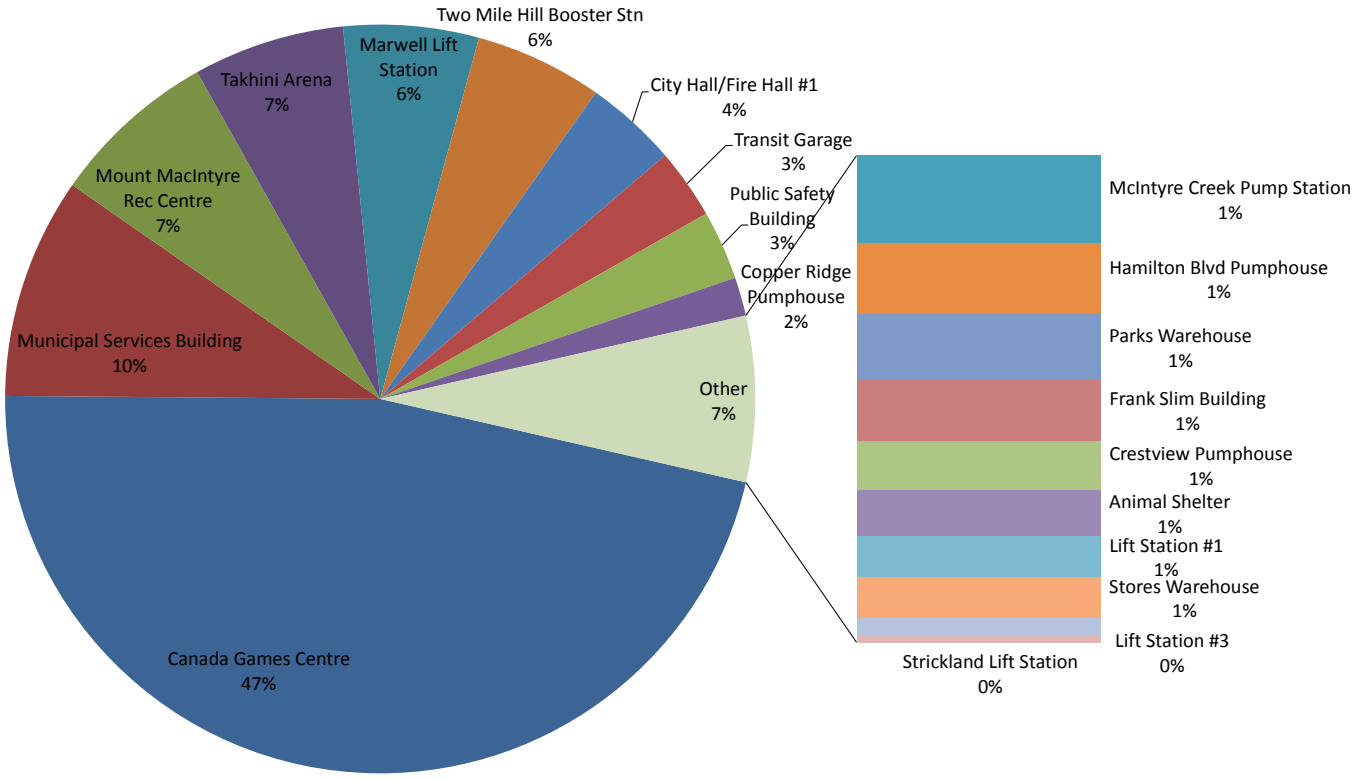
[3] The Public Safety Building and the Mount MacIntyre Recreation Centre had incomplete utility data – for these cases, the utility consumption was built from the ground up based on data collected during the site audit. Data was also missing for the Selkirk Station but since we were unable to access this site during the data collection phase, it has not been edited and remains as originally submitted.

2.1.2 Energy Use Breakdown

Energy Use by Facility

Exhibit 6 below shows the baseline energy use by facility.

Exhibit 6 Baseline Energy Use By Facility



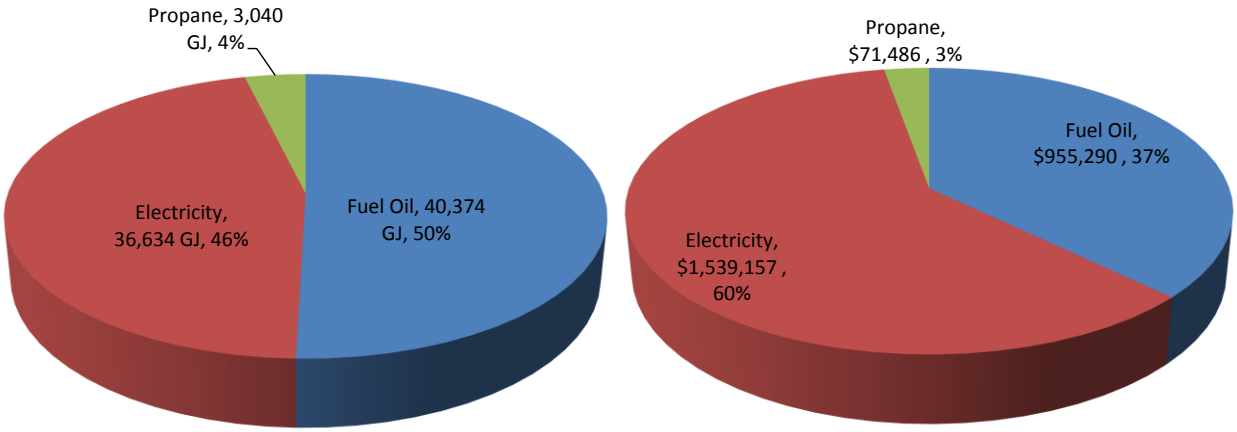
The key findings are summarized as follows:

- The Canada Games Centre is by far the highest energy user, at a 47% share of all buildings observed. Combining all recreation facilities together, they comprise over 61% of City buildings observed.
- The Municipal Services Building consumes more energy than any water or wastewater facility and more than the lowest 11 buildings combined.
- Offices and water/wastewater facilities utilize nearly the same amount of energy at 17% each. Offices would typically be expected to consume less, but the large energy use at the Municipal Services Building raises this number significantly.
- Warehouse/Garage facilities comprise the remaining 5% of energy use.

Energy Use by Fuel

Exhibit 7 below shows the fuel share in both energy equivalents (GJ) as well as cost.

Exhibit 7 Baseline Energy Use and Cost by Fuel



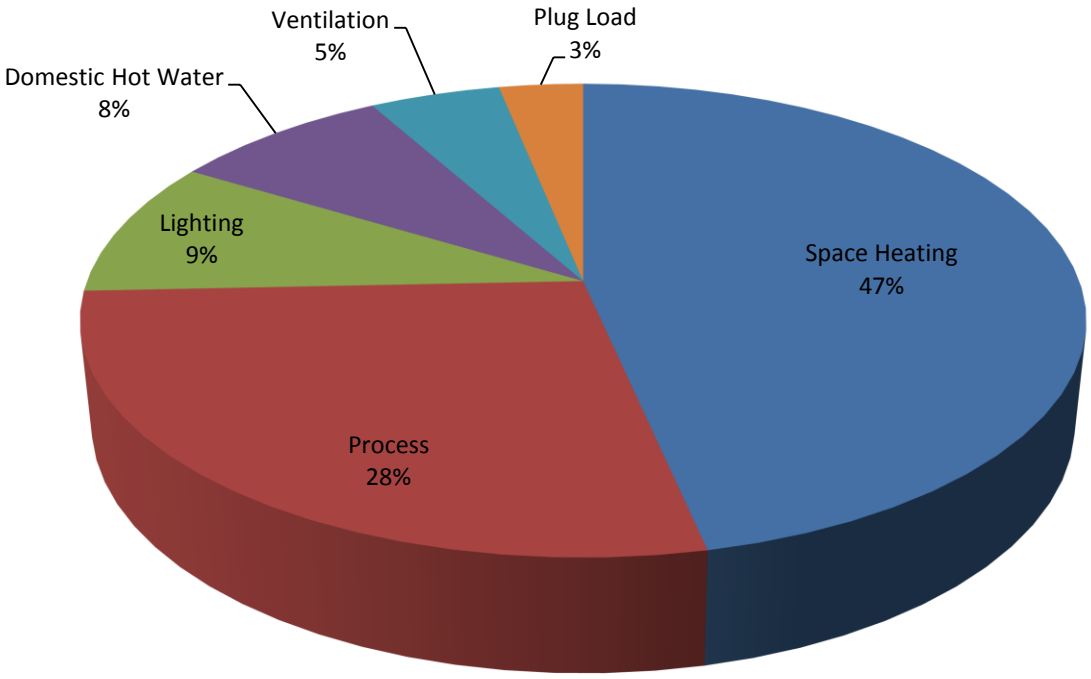
The key findings are summarized as follows:

- Electricity comprises 46% of the energy consumed but 60% of its costs, further highlighting the need to limit electric space heating.
- Oil is the main space heating fuel, comprising half of all energy used in the buildings observed and 37% of energy costs.
- Propane represents just 4% of the energy consumed, and is used in three buildings: CGC, Takhini Arena, and the Public Safety Building.

Energy Use by End Use

Exhibit 8 below shows the energy end-use breakdown, showing how the City uses its energy.

Exhibit 8 Baseline Energy End Use Breakdown



The key findings are summarized as follows:

- As is expected in a northern climate, space heating represents by far the largest share of energy use at 47%.
- Process is the next largest user at 28%; this includes refrigeration and well as water and wastewater pumping energy. For the purposes of this analysis, this also includes block heater usage.
- Lighting and hot water follow at 9% and 8% respectively. While the lighting energy consumption aligns with expectations, hot water is slightly higher than expected due to the large loads at the pool and ice rinks.
- Ventilation is a relatively low user at 5%; this is indicative of few fully ventilated and air conditioned spaces.
- Plug load is quite low at 3% and indicative of the low amount of office space.

2.1.3 Utility Rate Analysis

Electricity

Most facilities observed are subject to the Yukon Electrical Rate Schedule 2170, General Service within the Hydro Grid, Government Facilities. The rate structure is as follows:

- Consumption Charges
  - First 2,000 kWh/month: 10.00 cents cents/kWh
  - Between 2,001 – 15,000 kWh/month: 12.88 cents/kWh
  - Between 15,001 – 20,000 kWh/month: 15.68 cents/kWh
  - Above 20,000 kWh/month: 12.86 cents/kWh

- Demand Charge
  - All Demand: $7.39/kW
  - The deemed billing demand is the greater of:
    - The highest metered demand during the billing period;
    - The highest metered demand during the 12 months ending with the current billing month, excluding the months April through September;
    - The estimated demand;
    - 5 kW
  - This implies that high winter demand charges incurred by using electric heat can provide year-round penalties and that particular attention should be paid to the operations and maintenance and re-commissioning projects, which have great potential to reduce electric heating.

For the purposes of calculating potential savings for recommended retrofits, the marginal rates used are **12.86 cents/kWh** and **$7.39/kW**.

Fuel Oil

Fuel oil is provided to most City of Whitehorse facilities by North of 60 Petro Ltd at market rates. In order to calculate a marginal cost on which to base savings estimates, we have used 2011 market rates as submitted with the utility data provided. While individual oil shipments vary, the average incurred cost has been set at **99.0 cents/litre**.

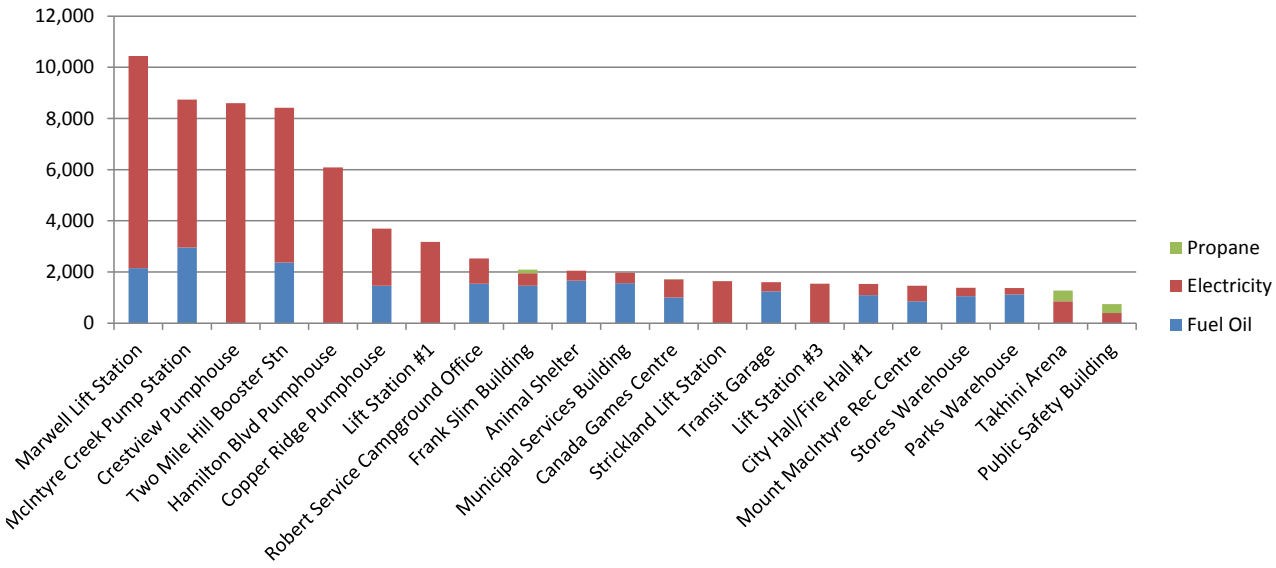
Propane

Propane is provided to some City of Whitehorse facilities by the Super Save Group at market rates. In order to calculate a marginal cost on which to base savings estimates, we have used 2011 market rates as submitted with the utility data provided. While individual propane shipments vary, the average incurred cost has been set at **88.3 cents/litre**.

2.1.4 Energy Use Benchmarking

Exhibit 9 presents the total energy use by facility, normalized by floor area for the purposes of comparison.

Exhibit 9 Total Energy Use - Normalized



The key findings are summarized as follows:

- The energy intensity ranges from a high of 10,439 MJ/m^2 per year for the Marwell Lift Station to a low of 746 MJ/m^2 per year for the Public Safety Building.
- The average energy intensity is 3,431 MJ/m^2 per year based on a total floor area of 43,929 m^2 of observed floor area.
- Pump houses tend to dominate this graph since they have very energy intensive pumping equipment and relatively low floor area.
- Several interesting building-based conclusions emerge:
  - The Municipal Services Building uses more energy per unit floor area than the Canada Games Centre - a multi-use recreation complex with two ice rinks and a pool.
  - Takhini Arena has one of the lowest intensity despite being an ice rink, traditionally thought of as the highest energy users.
  - While opportunities still exist and are identified in this report, the Public Safety Building has excellent energy performance.

2.2 Technical Best Practices Benchmarking

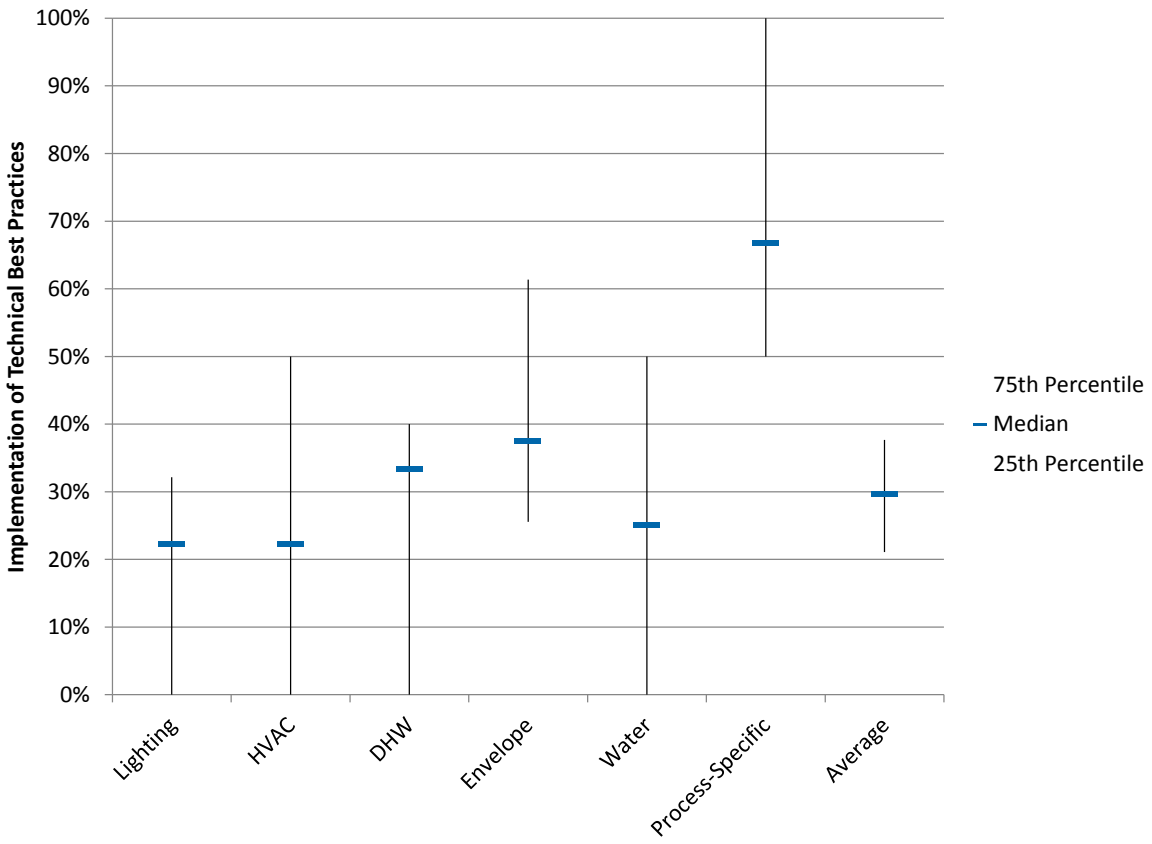
A Technical Best Practices (TBP) assessment of each facility was carried out to benchmark the current technical practices relative to best practices under the following technology categories:

- Lighting
- Heating, Ventilating, and Air-conditioning (HVAC)
- Domestic Hot Water (DHW)
- Building Envelope
- Water
- Process (Pools, Arena, Pumping)

A TBP assessment refers to a qualitative assessment of the penetration of technologies and technical practices that affect energy use performance. The results of the assessment are intended to inform the baseline penetration of technical practices in the facilities as well as the potential for energy performance improvements in each of the categories. TBP Benchmarking Reports for each facility are located in Appendix A.

The aggregated portfolio-level results are presented below in Exhibit 10 on a scale of 0 to 100. For each category, a median score is presented along with the range of scores within the 25th and 75th percentiles. A score of "0" indicates that no best practices are present in the facilities; and a score of "100" would indicate that all best practices have been implemented.

Exhibit 10 Implementation of Technical Best Practices



The key findings are summarized as follows:

- The median scores range from a low of 22% for lighting and HVAC to a high of 67% for Process-Specific measure; and an overall median score of 30% for the six categories. This indicates a generally low-penetration of technical best practices in the facility portfolio.

- With the exception of Process, the range of scores is relatively narrow indicating a consistent trend in the facility portfolio.

- The facilities generally show a low penetration of technical best practices indicating a high potential for energy performance improvements in all end-use categories.

2.3 Organizational Best Practices Benchmarking

An Organizational Best Practices (OBP) assessment was carried out to benchmark the City's current energy management practices relative to best practice. An organizational practices assessment refers to a qualitative assessment of management systems and practices related to the strategic and day-today management of energy performance. Organizational best practice is characterized by a high level of commitment, organization and action in support of the continual improvement of energy performance.

The OBP benchmarking survey (located in Appendix B) is organized in two interrelated sections: Corporate-Level and Facility-Level and consists of questions within the following competency categories:

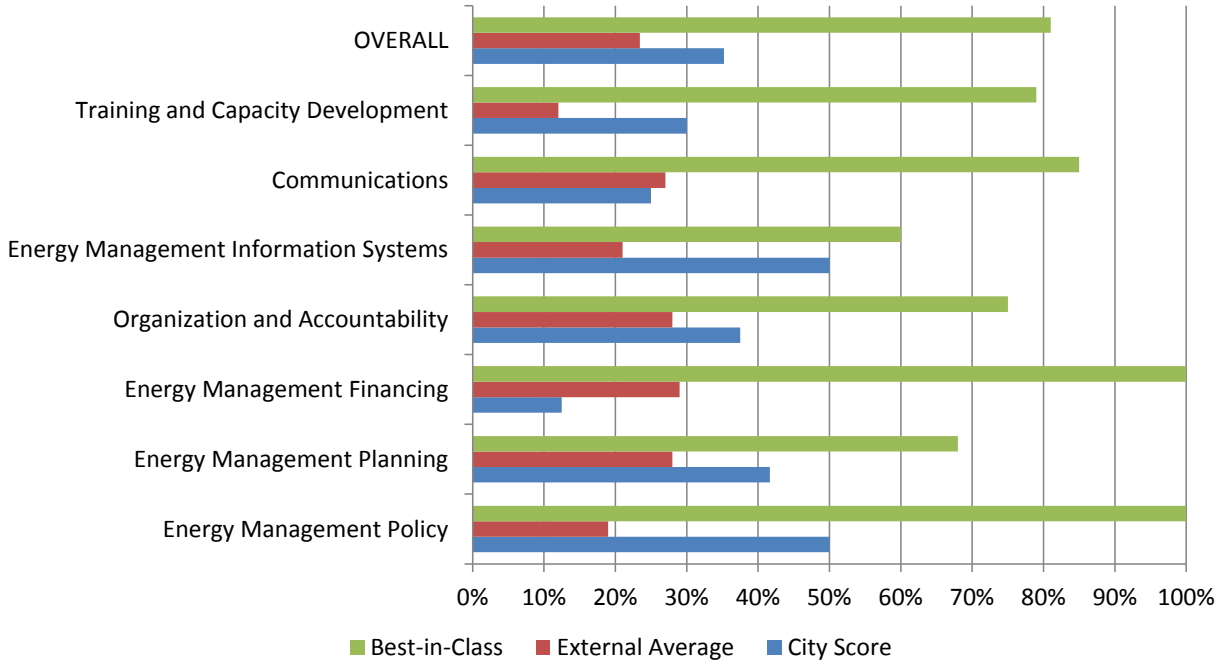
Corporate Level
- Energy Management Policy
- Energy Management Planning
- Energy Management Financing
- Organization & Accountability
- Energy Management Information Systems
- Communications
- Training and Capacity Development

Facility Level
- Energy Management Planning
- Organization & Accountability
- Opportunity Identification
- Project Development & Implementation
- Reporting & Communication

The results of this survey are intended to inform the baseline organizational practices as well as the opportunities for developing the organizational competencies necessary to improve and sustain energy performance over the long-term as part of a continual improvement process.

The corporate and facility-level results are presented below in Exhibit 11 and Exhibit 12 on a scale of 0 to 100. For each category, a score is presented along with external "average" and "best-in-class" benchmarks. A score of "0" indicates that no best practices are present; and a score of "100" would indicate that all best practices have been implemented.

Exhibit 11 Corporate-Level Organizational Practices



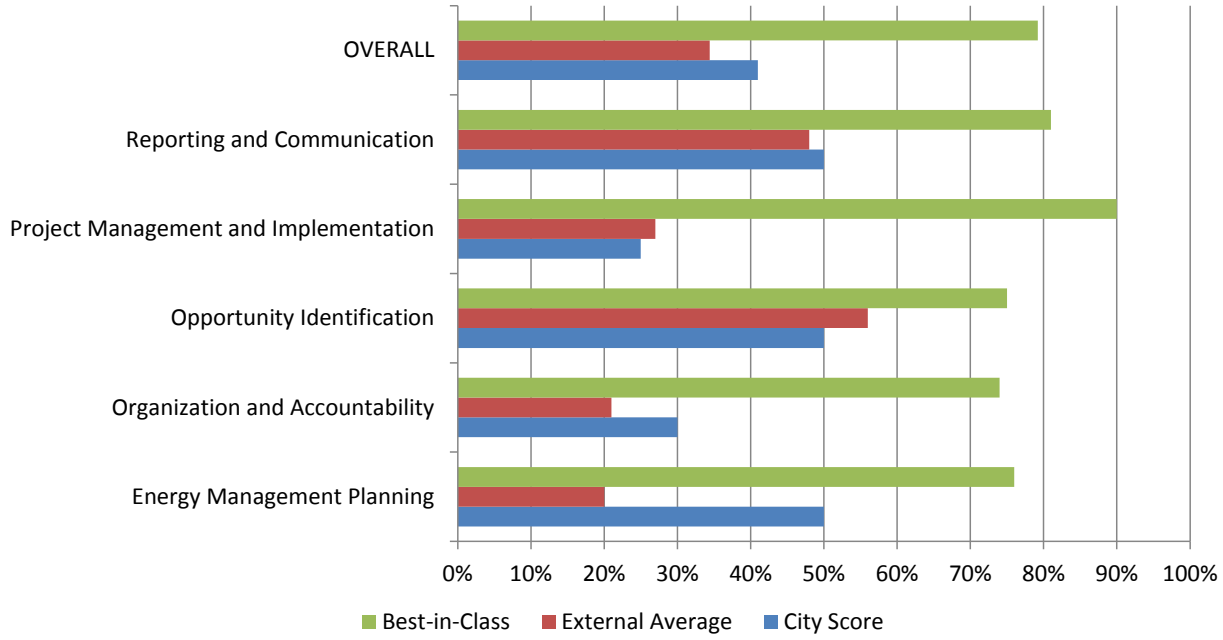
The key findings are summarized as follows:

- The actual scores range from a low of 13% for Energy Management Financing to a high of 50% for Energy Management Information Systems; and an overall score of 35% for the seven competency categories.

- Although better than average, the assessment generally identified a low-to-medium level of commitment, awareness, and action in support of energy management at the corporate-level.

- The gap between the City's current practice and best practice represents the opportunity for the adoption of improved organizational practices to support the continual improvement of energy performance. Specific organizational recommendations are provided in Section 4.

Exhibit 12 Facility-Level Organizational Practices



The key findings are summarized as follows:

- The scores range from a low of 25% for Project Management and Implementation to a high of 50% for Planning, Opportunity Identification, and Reporting and Communication; and an overall average score of 41% for the five competency categories.

- In general, the assessment identified a low-to-medium level of commitment, organization, and action in support of energy management at the facility level.

- The gap between the City's current practice and best practice represents the opportunity for the adoption of improved facility-level energy management practices.

3 Assessment of Energy Management Opportunities

This section summarizes the business case assessments of proposed energy management opportunities that would form basis of a comprehensive Energy Management Program. Each includes a description of the proposed opportunity, implementation costs, savings, ROI, and GHG emissions, impact on O&M, estimated service life, and implementation guidelines. Six major opportunity areas were evaluated:

- Lighting Upgrades
- Re-Commissioning/Controls Upgrades
- HVAC & Refrigeration Upgrades
- Water Efficient Fixtures
- Operating and Maintenance Practices
- Building Envelope Upgrades

Specific details related to the business case assessments for each facility can be found in Appendix C.

3.1 Lighting Upgrades

A wide variety of lighting exists in the City of Whitehorse building portfolio, from older 32W T8 lighting to obsolete T12 technology. High bay spaces are primarily illuminated by HID fixtures, which also provide opportunities for energy efficiency. Most buildings utilize HID exterior fixtures, and these can be replaced with LED fixtures, a measure which has already been implemented at certain facilities.

Proposed Energy Management Opportunity

The following lighting measures are proposed:

- Relamping of Existing Fixtures
  - Where they exist, 32W T8 fluorescent lamps should be replaced with 28W equivalents.
  - All existing incandescent lighting should be replaced with CFLs.
- Replacement of Electromagnetic Fixtures
  - Any existing T12 lighting is obsolete and should be replaced, including both 4’ and 8’ lengths.
- Replacement of interior HID Fixtures
  - There is an excellent financial case for replacing high bay HID fixtures with T5HO fixtures, especially in facilities where runtimes are high such as ice rink arenas.
  - This also brings an additional benefit of instant restrike – while HID lights require several minutes to start and restart, fluorescent lighting requires no warm-up time. This allows the lighting to be shut off for greater periods of time, reducing energy consumption and prolonging equipment life.
  - There are also opportunities to replace indoor HID flood lighting with LED fixtures in the Canada Games Centre.
- Replacement of exterior HID Fixtures
  - Wall and pole mounted HID exterior lighting can be replaced with LED fixtures, a measure which has already been implemented at the Mount McIntyre Recreational Centre and certain of the lift stations.

- Installation of Occupancy Sensors
  - All lighting in spaces which are occupied on an intermittent basis should be controlled using occupancy sensors to reduce overall runtime, which also increases lamp and ballast life.

The table below shows a matrix of which buildings are eligible for each of these upgrades:

Facility	Fluorescent Relamping		High Bay		Incandescent	LED	Controls
	32W to 28W	T12 to 28W T8	HID to T5HO	T12HO to T5HO	Inc. to CFL	HID to LED	Occupancy Sensors
Canada Games Centre	X		X			X	
Takhini Arena	X		X	X	X	X	X
Mount MacIntyre Rec Centre	X		X		X	X	
Municipal Services Building	X	X				X	X
Public Safety	X					X	
City Hall/Fire Hall #1	X	X			X	X	X
Transit Garage	X	X			X	X	X
Frank Slim	X					X	X
Robert Service Campground Office	X				X	X	X
Crestview Pumphouse	X	X				X	
Lift Station #1	X	X				X	
Lift Station #3	X	X				X	
Hamilton Blvd Pumphouse		X			X	X	
Selkirk Station							
Animal Shelter	X	X				X	X
Stores Warehouse	X	X		X		X	X
Copper Ridge Pumphouse		X				X	X
Marwell Lift Station	X	X		X			
Two Mile Hill Booster Stn		X		X			X
Strickland Lift Station		X				X	
McIntyre Creek Pump Station		X					
Parks Warehouse	X	X		X	X	X	X
Historic Buildings							

Financial Analysis

Exhibit 13 below presents a summary of the business case justification for the measure including total project cost, energy cost savings, simple payback period, and GHG emissions reduction.

Exhibit 13 Lighting Retrofit Measure Summary

Annual Savings					Estimated	Simple	NPV	ROI	GHG
Electricity	Fuel Oil	Propane	Water	Total	Total Cost	Payback			Reduction
[$]	[$]	[$]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
$95,018	-$12,009	-$2,838	$0	$80,171	$510,239	6.4	$79,637	9%	8.5

The interactive effects of the reduced lighting load with the heating system have been modeled, which results in an increase in heating fuel consumption.

Impact on Operations and Maintenance

The new equipment will require less maintenance than the existing stock of lighting equipment.

Estimated Service Life

- Fluorescent Ballasts – 30,000 hours
- Fluorescent Lamps – 24,000 hours
- Occupancy Sensors – 10 years

Impact on Indoor Environment

Light levels should be maintained in accordance with IESNA guidelines.

Implementation Approach

- It is recommended that the City implement the proposed lighting upgrades as the first measure. Given the size and scope, it is recommended that the implementation of the upgrade be outsourced. Some of the areas will require a lighting redesign therefore formal engineering and design documents will have to be developed.
- The implementation approach would involve starting with the largest buildings and dividing the work into groups of buildings with similar scope, size and complexity. The work can be undertaken during the day and will have to be coordinated with building activities and rentals such as pools and ice rinks.
- It is recommended that a pilot project for each "typical lighting retrofit" be undertaken and approved by the City prior to rolling out the full implementation.
- Yukon Energy is expected to introduce a lighting incentive program which could offset some of the costs associated with this measure.
- A proposed implementation schedule is provided in Section 5.

3.2 Re-commissioning/Controls Optimization

The audit of the lighting, HVAC, and refrigeration systems identified opportunities for re-optimizing the energy performance of building systems through an integrated process of re-commission (RCx) and control upgrades.

Proposed Energy Management Opportunities

The proposed opportunities involve re-commissioning lighting, HVAC, and refrigeration systems and implementing control upgrades to achieve energy savings. A summary of representative opportunities (from the Canada Games Centre) is outlined below:

- Tune up/inspect all ventilation and heating equipment and check/adjust the air and water balance.
- Install variable speed drives on pumping systems with variable loads/bypass control to reduce pumping energy.
- Install CO_2-based demand control ventilation on air handling systems to control ventilation rates and use of electric preheat coils.
- Re-commission/optimize existing refrigeration plant controls based on integrated infrared/slab control to facilitate scheduling of ice temperature based on activity and improved reset during unoccupied hours.
- Rewire/re-commission the existing lighting occupancy controls in the change rooms to provide individual room control.

- Install spring-wound timers or push button controls to control the operation of large pumps serving the lazy river, water slides, spray bear.
- Implement an electric demand management strategy to monitor peak demand and shed loads to minimize peak demand charges.

Applicability

Facility	Lighting	HVAC	Refrigeration	Water Pumping
Canada Games Centre	X	X	X	
Takhini Arena		X	X	
Mount MacIntyre Rec Centre		X	X	
Municipal Services Building		X	X	
Public Safety	X	X		
City Hall/Fire Hall #1		X		
Transit Garage		X		
Frank Slim		X		
Robert Service Campground Office		X		
Crestview Pumphouse		X		X
Lift Station #1		X		X
Lift Station #3		X		X
Hamilton Blvd Pumphouse		X		X
Selkirk Station				
Animal Shelter		X		
Stores Warehouse		X		
Copper Ridge Pumphouse		X		X
Marwell Lift Station		X		X
Two Mile Hill Booster Stn		X		X
Strickland Lift Station		X		X
McIntyre Creek Pump Station		X		X
Parks Warehouse		X		
Historic Buildings				

Financial Analysis

Exhibit 14 below presents a summary of the financial justification for the measure including total project cost, energy cost savings, simple payback period, and GHG emissions reduction.

Exhibit 14 RCx/Controls Upgrades Measure Summary

Energy Management Opportunity	Electricity		Propane		Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	547,405	$70,396	5,694	$5,028	55,648	$55,092	$130,515	$359,120	2.8	199.1

Impact on Operations and Maintenance

- New controls will require periodic maintenance including calibration as per manufacturers' guidelines.
- Reducing the run time of equipment will reduce the maintenance requirements and extend equipment lifetimes.

Estimated Service Life

- New controls – 10 to 15 years
- Re-commissioning – 5 years

Impact on Indoor Environment

- It is anticipated that this measure would improve the comfort and space conditions in the buildings including temperature, humidity and ventilation rates.

Implementation Approach

- It is recommended that the City implement the re-commissioning and control upgrades in parallel with the lighting measure. Re-commissioning requires specialized skills in HVAC and controls and some of this work – particularly in the smaller buildings could be undertaken by the City's maintenance staff. However, the proposed building automation system (BAS) upgrades would require specialized HVAC controls contractors.
- The implementation approach would involve starting with the largest buildings and dividing the work into of groups of buildings of similar scope, size and controls suppliers.
- Yukon Energy is expected to introduce a RCx incentive program which could offset some of the costs associated with this measure.

3.3 HVAC & Refrigeration Upgrades

The audit identified several opportunities for energy savings through major capital upgrades to HVAC and refrigeration systems.

Proposed Energy Management Opportunities

The following upgrades are proposed:

Canada Games Centre - Install a thermal pool blanket at night (10:30 pm to 5:00 am) to reduce the evaporation rate from the pool and consequently the ventilation requirements and pool heating requirements.

Takhini Arena - Install a desuperheater heat exchanger, piping, controls to preheat DHW for flooding and showers.

Takhini Arena - Replace the existing storage tank heaters with high efficiency (94%) condensing storage tank heaters.

Takhini Arena - Install two high efficiency condensing (95%) condensing furnaces to heat the change rooms and modify the ductwork to operate as a recirculation system with minimum outside air as per ASHRAE guidelines and exhaust air requirements.

Financial Analysis

Exhibit 15 presents a summary of the financial justification for the measure including total project cost, cost savings, simple payback period, and GHG emissions reduction.

Exhibit 15 HVAC and Refrigeration Measure Summary

Annual Savings					Estimated	Simple	NPV	ROI	GHG
Electricity	Fuel Oil	Propane	Water	Total	Total Cost	Payback			Reduction
[$]	[$]	[$]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
$2,801	$13,365	$20,574	$0	$36,740	$125,625	3.4	$65,920	26%	73.6

Impact on Operations and Maintenance

- The pool cover will have to be deployed daily by pool staff
- The new mechanical equipment will require periodic maintenance as per manufacturers recommendations.

Estimated Service Life

- Pool cover – 6 years
- Condensing storage tank heaters – 15 years
- Condensing furnace – 15 years
- Desuperheater heat exchanger – 20 years

Implementation Approach

- It is recommended that the City incorporate the HVAC and refrigeration upgrade recommendations into their capital planning process and undertake the measures starting in year two.
- The engineering could be undertaken in-house or outsourced, and local mechanical contractors could implement the work. The three measures at Takhini could be bundled into a common tender package.
- The work at Takhini would have to be implemented during the summer months and the pool blanket at CGC could be implemented anytime.

3.4 Water Efficient Fixtures

The existing washroom fixtures consist primarily of standard efficiency 13 litre/flush toilets, 8.3 litre/minute faucet aerators and 12 litre/minute shower heads.

Proposed Energy Management Opportunity

The proposed water reduction measures are to:

- Replace the existing toilets with water-efficient 6 litre/flush units

- Replace the faucet aerators with 4.2 litre/minute faucet aerators
- Replace all showerheads with 8.3 litre/minute units.

The table below shows a matrix of which buildings are eligible for each of these upgrades:

Facility	6 LPF Toilets	4.2 LPM aerators	8.3 LPM showerheads
Canada Games Centre		X	X
Takhini Arena	X		X
Mount MacIntyre Rec Centre	X	X	X
Municipal Services Building		X	X
Public Safety		X	
City Hall/Fire Hall #1	X	X	X
Transit Garage	X	X	X
Frank Slim		X	
Robert Service Campground Office	X	X	X
Crestview Pumphouse			
Lift Station #1			
Lift Station #3			
Hamilton Blvd Pumphouse	X	X	
Selkirk Station			
Animal Shelter	X	X	X
Stores Warehouse	X	X	
Copper Ridge Pumphouse	X	X	
Marwell Lift Station	X	X	
Two Mile Hill Booster Stn	X	X	X
Strickland Lift Station			
McIntyre Creek Pump Station			
Parks Warehouse		X	X
Historic Buildings			

Financial Analysis

Exhibit 16 presents a summary of the financial justification for the measure including total project cost, water cost savings, simple payback period and GHG emissions reduction.

Exhibit 16 Water Measure Summary

Annual Savings					Estimated	Simple	NPV	ROI	GHG
Electricity	Fuel Oil	Propane	Water	Total	Total Cost	Payback			Reduction
[$]	[$]	[$]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
$1,112	$11,184	$1,086	$7,134	$20,515	$58,896	2.9	$92,007	33%	33.4

Domestic hot water savings have been included, which result in energy savings in addition to the water savings.

Impact on Operations and Maintenance

- There will be no major changes to operations and maintenance.

Estimated Service Life

- Toilets – 20 years
- Aerators – 10 years
- Shower heads – 10 years

Impact on Indoor Environment

- No major impacts to the functionality of the water fixtures will result.

Implementation Approach

- It is recommended that the water efficiency upgrades be implemented in-house using the City's maintenance staff.
- The work could start in the second year of the program in parallel with the HVAC and Refrigeration Upgrades.
- It is also recommended that the City "pilot test" a number of toilets, aerators and shower heads to ensure satisfactory operation prior to selecting and installing the proposed improvements.

3.5 Operating and Maintenance Practices

The audit of the facility operations identified various opportunities to reduce energy consumption through improved O&M procedures and practices that impact energy use.

Proposed Energy Management Opportunities

Examples of representative O&M opportunities include:

- Air seal the perimeter wall-roof joint and other penetrations to control infiltration
- Repair and replace the door weather-stripping as needed
- Dispose of old fridge that uses thee-times more energy than a new Energy Star fridge.
- Control trace heating/shut off at end of season
- Install smart block heater receptacles controls
- Install Vending-Misers on beverage vending machines.
- Install solenoid valve to control cold water "bleeders" or use trace heating or bypass to save water
- Eliminate/minimize the use of domestic cold water for supplemental condenser cooling
- Install water sub-meters on major loads including cooling tower make-ups and irrigation to track consumption.

Applicability

Recommendations for improved O&M practices have been developed for all facilities except Selkirk and Robert Service Campground.

Financial Analysis

Exhibit 17 presents a summary of the financial justification for the measure including total project cost, energy cost savings, simple payback period and GHG emissions reduction

Exhibit 17 O&M Measure Summary

Annual Savings					Estimated	Simple	NPV	ROI	GHG
Electricity	Fuel Oil	Propane	Water	Total	Total Cost	Payback			Reduction
[$]	[$]	[$]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
$27,775	$15,913	$1,201	$5,282	$50,171	$78,311	1.6	$286,157	64%	61.1

Impact on Operations and Maintenance

- These opportunities would be implemented by maintenance staff.

Estimated Service Life

- Door seals and sweeps – 5 years
- Vending miser - 10 years
- Block heater controls – 15 years

Discussion of Implementation Approach

- It is recommended the City incorporate the proposed recommendations into their regular maintenance schedules and budgets.
- Common cross-cutting measures such as block heaters or weather-stripping could be implemented as the same time by maintenance staff.

3.6 Building Envelope

The following provides a summary of the screening assessment of potential building envelope energy management opportunities that could be implemented in the context of future capital renewal projects.

Potential Energy Management Opportunities

High performance glazing
- Triple glazing with a sealed insulating glass unit
- Low-E glass
- Inert gas such as argon or krypton in the sealed unit
- Low conductivity or “warm edge” spacer bars
- Insulated frames and sashes.

Super high performance glazing
- High insulation technology (HIT) windows

Wall insulation
- Apply rigid polystyrene board to the exterior
- Install fiberglass batts between interior wall studs

Roof insulation
- Upgrade roof insulation at time of re-roofing

Applicability

- Selkirk Pump House Windows and Insulation (planned 2016)
- City Hall Roof (planned 2016)

Financial Analysis

Exhibit 18 presents a summary of the financial justification for the measure including total project cost, energy cost savings, simple payback period and GHG emissions reduction. *Note, the cost below is based on the incremental cost for the energy upgrade (not the full cost).*

Exhibit 18 Envelope Analysis

System	Baseline	Simple Payback (Years)
High Performance Glazing	Standard double glazing	9
Super High Performance Glazing	Triple glazing	25
Upgraded Wall Insulation R-28	R-18	13
Upgraded Roof Insulation R-30	R-20	16

Impact on Operations and Maintenance

- The new envelope components will not require any maintenance for several years.

Estimated Service Life

- Window - 25 years
- Roof – 25 years
- Wall – 30 years

Discussion of Implementation Approach

- It is recommended that the City incorporate building envelope energy efficiency upgrades into their capital planning process.

3.7 Recommended Energy Management Opportunities

This section provides a summary of the recommended energy management opportunities that would form the basis of a comprehensive Energy Management Program. As shown in Exhibit 19 the table includes the annual energy savings, estimated total project cost, simple payback, net-present value (NPV), return on investment (ROI), and impact on GHG emissions. The estimated costs were developed for planning purposes based on standard industry guides and include all probable costs for labour and materials at the time of the study.

General descriptions of each energy management opportunity are provided in sections 3.1 to 3.6, while specific details related to the business case assessments for each facility can be found in Appendix C.

Exhibit 19 (overleaf) provides a summary of the business case assessments for the five recommended energy management opportunity areas:

- Lighting Retrofit
- Heating, Ventilating and Air-Conditioning (HVAC) and Refrigeration Upgrades
- Re-commissioning and Controls Optimization
- Operating and Maintenance Practices
- Water-Efficient Plumbing Fixtures

As shown, the total annual cost savings for the recommended measures are estimated to be $313,000, with an estimated implementation cost of $1,200,000 - resulting in a simple payback of 3.9 years. These savings represent a 12% overall reduction in energy use including a 12% reduction in electricity, a 9% reduction in fuel oil, a 38% reduction in propane, and a 16% reduction in water use. The resulting GHG emission reductions total 384 tonnes of eCO_2.

Exhibit 19 Summary of Recommended Energy Management Opportunities

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	107	664,840	$95,018	-12,131	-$12,009	-3,214	-$2,838	0	$0	$80,171	$510,239	6.4	$79,637	9%	8.5
Refrigeration and HVAC	0	21,783	$2,801	13,500	$13,365	23,300	$20,574	0	$0	$36,740	$125,625	3.4	$65,920	26%	73.6
RCx and Controls Optimization	0	468,269	$60,219	59,415	$58,821	8,026	$7,087	0	$0	$126,127	$446,108	3.5	$474,426	25%	207.4
Operations and Maintenance	0	215,980	$27,775	16,074	$15,913	1,360	$1,201	3,144	$5,282	$50,171	$78,311	1.6	$286,157	64%	61.1
Water Efficient Fixtures	0	8,644	$1,112	11,297	$11,184	1,229	$1,086	4,246	$7,134	$20,515	$58,896	2.9	$92,007	33%	33.4
Total	**107**	**1,379,516**	**$186,925**	**88,156**	**$87,274**	**30,701**	**$27,109**	**7,390**	**$12,415**	**$313,724**	**$1,219,179**	**3.9**	**$998,147**		**384.0**
Baseline Consumption		10,168,638	$1,575,552	958,367	$955,290	118,763	$71,486	45,033	$75,405	$2,677,734					3,512
Estimated Savings			12%		9%		38%		16%	12%					11%
Post-Retrofit Target		8,789,121	$1,388,627	870,211	$868,016	88,062	$44,377	37,642	$62,990	$2,364,010					3,128

4 Organizational Action Plan

This section presents a number of recommendations for developing the City's organizational and management capacity for long-term continual improvement of energy performance. The recommendations are informed by the results of the energy performance benchmarking assessment of organizational and management best practices as well as the outcomes of two stakeholder workshops.

The recommendations below are organized under the following organizational competencies as follows:

- Commitment to Energy Management
- Planning Processes
- Organization and Accountability
- Energy Management Financing
- Developing Energy Management Projects
- Monitoring and Communication

***Overall Goal**:* The overall goal is to integrate energy management into all organizational and management practices, at all levels of the organization; from the strategic management of energy, to operating and maintenance practices and occupant behaviours. Specific measurable goals would include:

- Top Management Support
- Designated Energy Management Resources
- Action Framework and Energy Management Plan
- Tracking and Reporting of Energy Use
- Communication and Sharing of Results
- Integration of Energy Management into the Organizational/Management Processes and O&M Practices
- Employee Engagement, Awareness & Training

4.1 Commitment to Energy Management

Commitment refers to the development and distribution of a formal policy statement that commits an organization to energy management and GHG reductions as an integral part of its operations along with measureable goals, targets, and objectives.

Recommendation # 1:

Policy - Develop a formal energy management policy that documents the City's commitment to sustainable energy policies and implementation of the Energy Management Plan. The policy should be communicated broadly to both internal and external stakeholders and updated on an annual basis. The Commitment could include the following elements:

- Declaration of commitment
- Accountability
- Vision statement
- Policy statement

- Long-term goals
- Targets
- Short and medium-term objectives

Communication Strategy - Develop a communication strategy that creates and sustains awareness of energy management as a corporate priority, and conveys their commitment to our employees and stakeholders.

4.2 Planning Processes

Planning refers to planning for energy action; which is characterized by strong links to energy policy, and the treatment of energy as a strategic issue, rather than an operating cost. Effective energy plans link goals and targets with tasks, schedules, responsibilities, and a means of evaluation.

Recommendation # 2:

Planning - Develop and follow a formal energy management planning process, which involves:

- Conducting energy performance benchmarking on an annual basis
- Regular reviews of facility and portfolio-level energy performance reports
- Setting targets for reducing energy use and GHG emissions
- Setting guidelines and defines objectives for achieving targets
- Identifying candidate facilities for energy audits and performance improvements

Energy Audits - Conduct energy audits of appropriate effort and scope on a 5 year cycle. Use the results of the audits to develop an energy management action plan for each major owned-facility including:

- Energy performance targets and key performance indicators
- Staff responsibilities and accountabilities
- A plan to implement specific projects and actions

Integration of Planning - Integrate our Energy Management Plan and planning processes with our capital planning process, preventative maintenance plan, environmental management plan, and overall asset management plan.

4.3 Organization and Accountability

Organization and Accountability refers to the competencies and organizational structure required for efficient operation, maintenance, promotion, and management of energy systems, and action plans. It involves the organization of people, the allocations of energy management responsibilities, and integration with other management and functions.

Recommendation # 3

Organizational System: Implement an organizational system that is accountable for energy performance that will support the identification and implementation of energy saving actions as part of a continual improvement process.

Energy Leader: Assign leadership and overall responsibility for corporate energy management. The Energy Leader will have overall accountability for implementing the Energy Management Plan and for achieving energy performance targets.

Energy Managers: Appoint a manager at each major facility or group of facilities to act as Energy Manager. The Energy Manager will be empowered and accountable for the implementation of the Plan at the facility level and overall energy performance of the facility.

Energy Team: Establish an Energy Team to support the Energy Leader and Energy Manager(s) in implementing the Plan. The Energy Team will include representation from senior management, research, and operations and maintenance.

Energy Skills Training: Deliver focused energy skills training to facility managers and maintenance staff as well as members of the Energy Team in order to enhance their capacity to achieve energy reductions in their respective facilities.

Energy Awareness Training: Deliver energy awareness training to all City employees focused on day-to-day conservation opportunities in the workplace within their sphere of influence.

4.4 Energy Management Financing

Financing refers to the availability of financing and financial systems to support the identification, development and implementation of energy management projects. It includes business case development as well as the integration of energy management in financial planning.

Recommendation # 4

Business Case Guidelines: Develop guidelines for the business case development of proposed energy projects and actions; including the use of simple payback, net-present value (NPV) and return on investment (ROI) methodologies, as well as selection criteria and the calculation of GHG emissions.

Financial Analysis Template: Develop a spreadsheet-based template for preparing cost-benefit analyses of proposed energy management actions and projects. The template, along with the guidelines, will be used to develop the business case for energy projects.

Funding Guidelines: Develop guidelines for funding energy management projects including the financial selection criteria and the priority given to energy projects over other investment needs such as maintenance and health and safety improvements.

External Financing Options: Consider other external financing options for delivering energy management projects including green revolving funds, and energy performance contracting.

Other Sources of Funds: Investigate other funding sources for energy projects such as government and utility grants and incentive programs including potential incentives from Yukon Energy.

4.5 Developing Energy Management Projects

Project Development refers to identifying, developing and implementing energy management actions and projects. Project development requires knowledge, internal standards, and capacity to identify, assess, and implement opportunities.

Recommendation # 5

Scope of Energy Management Activities - Build the internal capacity to recognize and develop all cost-effective energy management opportunities in support of energy and cost reduction targets in the following areas:

- Energy efficiency, conservation, and fuel switching
- Peak load and demand management
- Renewable energy sources
- Water efficiency and conservation
- Energy purchasing
- Purchase of materials and equipment
- Standards for new buildings, major renovations, and leased buildings

Internal Implementation: Develop criteria for determining when internal resources can be utilized for the identification and implementation of energy projects.

External Service Providers: Develop a strategy and criteria for securing external service providers for the implementation of energy projects.

Renewable Energy Guidelines: Develop guidelines for the implementation of on-site renewable energy technologies including acceptable technologies, financial selection criteria, and targets for the percentage of total energy supplied by renewable sources.

Performance Standards for Buildings: Develop energy performance guidelines for the design of new buildings, major renovations of existing buildings, and leased buildings. The performance requirements will be based on performance standards such as Leadership in Energy and Environmental Design (LEED), the Model National Energy Code For Buildings (MNECB 2011), City of Whitehorse Building Code.

Future Capital Replacements, Building Renovations: Evaluate and incorporate cost-effective energy saving technologies and measures in accordance with our internal guidelines in all of our future capital replacements of equipment and systems, and major renovation projects. For capital projects of a certain scale, the City should assign a resource internally, or hire an external resource to be the commissioning agent and/or commissioning oversight agent. This will ensure that buildings begin their life operating close to optimal, and that more thorough reporting will be in-place to serve as the basis for future re-commissioning efforts.

Green Lease: Incorporate "green" terms in our lease agreements for non-owned facilities including energy and GHG reduction targets, technical actions, renewable energy, and measurement and verification guidelines.

Purchasing Procedures: Modify purchasing procedures as required to incorporate energy efficiency and performance into the criteria for selection of material and equipment.

Energy Purchasing: Develop guidelines for the purchase of energy that appropriately addresses our available energy services, green energy requirements, and cost considerations.

4.6 Monitoring & Communication

Monitoring & Communication: Monitoring refers to the process of gathering, analyzing and reporting data for the purposes of measuring and reporting energy performance. Communication refers to the proactive communication and promotion, both internally and externally, to build and sustain awareness of energy management and its impacts, to receive input from employees on savings opportunities, to provide feedback on needs and achievements, and to establish corporate responsibility.

Recommendation # 6

Monitoring and Tracking System: Implement an energy monitoring and tracking system as an integral component of an overall management information system. The system will be capable of measuring and reporting energy performance for individual facilities as well as aggregating results at the portfolio-level.

Measurement and Verification of Projects: Adopt a measurement and verification (M&V) protocol (such as IPMVP) for energy savings verification and incorporate a measurement and verification plan into all major energy projects.

Reporting Energy Savings: Monitor and report energy savings relative to targets on a regular basis. Make adjustments for weather and other significant energy drivers, as appropriate.

Reporting to External Stakeholders: Generate annual reports for external stakeholders including reports on the energy performance of individual facilities as well as overall performance relative to targets.

Reports to City Executive: Generate quarterly energy performance summary reports to apprise the City executive of the progress made towards energy and cost saving goals.

Reports to Accountable Staff: Provide regular and timely reports to the Energy Leader, Energy Managers, and Energy Committee Members at a level of detail that reflects their spheres of influence.

Reports to Energy Users: Provide regular and timely reports to all City employees including key influencers such as maintenance staff.

5 Implementation Plan

This section presents an action plan for the implementation of identified energy management opportunities recommended in Section 3. The Plan draws on the results of the energy performance benchmarking assessment of technical best practices, business case assessments, as well as the outcomes of two stakeholder workshops.

5.1 Goals and Targets

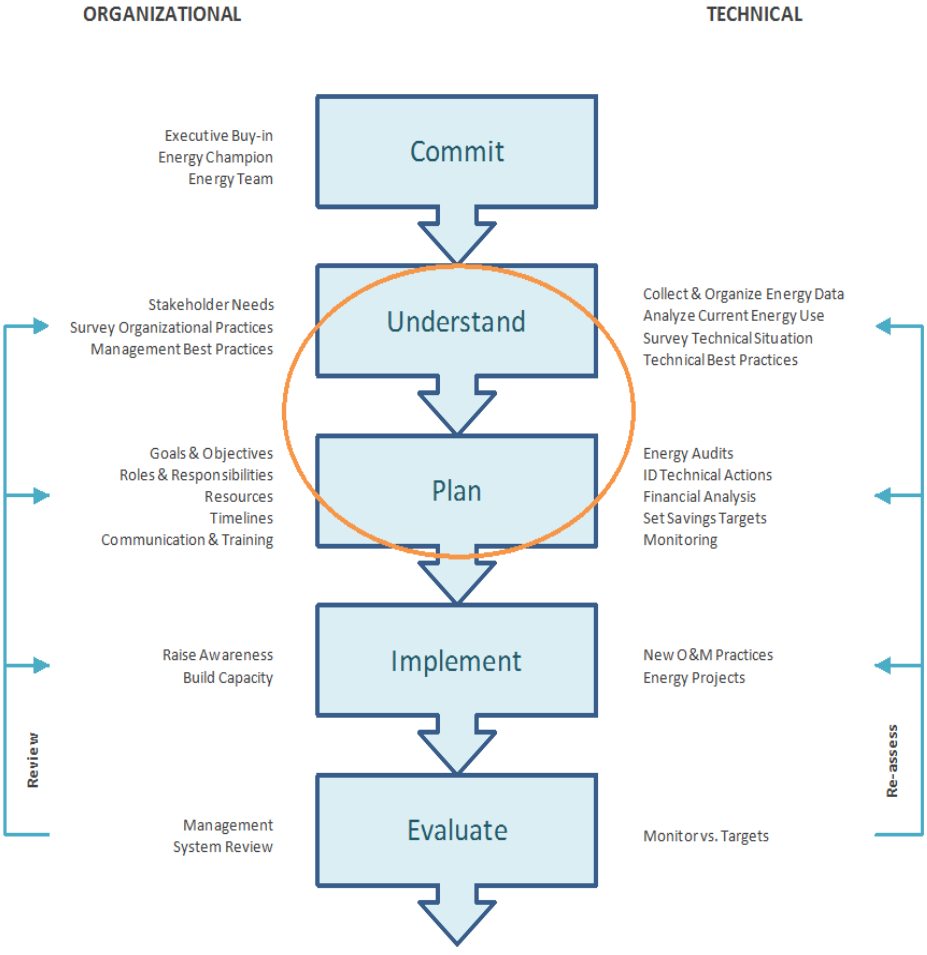
The overall goal is to implement a comprehensive Energy Management Program and continuously improve the energy performance of City facilities towards achieving the following three-year energy reduction targets.

- 12% energy savings from 2011 levels by the year 2016
- 16% water savings from 2011 levels by the year 2016

5.2 Energy Management Program Framework

The proposed energy management program framework is presented overleaf in Exhibit 20.

Exhibit 20 Energy Management Program Framework



As shown, there are five phases in the evolution of an Energy Management Program: Commit, Understand, Plan, Implement and Evaluate (this Plan addresses the Understanding and Planning phases). Each phase integrates both Organizational and Technical actions. The Organizational stream outlines the steps for developing an effective management system; while the Technical stream outlines the steps for identifying, implementing and monitoring energy and GHG reduction measures. Together, the two streams provide an integrated process for the continual improvement of energy performance.

The key aspects of this framework that are relevant to the approach used for this plan include:

- The integration of the technical and organizational/management elements
- A continual improvement process in which the organizational elements are continuously reviewed and the technical elements are revised for optimal results
- The implicit importance of people and processes throughout the cycle

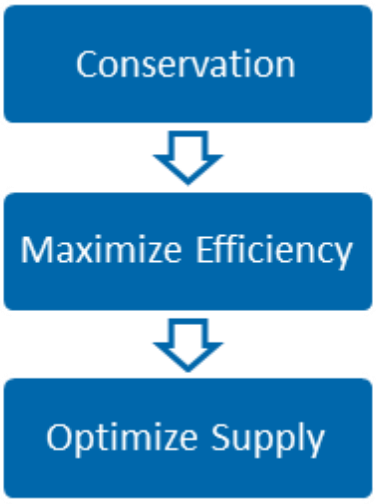
5.3 Implementation Approach

Seven major opportunities areas were considered in the scope of this plan, and; as presented in Section 3, six of the seven were found to be cost effective:

- Lighting Upgrades
- Re-commisioning and Controls Upgrades
- HVAC and Refrigeration Upgrades
- Water Efficient Fixtures
- O&M Measures
- Building Envelope (incremental cost only)
- Renewables (not practically or financially feasibly in existing buildings)

From a practical and financial standpoint, the Exhibit 21 presents a general guide for sequencing and prioritizing energy savings opportunities.

Exhibit 21 Sequencing Savings Opportunities



Conservation – the first step is to conserve energy by using what you need and eliminating waste. This approach brings focus to low-cost operational measures before money is invested in more capital-intensive measures. Typical examples include occupancy awareness measures, operating and maintenance practices, and basic re-commissioning.

Maximize Efficiency – Once the need and usage are matched properly, the next step is to ensure that components and systems are operating as efficiently as possible. Typical examples include lighting retrofit measures and continuous commissioning.

Optimize Supply – The previous two stages reduce the requirement for energy. This step seeks the optimum source for the overall energy requirement. Typical examples include boiler replacements, heat recovery, and renewable energy technologies.

5.3.1 Major Opportunity Areas

Re-commissioning - Re-commissioning is a re-optimization process for ensuring that a building's complex array of mechanical and electrical systems are operated to perform according to the design intent and current operational needs of the building. In larger buildings, the process can involve investigation or monitoring and simulation of building systems to gain a thorough understanding of current operation and opportunities for re-optimization. The process can be scaled based on the size of the building, energy budget, and opportunities for improvement. In smaller buildings, the process is generally similar to a tune-up. Energy savings generally result from equipment repairs, air and water rebalancing and control optimization.

Re-commissioning is a usually the first-step in a comprehensive energy reduction program because it is usually financially attractive (1 to 4 year payback); it provides an understanding of how a facility is operating relative to current needs; and it helps to identify other energy reduction opportunities. More specifically it helps to identify improper equipment performance, equipment that needs to be replaced, and operating strategies for improving performance. This approach brings focus to O&M measures and other low-cost operational improvements before money is invested in energy retrofits, equipment replacements, and other more capital-intensive measures.

Energy Upgrade - An energy upgrade refers to the addition of new technologies or features to older systems to make them more energy-efficient or to conserve energy. Typical examples include retrofitting light fixtures with more efficient lamps and ballasts, installing lighting occupancy controls, or retrofitting a fan motor with a variable speed drive. These measures can be implemented at any time during the equipment life-cycle (as opposed to end of life-cycle), therefore the business case is usually based on the full-cost of the improvement.

Capital Replacements - Refers to the planned replacement of a piece of equipment or system at the end of its life-cycle, or as part of a major renovation. Examples include the replacement of a boiler with an equivalent best-in-class unit when it reaches the end of its expected service life. Other examples include upgrading roofing insulation and window replacements. The business case for these types of measures is usually based on the incremental cost and performance of the upgrade, relative to a standard-efficiency replacement. In some cases, it is not financial attractive to upgrade to best-in-class; and in other cases the upgrade is required by codes or standards and therefore no business case justification is necessary.

Renewable Energy - Refers to energy generated from natural resources such as sunlight and wind, which are renewable or naturally replenished. This study considered three market-ready renewable energy systems:

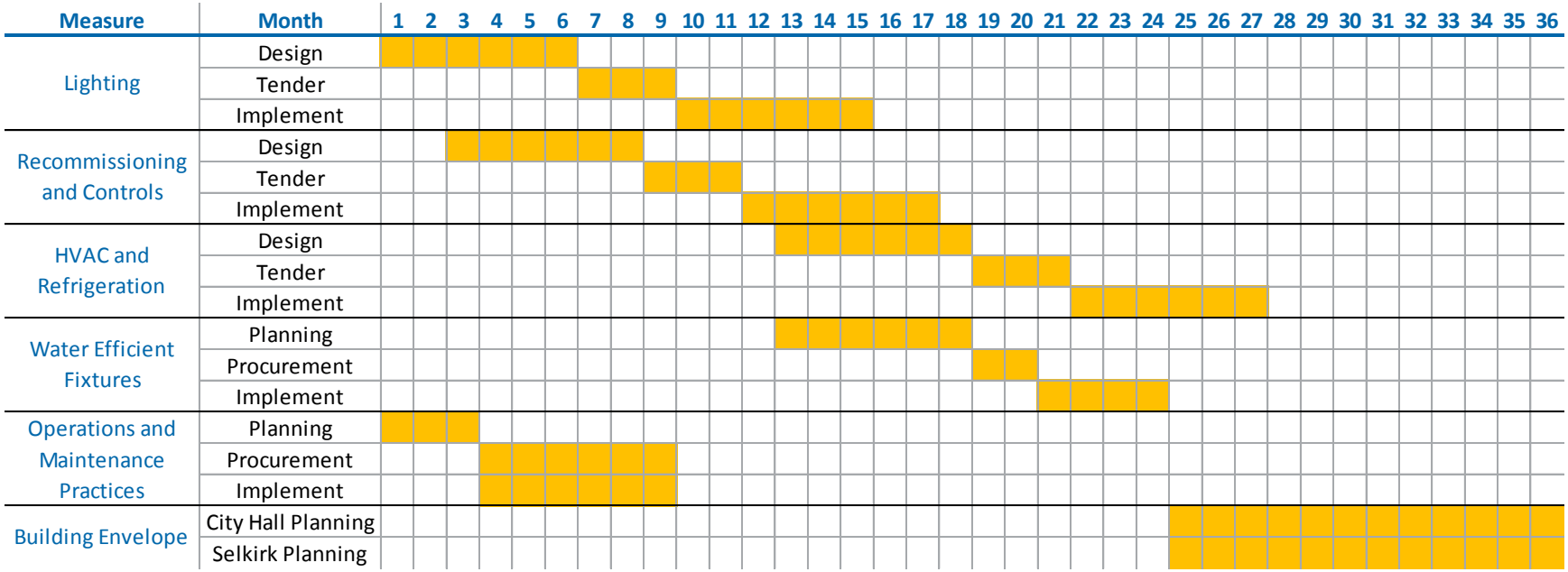
- Solar PV
- Solar hot water
- Solar air

Solar PV is not cost-effective without incentives, and the results of the audits did not find any practical opportunities for solar air or hot water. In the latter, the use of recovered heat in the CGC and Takhini facilities limits the opportunity. In the case of solar air, it is most practical to consider in the context of new building construction.

5.4 Implementation Schedule

This sub-section provides an implementation schedule for the implementation of the identified energy management opportunities based on the outcomes of Workshop II in September 2012. A Gantt chart of the proposed schedule is shown overleaf in Exhibit 22.

Exhibit 22 Implementation Schedule



Appendix A TBP Benchmarking Reports

Energy Performance Benchmarking Report

Facility Information

Facility Name	Canada Games Centre	**Floor Area**	233,538	ft^2
Address	200 Hamilton Blvd		21,708	m^2
Facility Type	Multi-Use Recreation Centre			

Facility Energy Profile

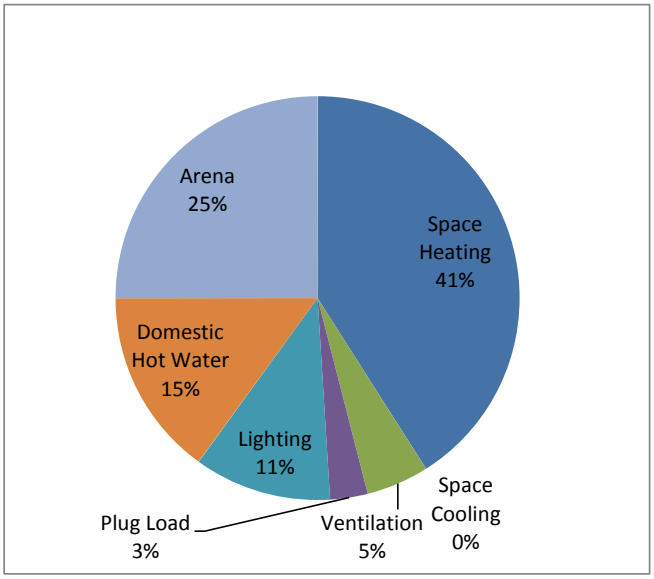
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	15,301	$670,968	56%
Propane	134	$3,098	0%
Fuel Oil	21,784	$518,589	43%
Total	37,219	$1,192,655	

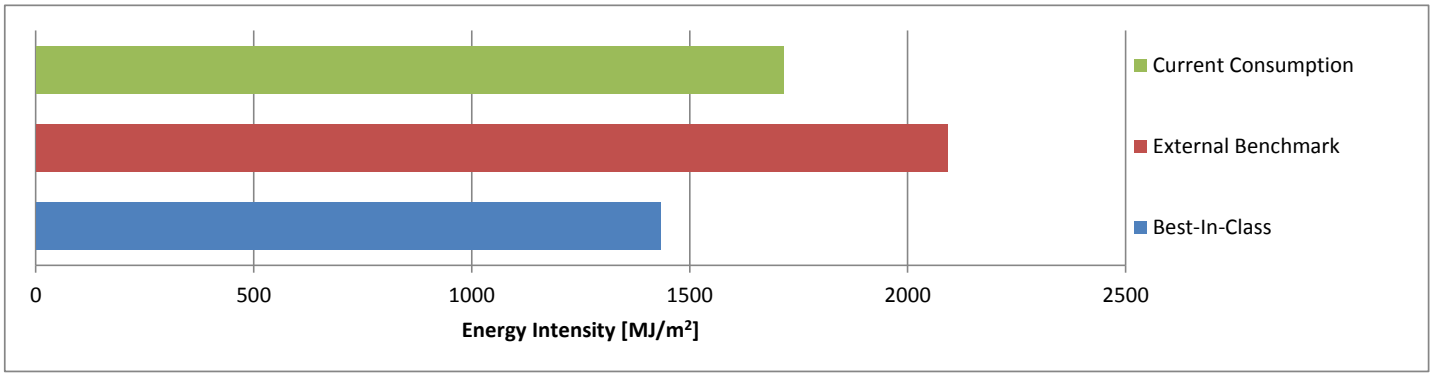
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	15,260	703.0	41%
Space Cooling	0	N/A	N/A
Ventilation	1,861	85.7	5%
Plug Load	1,117	51.4	3%
Lighting	4,094	188.6	11%
Domestic Hot Water	5,583	257.2	15%
Arena	9,305	428.6	25%
Total	**37,219**	**1,715**	**100%**

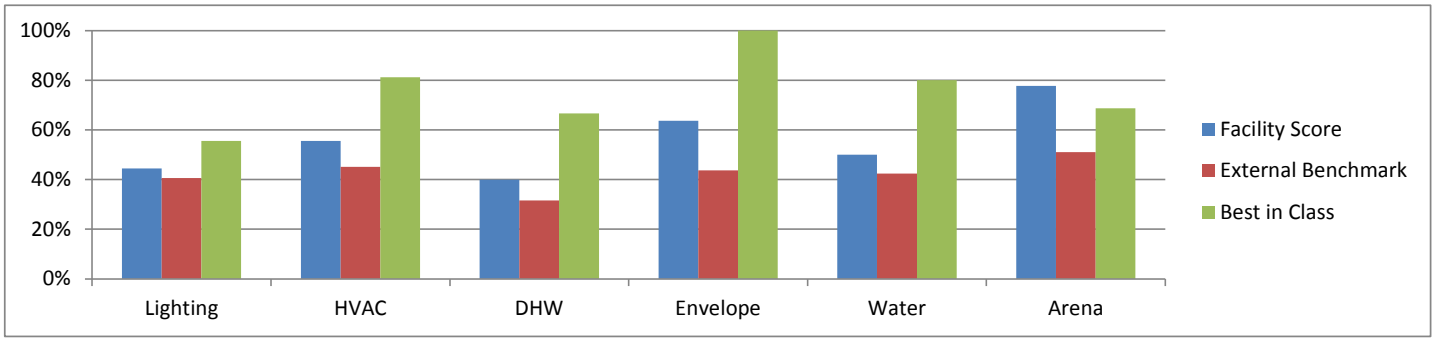
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Takhini Arena	**Floor Area**	44,055	ft^2
Address	345 Range Road		4,095	m^2
Facility Type	Arena			

Facility Energy Profile

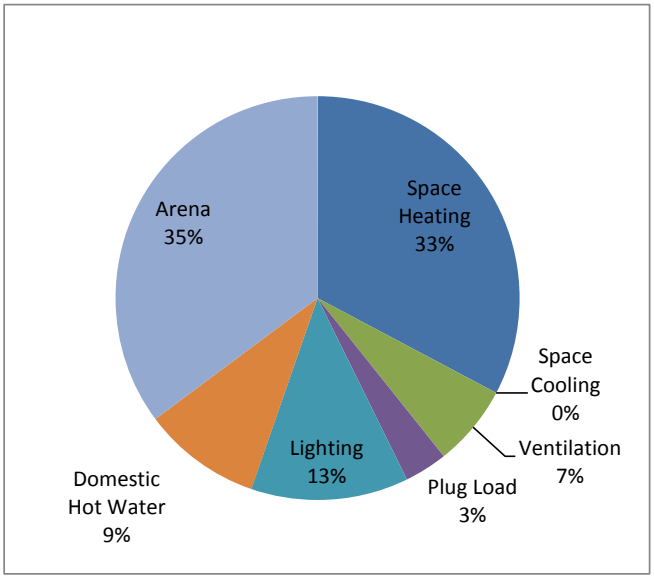
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	3,474	$160,950	80%
Propane	1,744	$41,015	20%
Fuel Oil	0	$0	0%
Total	5,219	$201,965	

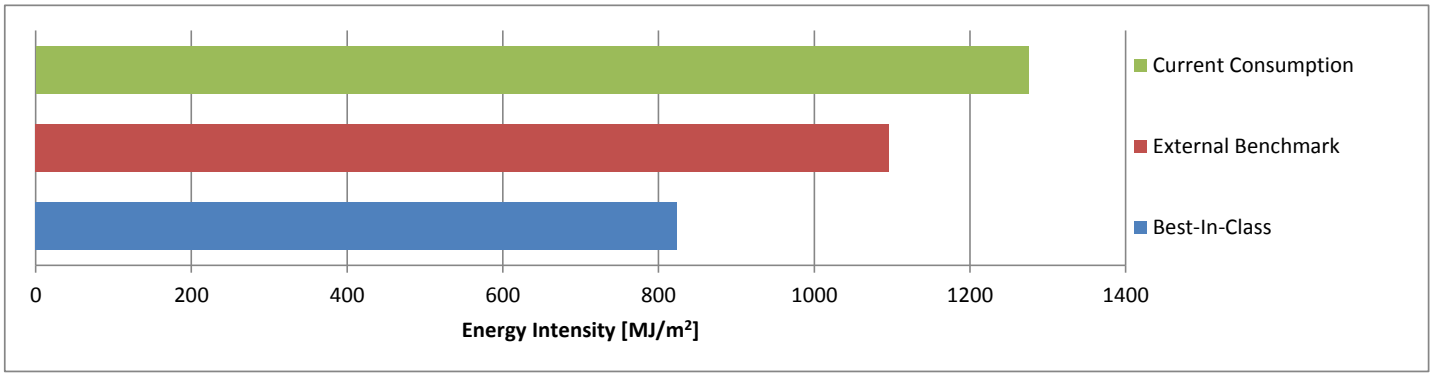
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	1,710	417.6	33%
Space Cooling	0	N/A	N/A
Ventilation	340	83.0	7%
Plug Load	179	43.7	3%
Lighting	658	160.6	13%
Domestic Hot Water	494	120.7	9%
Arena	1,838	448.7	35%
Total	**5,219**	**1,274**	**100%**

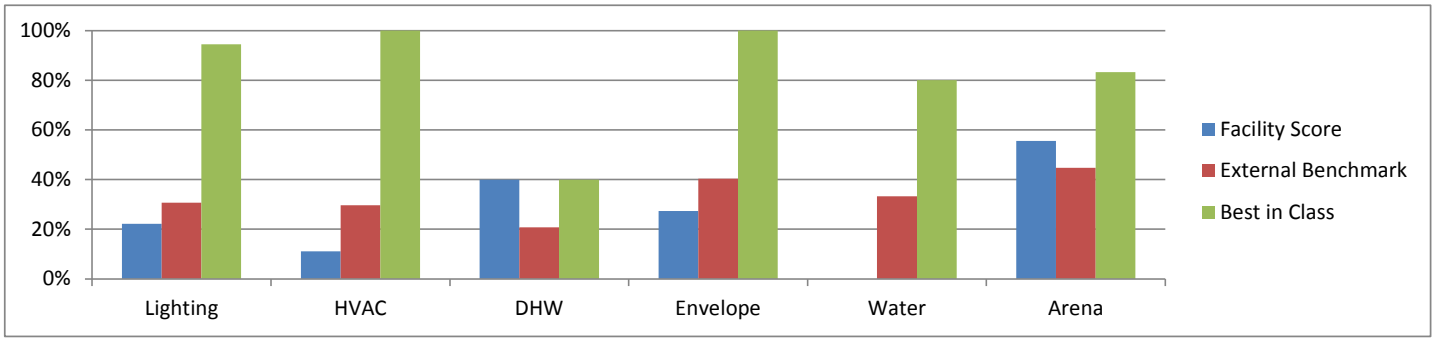
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Whitehorse

Energy Performance Benchmarking Report

Facility Information

Facility Name	Mount MacIntyre Rec Centre	**Floor Area**	42,406	ft^2
Address	1 Sumanik Drive		3,942	m^2
Facility Type	Curling Arena			

Facility Energy Profile

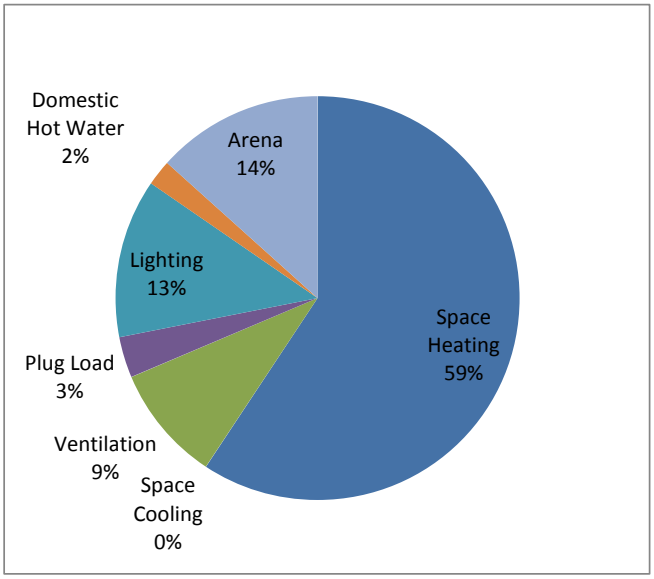
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	2,408	$86,029	52%
Propane	0	$0	0%
Fuel Oil	3,357	$79,162	48%
Total	5,765	$165,191	

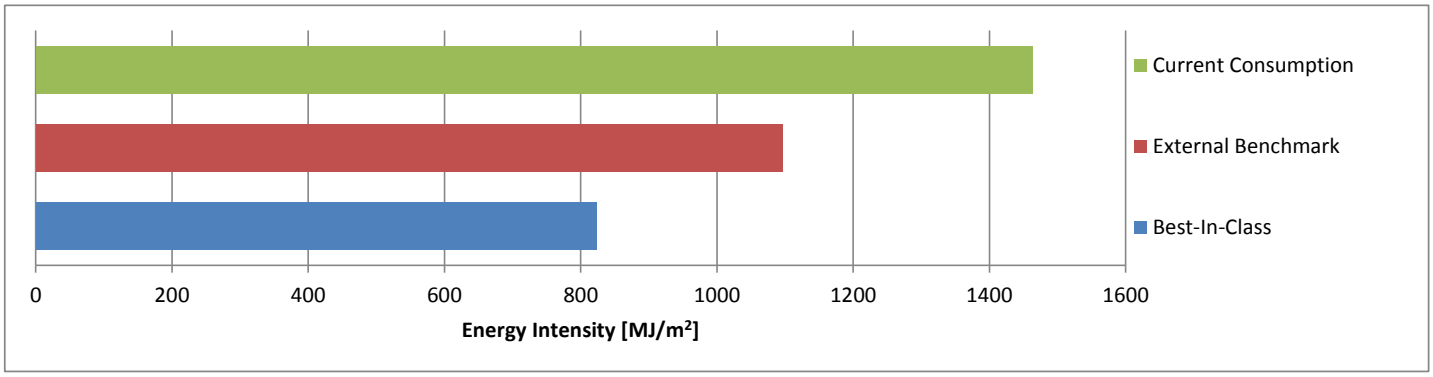
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	3,419	867.4	59%
Space Cooling	0	N/A	N/A
Ventilation	537	136.1	9%
Plug Load	189	48.0	3%
Lighting	732	185.7	13%
Domestic Hot Water	119	30.2	2%
Arena	769	195.1	13%
Total	**5,765**	**1,463**	**100%**

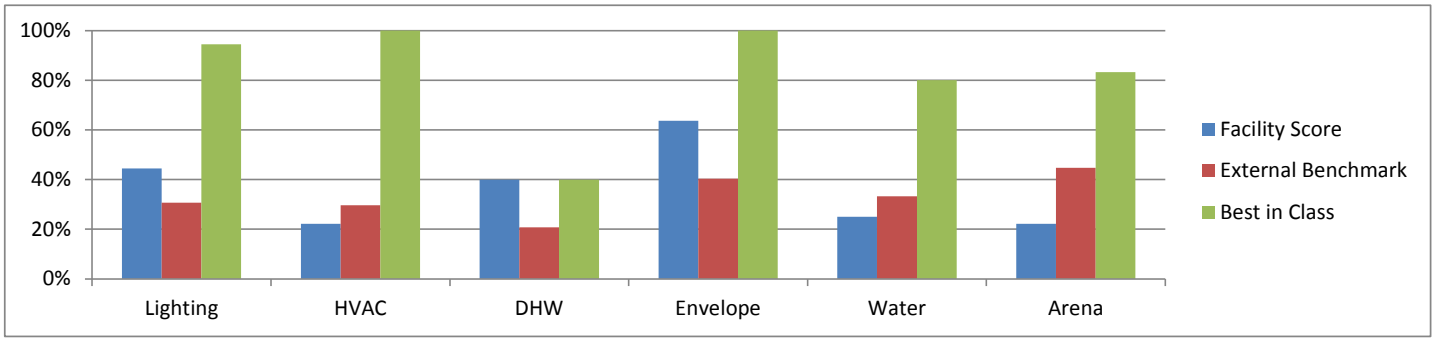
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Whitehorse

Energy Performance Benchmarking Report

Facility Information

Facility Name	Municipal Services Building	**Floor Area**	41,689	ft^2
Address	4210 Fourth Avenue		3,875	m^2
Facility Type	Office/Garage			

Facility Energy Profile

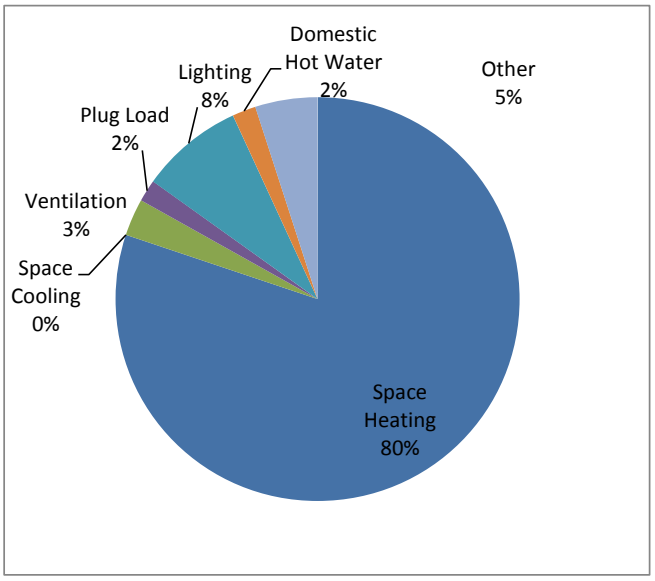
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	1,593	$69,127	33%
Propane	0	$0	0%
Fuel Oil	6,041	$142,736	67%
Total	7,634	$211,862	

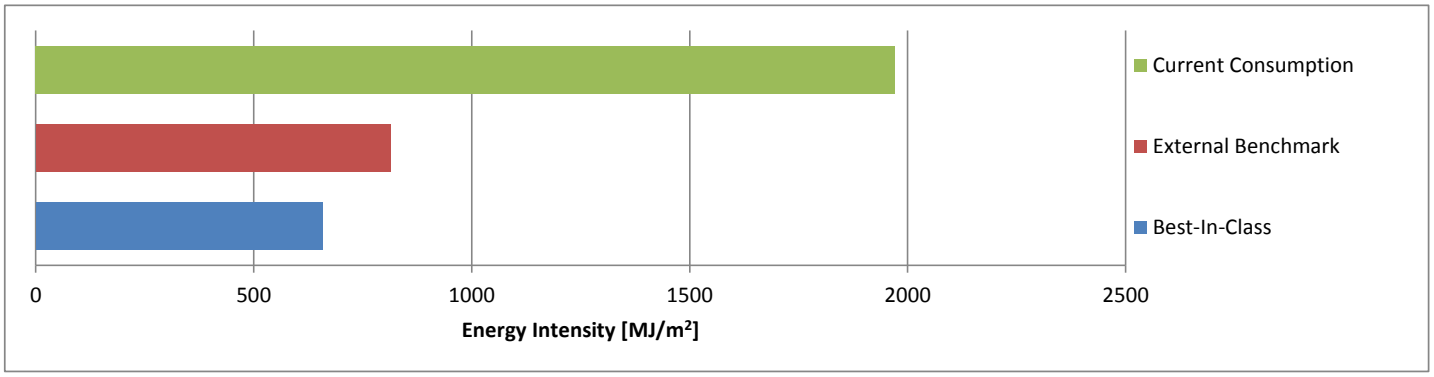
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	6,119	1579.0	80%
Space Cooling	0	N/A	N/A
Ventilation	227	58.6	3%
Plug Load	135	34.7	2%
Lighting	629	162.3	8%
Domestic Hot Water	145	37.3	2%
Other	380	98.1	5%
Total	**7,634**	**1,970**	**100%**

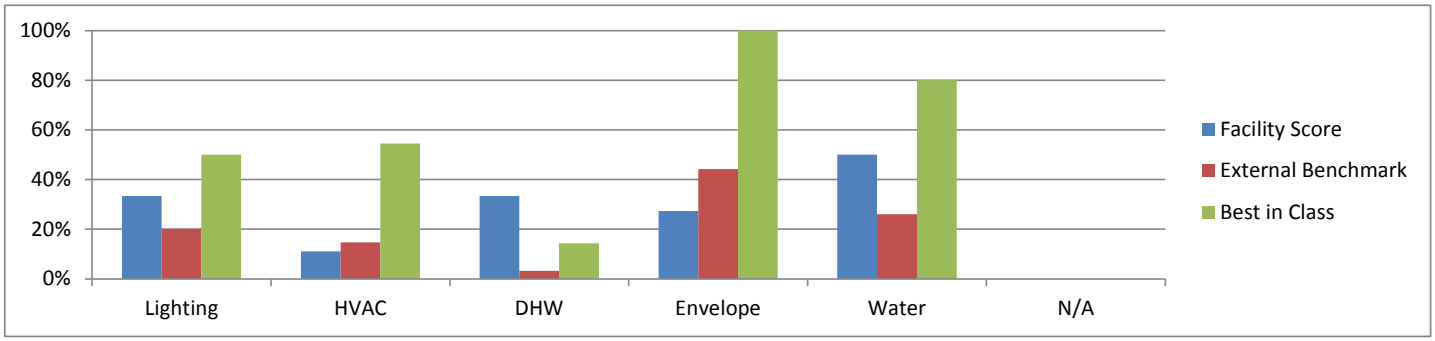
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Public Safety Building	**Floor Area**	34,573	ft^2
Address	305 Range Road		3,214	m^2
Facility Type	Office/Garage			

Facility Energy Profile

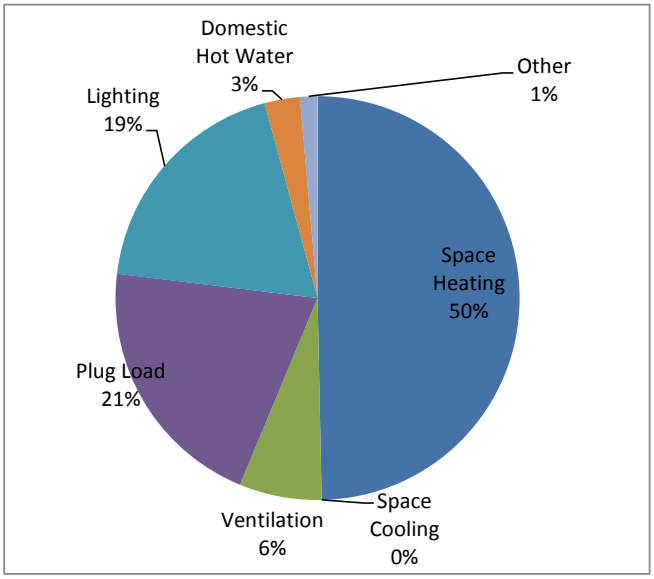
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	1,280	$10,975	29%
Propane	1,115	$26,268	71%
Fuel Oil	0	$0	0%
Total	2,395	$37,243	

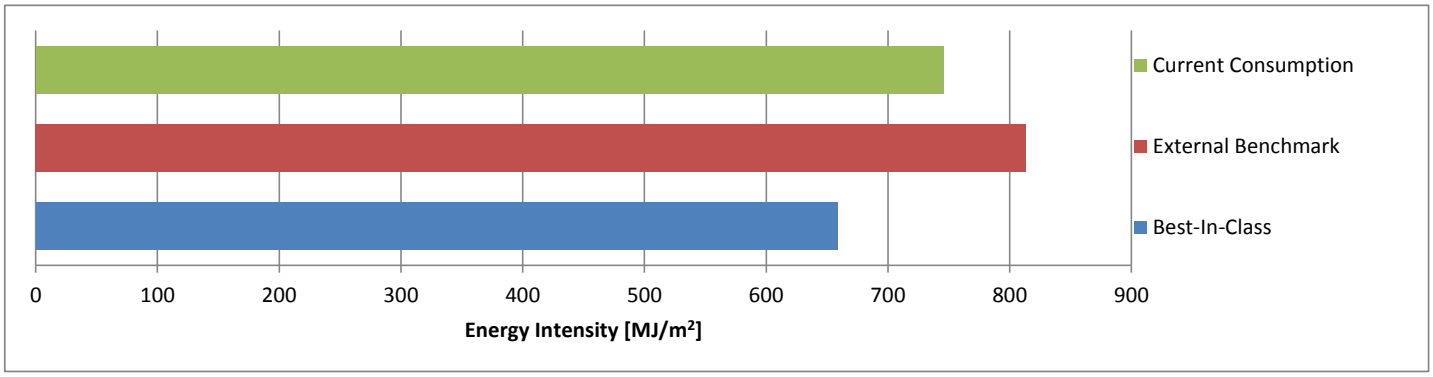
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	1,190	370.2	50%
Space Cooling	0	N/A	N/A
Ventilation	158	49.1	7%
Plug Load	494	153.9	21%
Lighting	451	140.5	19%
Domestic Hot Water	68	21.1	3%
Other	34	10.4	1%
Total	**2,395**	**745**	**100%**

Facility Energy Summary



Comparative Energy Intensity



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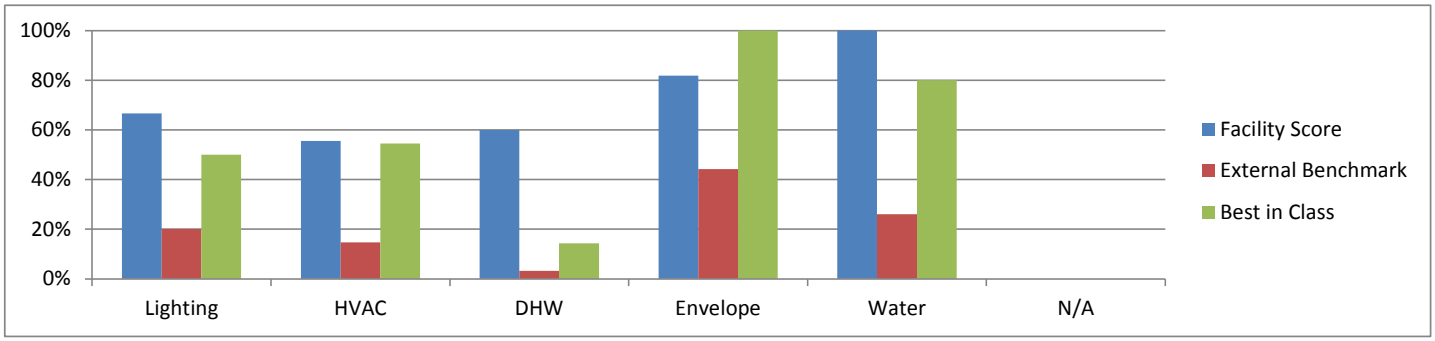


Energy Performance Benchmarking Report

Facility Information

Facility Name	City Hall/Fire Hall #1	**Floor Area**	22,314	ft^2
Address	2121 Second Avenue		2,074	m^2
Facility Type	Office/Garage			

Facility Energy Profile

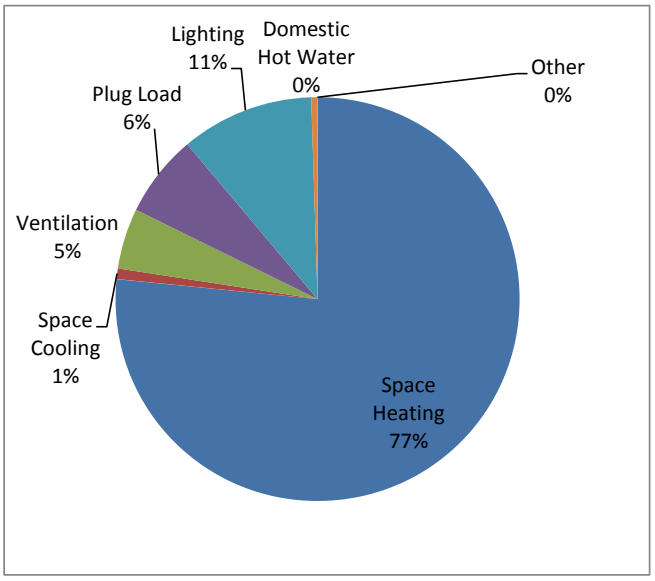
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	919	$32,839	38%
Propane	0	$0	0%
Fuel Oil	2,264	$53,508	62%
Total	3,183	$86,347	

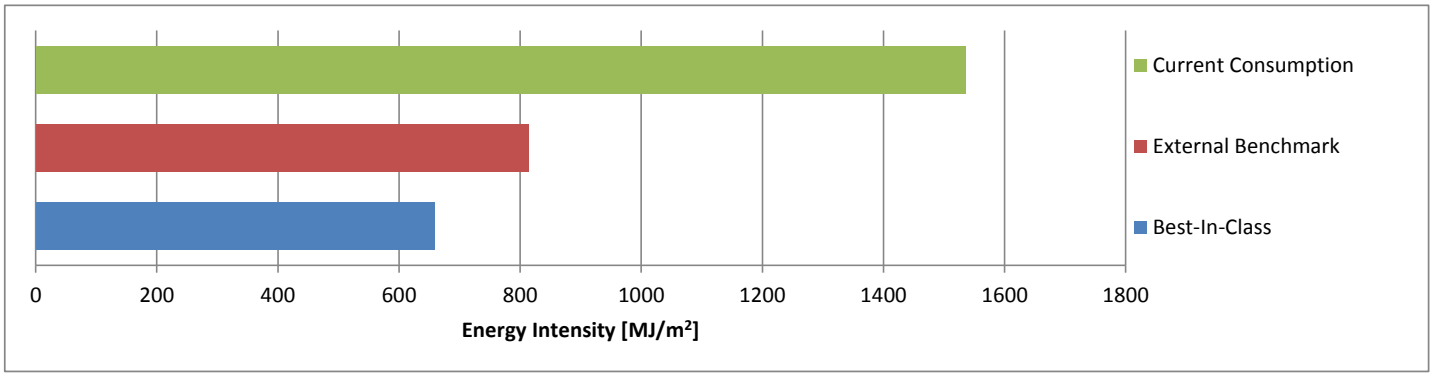
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	2,438	1175.4	77%
Space Cooling	27	12.9	1%
Ventilation	155	74.5	5%
Plug Load	210	101.0	7%
Lighting	338	163.0	11%
Domestic Hot Water	16	7.8	1%
Other	0	N/A	N/A
Total	**3,183**	**1,535**	**100%**

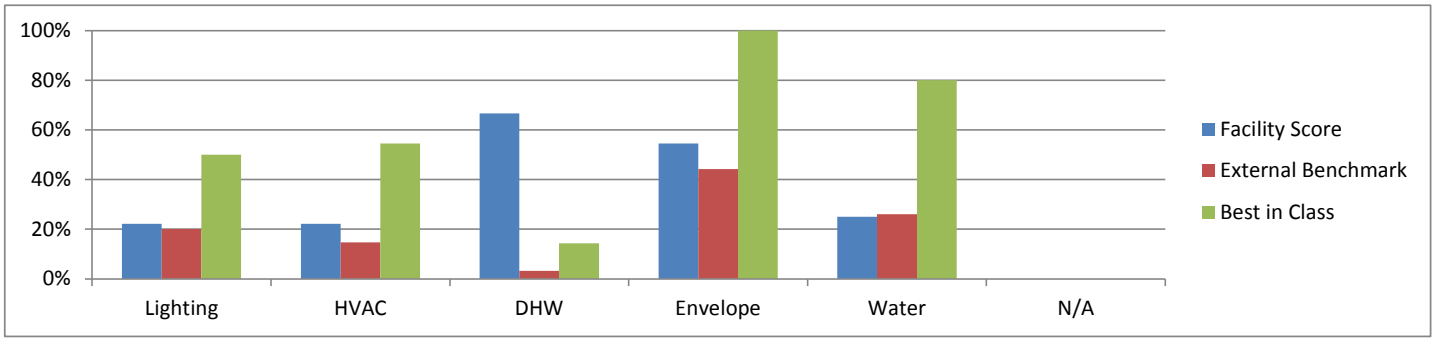
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Transit Garage	**Floor Area**	16,320	ft^2
Address	110 Tlingit Street		1,517	m^2
Facility Type	Public Works			

Facility Energy Profile

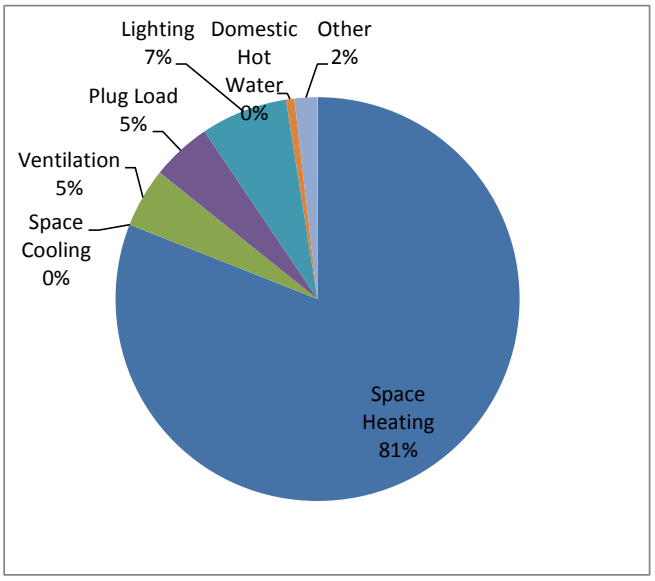
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	548	$23,559	35%
Propane	0	$0	0%
Fuel Oil	1,878	$44,068	65%
Total	2,426	$67,627	

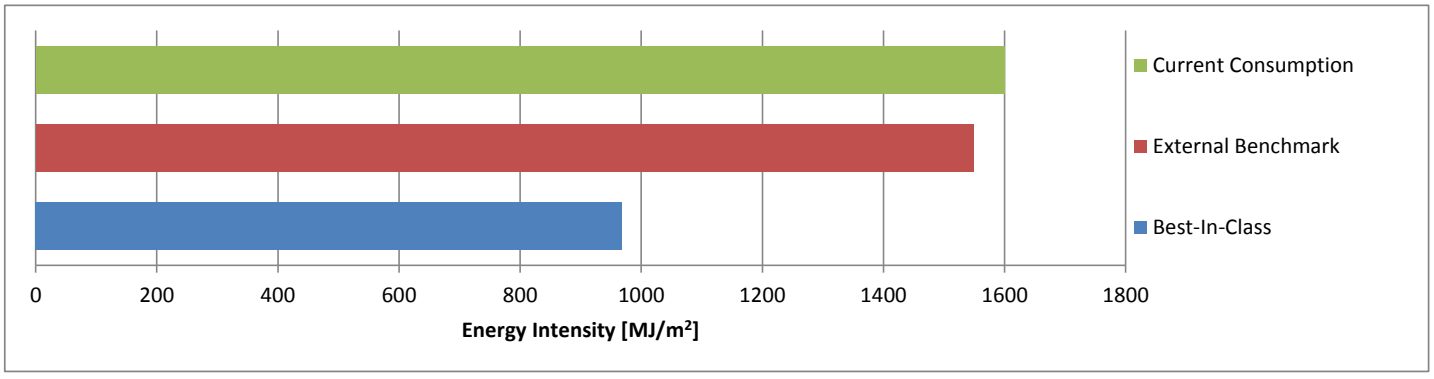
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	1,965	1295.3	81%
Space Cooling	0	N/A	N/A
Ventilation	115	76.0	5%
Plug Load	117	76.9	5%
Lighting	168	110.8	7%
Domestic Hot Water	16	10.6	1%
Other	45	29.4	2%
Total	**2,426**	**1,599**	**100%**

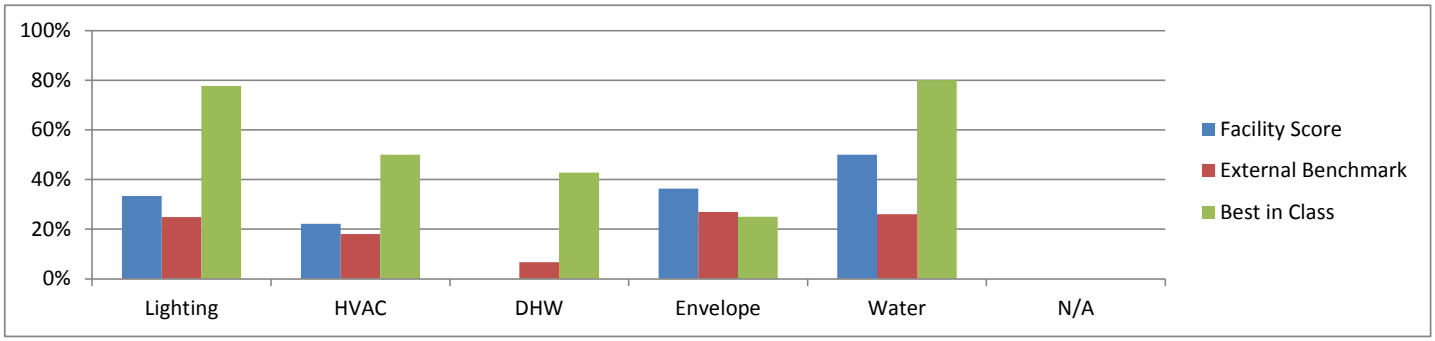
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Frank Slim Building	**Floor Area**	3,710	ft^2
Address	2nd and Ogilvie		345	m^2
Facility Type	Community Centre			

Facility Energy Profile

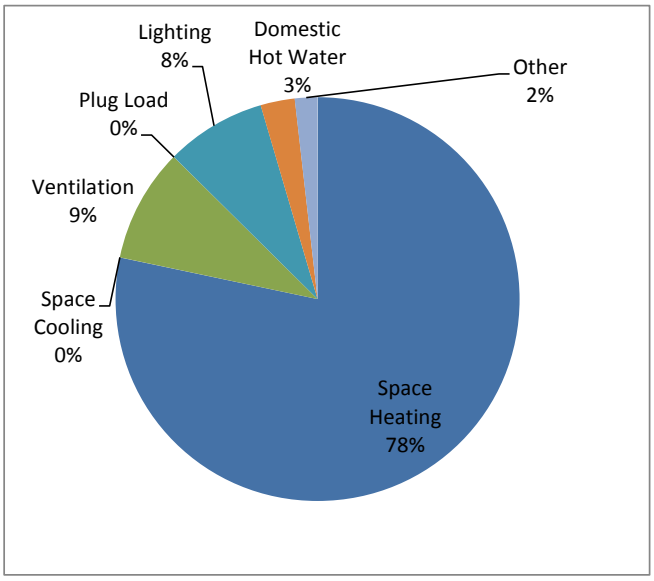
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	167	$7,748	37%
Propane	47	$1,106	5%
Fuel Oil	505	$11,883	57%
Total	719	$20,737	

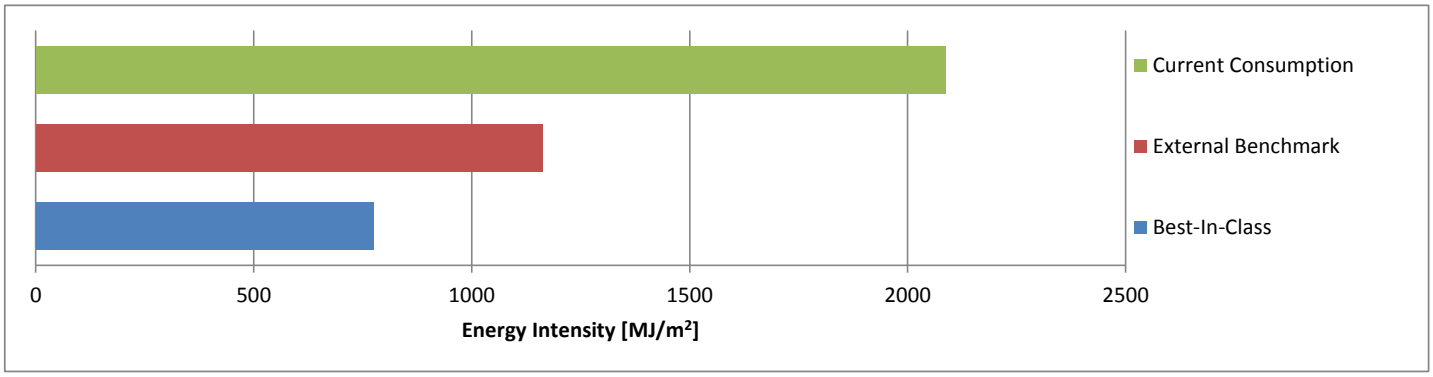
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	563	1633.1	78%
Space Cooling	0	N/A	N/A
Ventilation	65	189.9	9%
Plug Load	0	N/A	N/A
Lighting	58	167.5	8%
Domestic Hot Water	20	57.3	3%
Other	13	37.6	2%
Total	**719**	**2,085**	**100%**

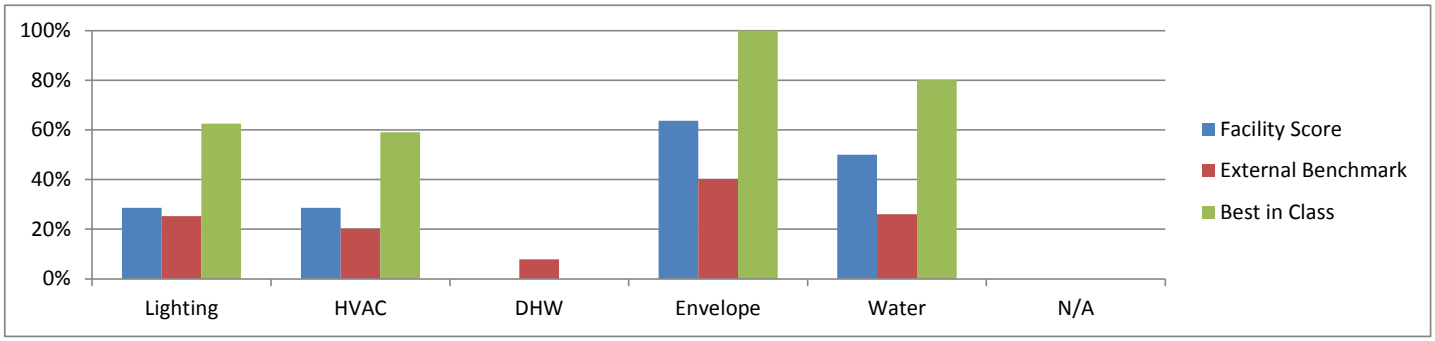
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Crestview Pumphouse	**Floor Area**	725	ft^2
Address	Azure Road		67	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

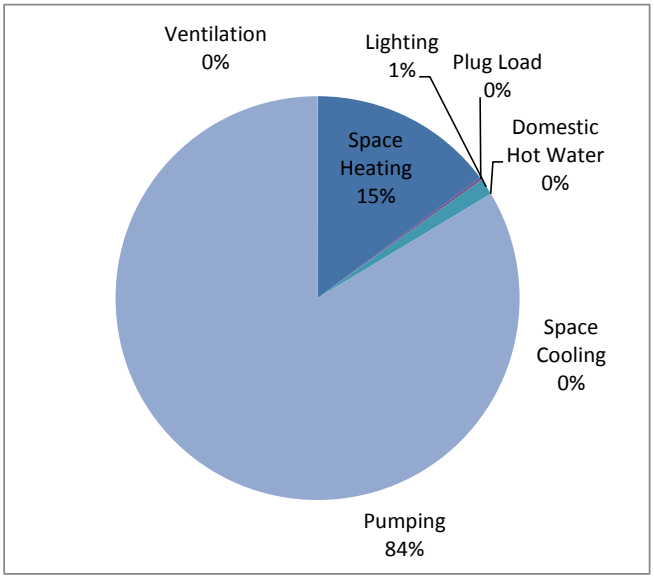
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	579	$18,052	100%
Propane	0	$0	0%
Fuel Oil	0	$0	0%
Total	579	$18,052	

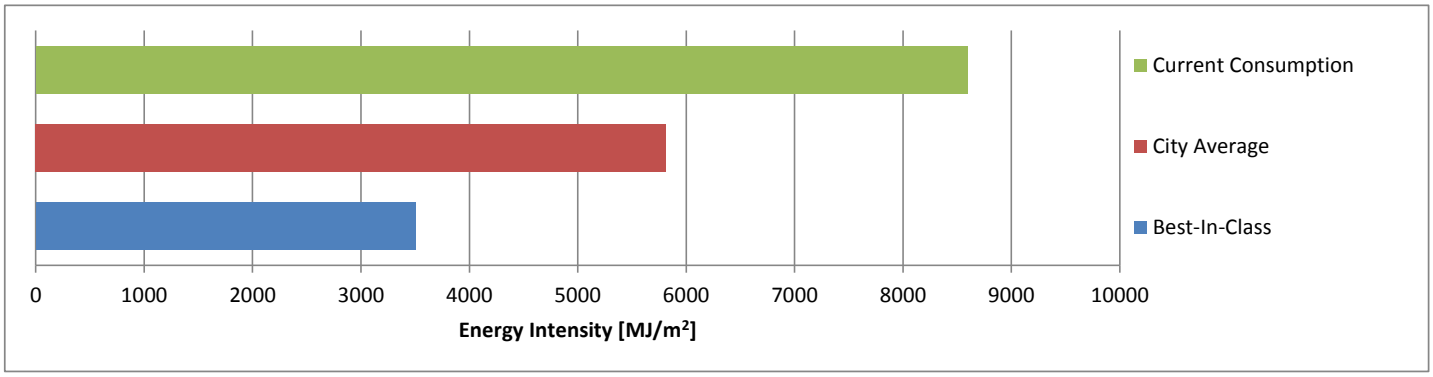
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	86	1274.2	15%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	1	19.2	0%
Lighting	8	112.9	1%
Domestic Hot Water	0	N/A	N/A
Pumping	484	7181.6	84%
Total	**579**	**8,588**	**100%**

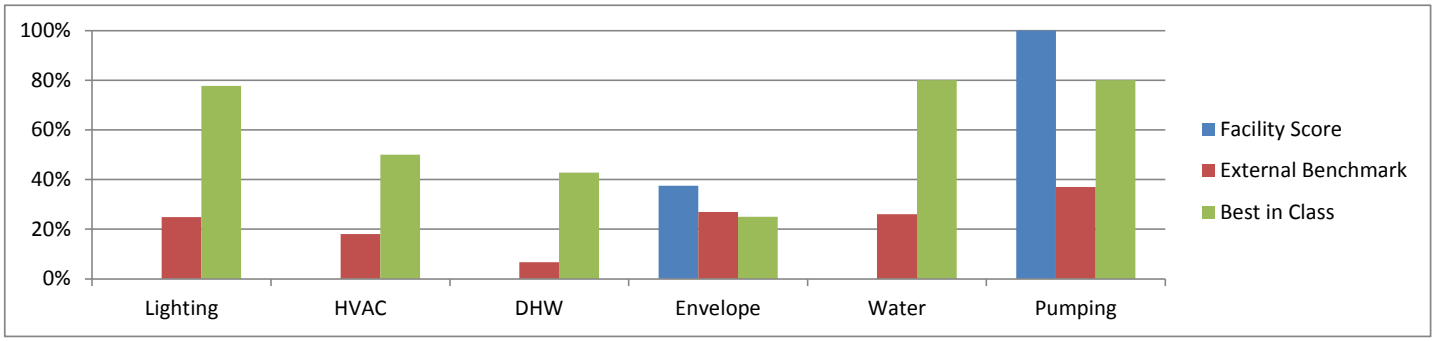
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Lift Station #1	**Floor Area**	1,640	ft^2
Address	2nd and Ogilvie		152	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

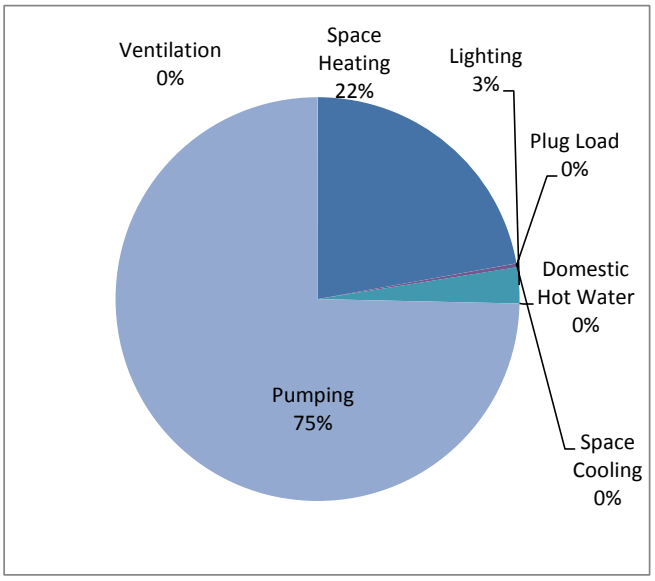
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	484	$20,843	100%
Propane	0	$0	0%
Fuel Oil	0	$0	0%
Total	484	$20,843	

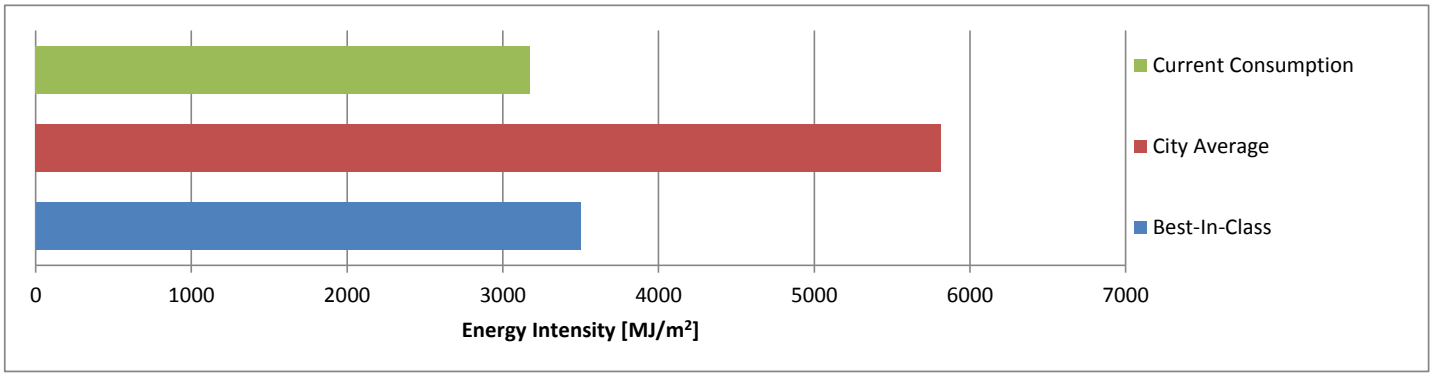
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	107	703.4	22%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	1	9.6	0%
Lighting	14	90.8	3%
Domestic Hot Water	0	N/A	N/A
Pumping	361	2368.3	75%
Total	**484**	**3,172**	**100%**

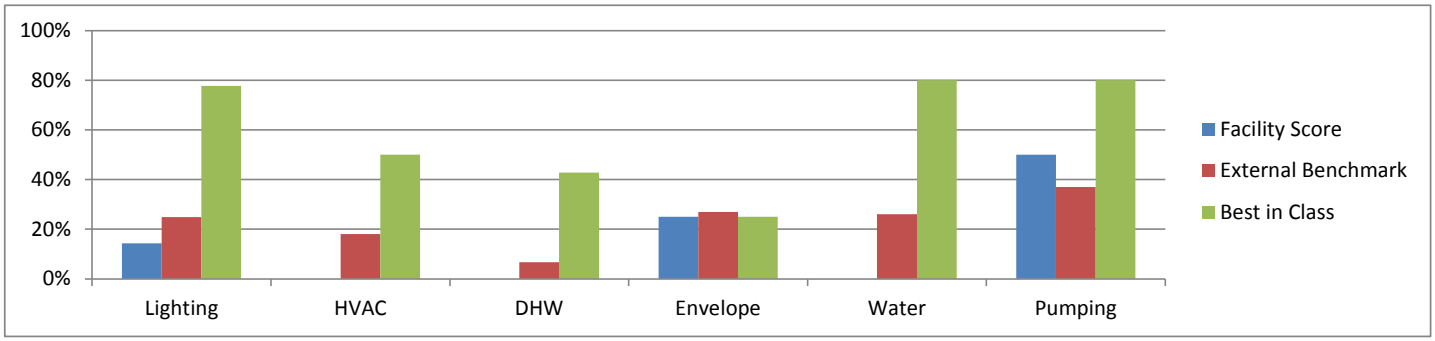
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Whitehorse

Energy Performance Benchmarking Report

Facility Information

Facility Name	Lift Station #3	**Floor Area**	1,382	ft^2
Address	Lewes Blvd		128	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

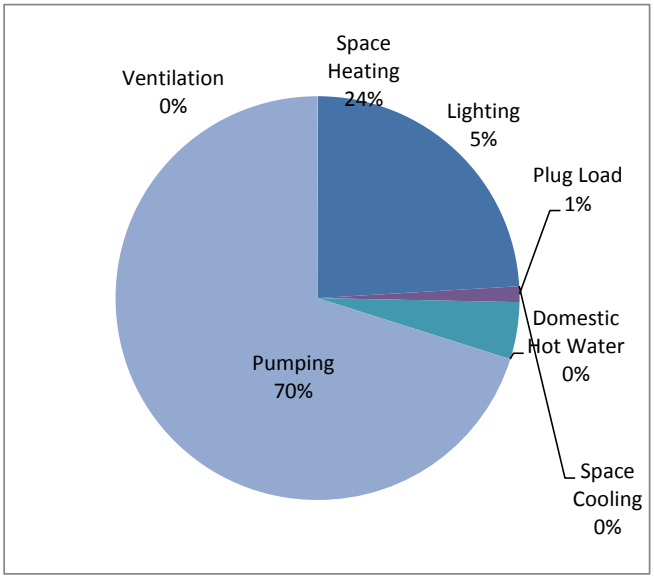
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	198	$6,759	100%
Propane	0	$0	0%
Fuel Oil	0	$0	0%
Total	198	$6,759	

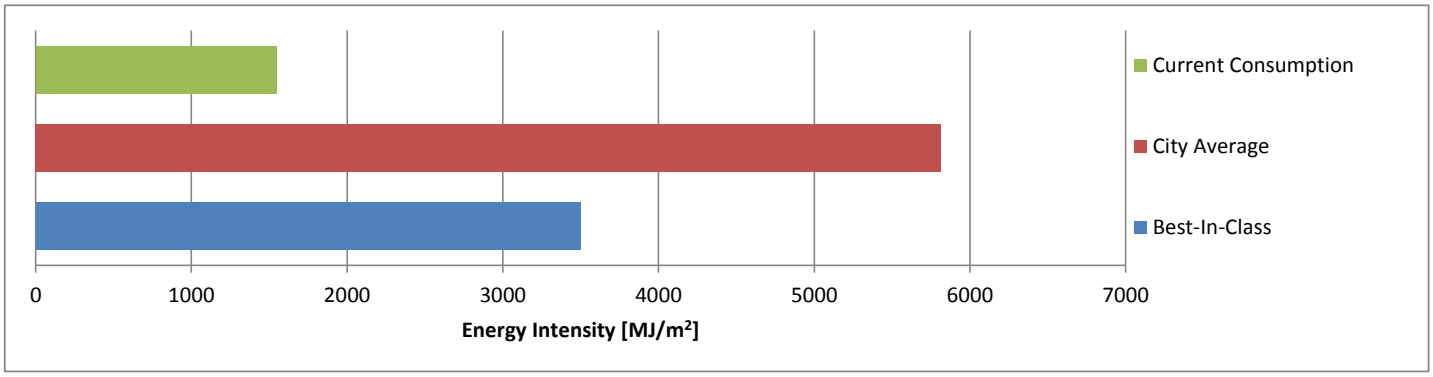
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	48	371.6	24%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	2	19.5	1%
Lighting	9	70.6	5%
Domestic Hot Water	0	N/A	N/A
Pumping	139	1083.1	70%
Total	**198**	**1,545**	**100%**

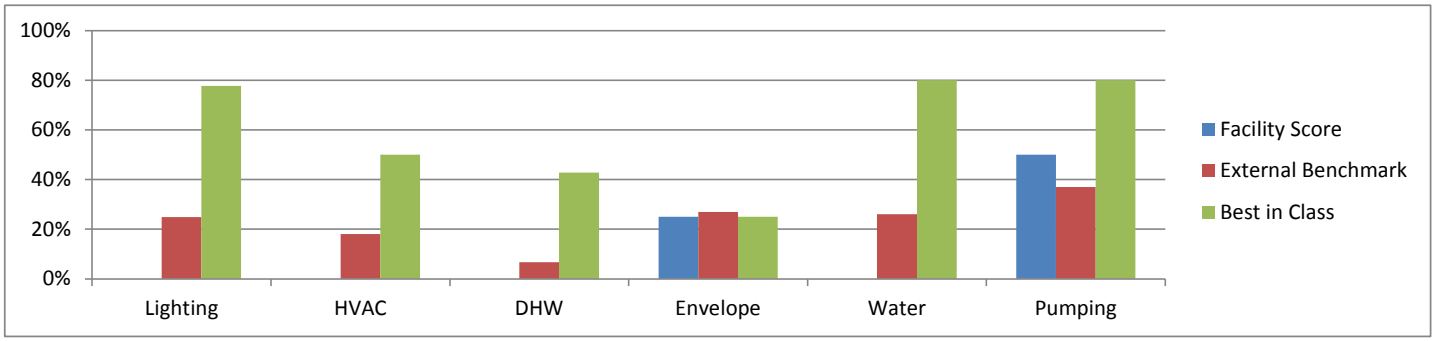
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Hamilton Blvd Pumphouse	**Floor Area**	1,495	ft^2
Address	Hamilton Blvd near Mallard Way		139	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

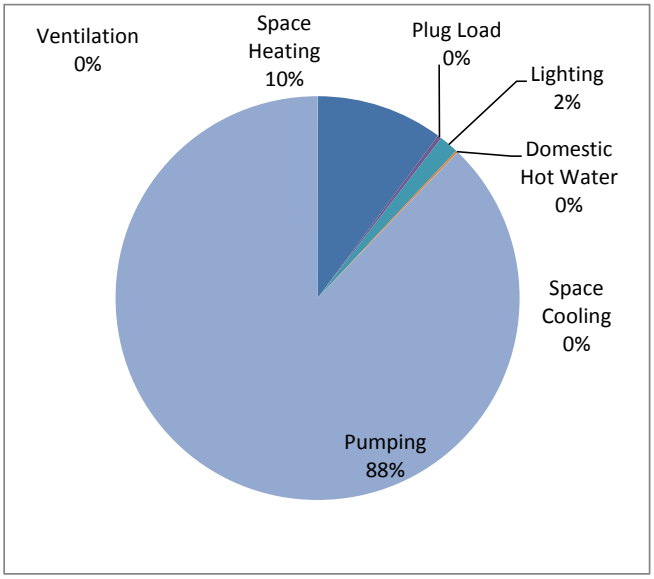
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	845	$30,207	100%
Propane	0	$0	0%
Fuel Oil	0	$0	0%
Total	845	$30,207	

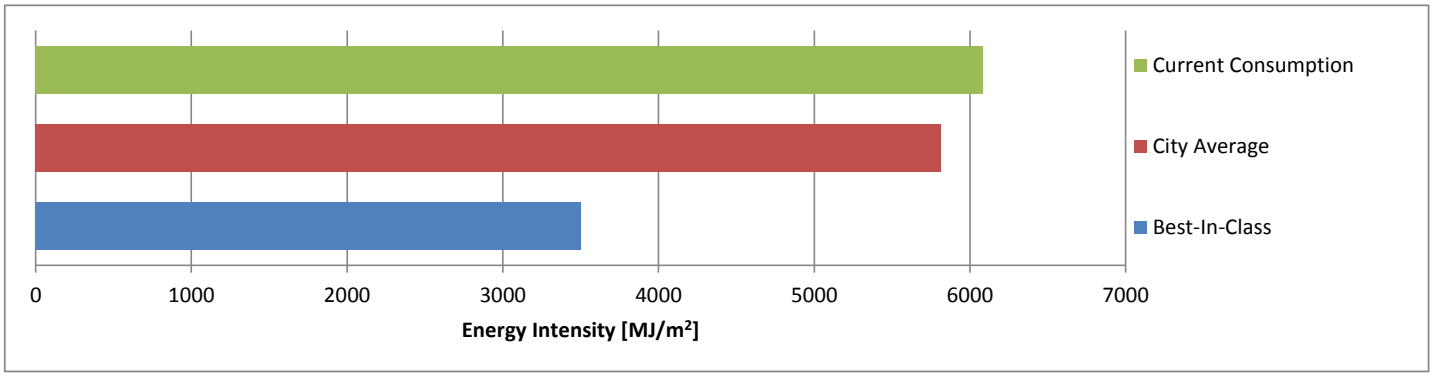
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	86	617.4	10%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	3	19.2	0%
Lighting	13	93.7	2%
Domestic Hot Water	1	9.6	0%
Pumping	742	5340.7	88%
Total	**845**	**6,081**	**100%**

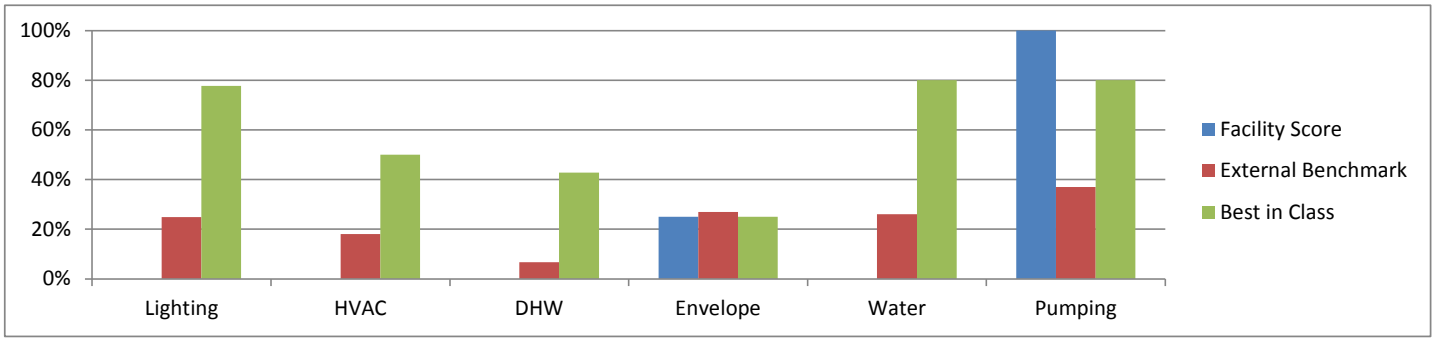
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Animal Shelter	**Floor Area**	2,841	ft^2
Address	9032 Quartz Road		264	m^2
Facility Type	Public Works			

Facility Energy Profile

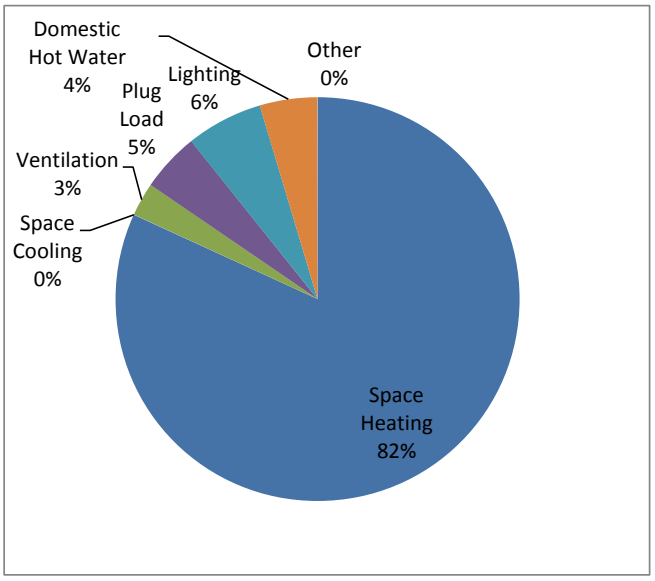
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	100	$3,825	27%
Propane	0	$0	0%
Fuel Oil	439	$10,394	73%
Total	540	$14,219	

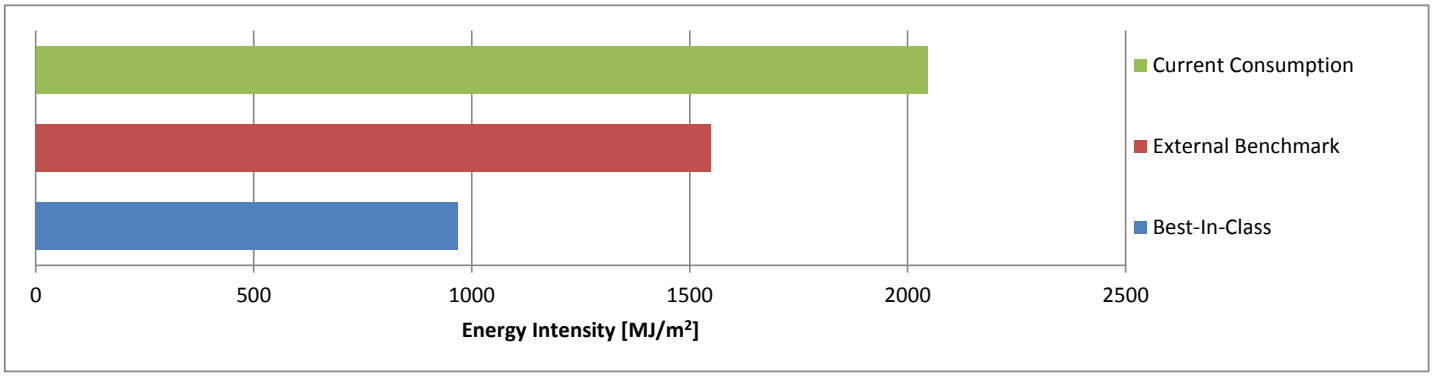
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	442	1673.0	82%
Space Cooling	0	N/A	N/A
Ventilation	15	54.9	3%
Plug Load	25	96.3	5%
Lighting	33	125.0	6%
Domestic Hot Water	25	94.4	5%
Other	0	N/A	N/A
Total	**540**	**2,044**	**100%**

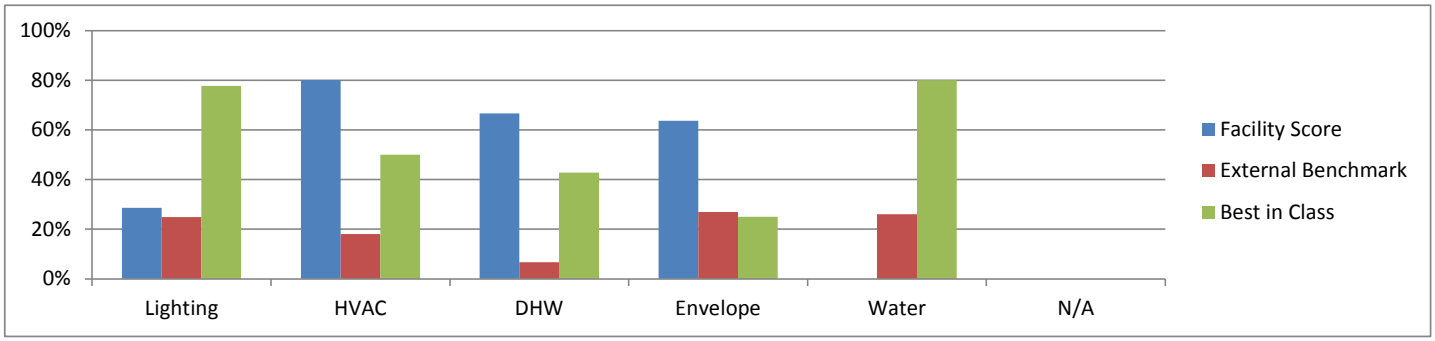
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Stores Warehouse	**Floor Area**	3,728	ft^2
Address	9000 Quartz Road		347	m^2
Facility Type	Public Works			

Facility Energy Profile

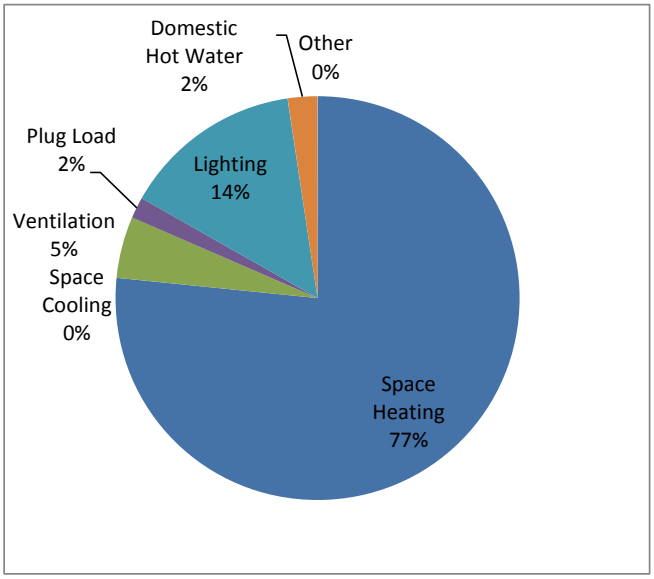
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	113	$5,579	39%
Propane	0	$0	0%
Fuel Oil	366	$8,641	61%
Total	479	$14,220	

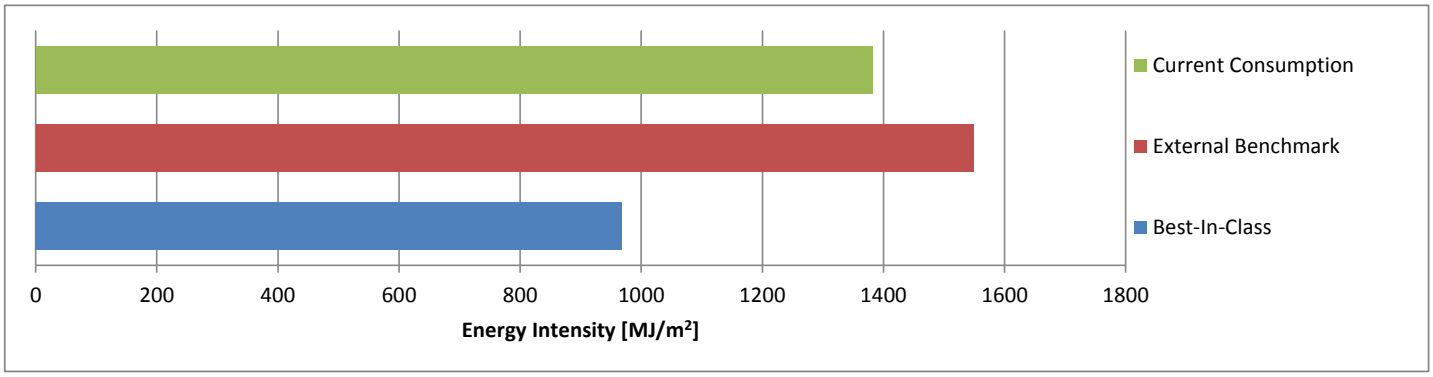
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	367	1058.3	77%
Space Cooling	0	N/A	N/A
Ventilation	24	68.0	5%
Plug Load	8	23.3	2%
Lighting	69	199.1	14%
Domestic Hot Water	11	32.8	2%
Other	0	N/A	N/A
Total	**479**	**1,382**	**100%**

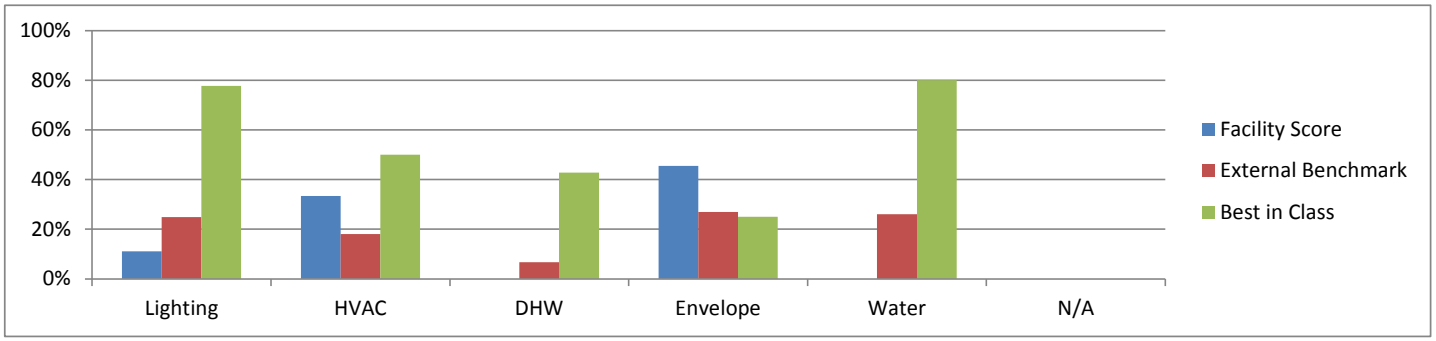
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Copper Ridge Pumphouse	**Floor Area**	3,882	ft^2
Address	Falcon Drive		361	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

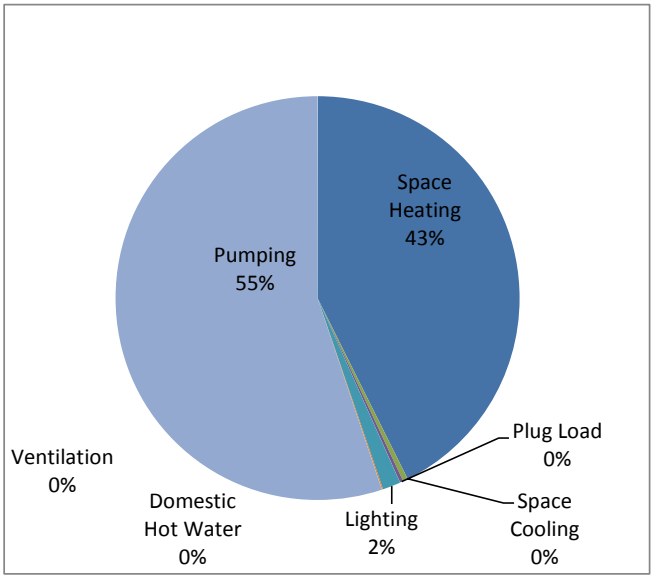
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	805	$36,688	74%
Propane	0	$0	0%
Fuel Oil	528	$12,809	26%
Total	1,333	$49,497	

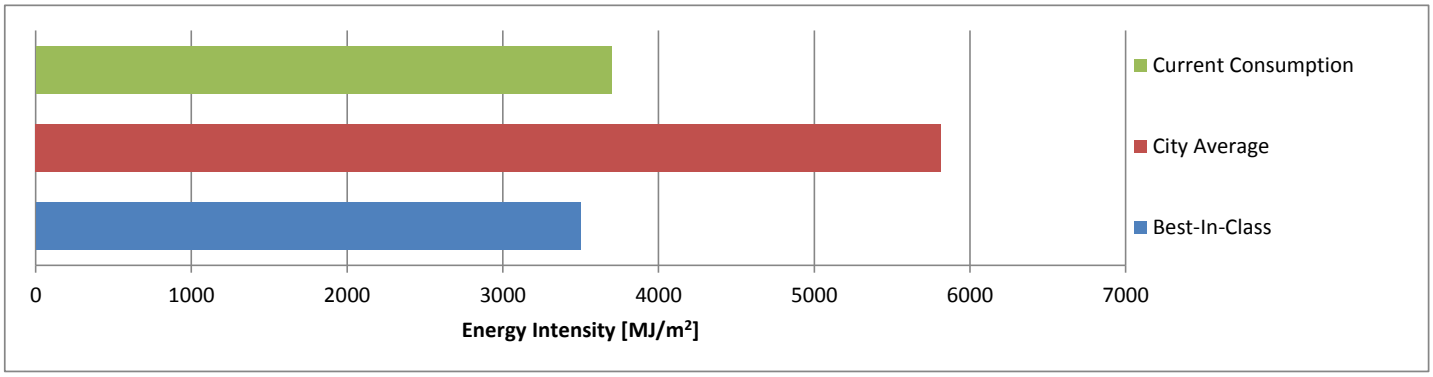
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	569	1575.8	43%
Space Cooling	0	N/A	N/A
Ventilation	5	14.6	0%
Plug Load	4	9.7	0%
Lighting	19	53.0	1%
Domestic Hot Water	1	3.6	0%
Pumping	735	2038.2	55%
Total	**1,333**	**3,695**	**100%**

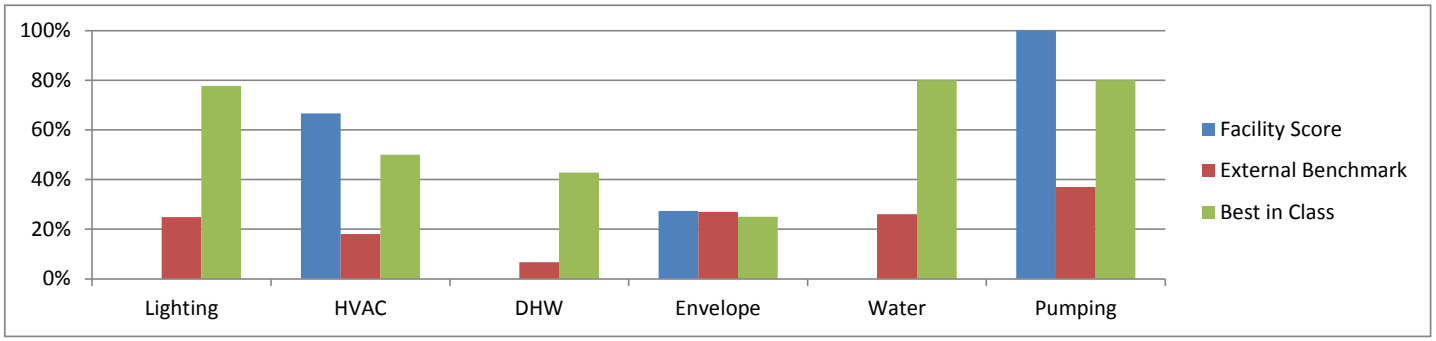
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Marwell Lift Station	**Floor Area**	4,802	ft^2
Address	Gypsum Road		446	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

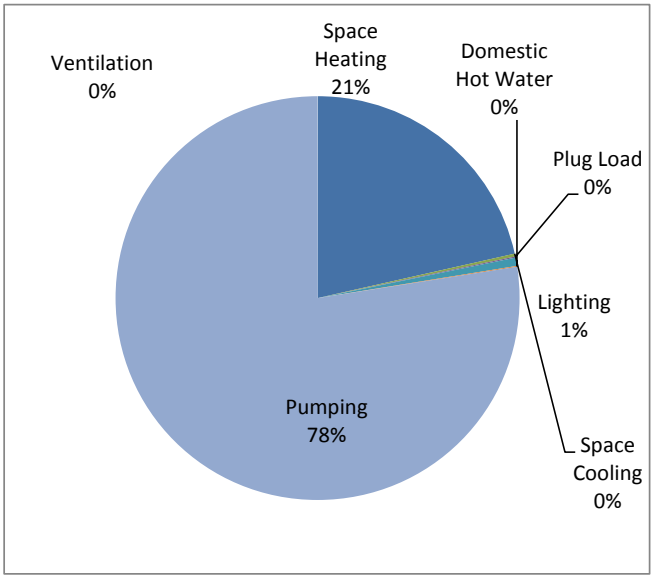
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	3,699	$167,116	89%
Propane	0	$0	0%
Fuel Oil	958	$21,346	11%
Total	4,657	$188,462	

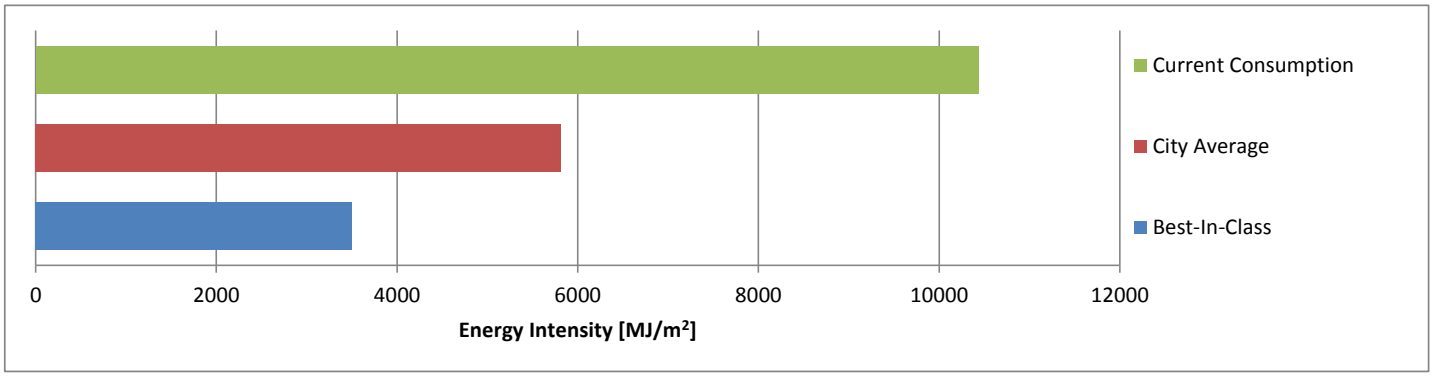
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	1,000	2239.5	21%
Space Cooling	0	N/A	N/A
Ventilation	11	23.9	0%
Plug Load	4	9.6	0%
Lighting	31	69.2	1%
Domestic Hot Water	4	8.4	0%
Pumping	3,608	8082.8	77%
Total	**4,657**	**10,433**	**100%**

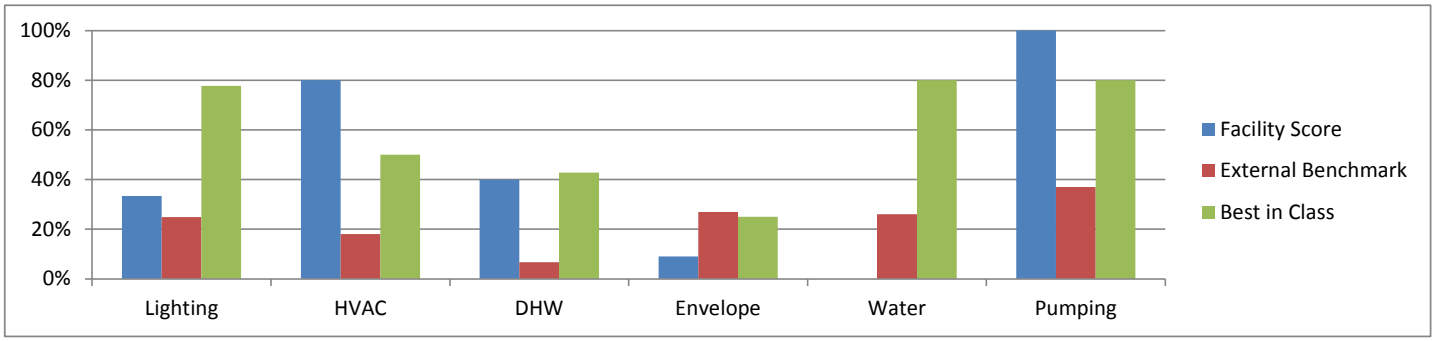
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Two Mile Hill Booster Stn	**Floor Area**	5,627	ft^2
Address	Two Mile Hill at Industrial		523	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

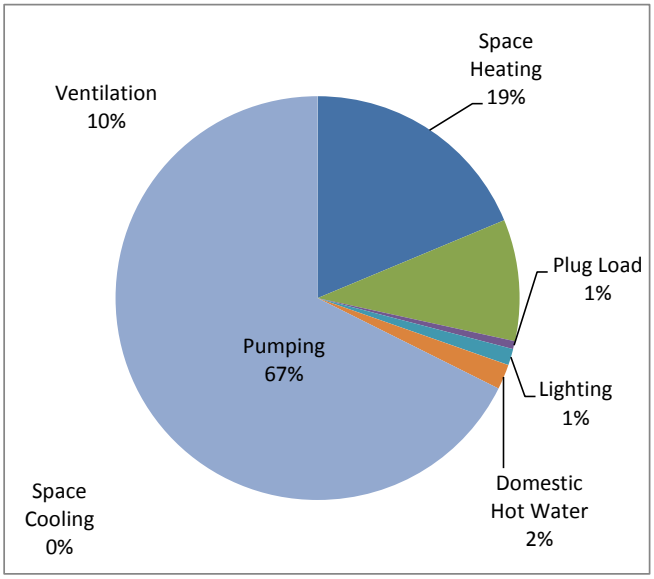
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	3,162	$143,921	84%
Propane	0	$0	0%
Fuel Oil	1,240	$27,584	16%
Total	4,402	$171,505	

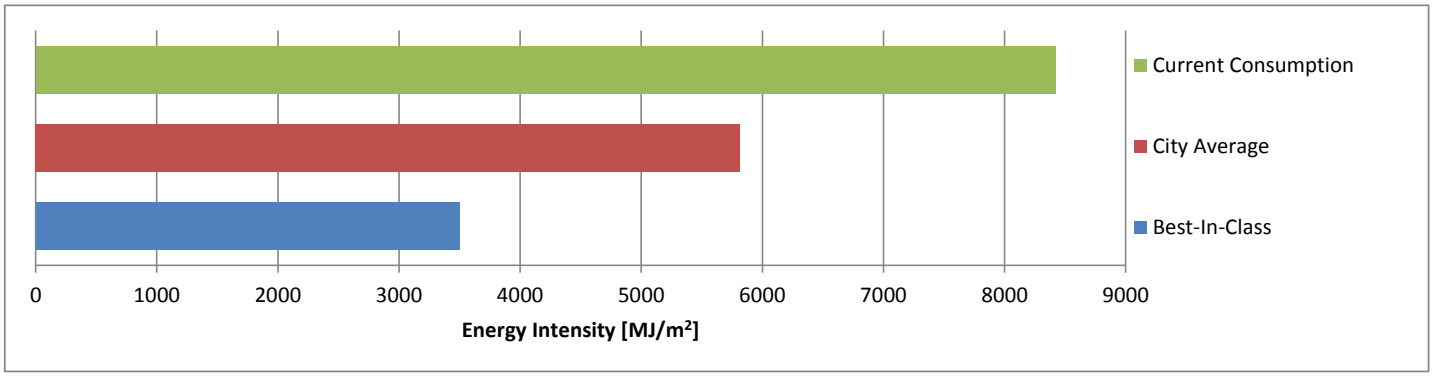
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	824	1574.7	19%
Space Cooling	0	N/A	N/A
Ventilation	428	818.0	10%
Plug Load	28	53.4	1%
Lighting	58	110.7	1%
Domestic Hot Water	88	167.7	2%
Pumping	2,977	5691.7	68%
Total	**4,402**	**8,416**	**100%**

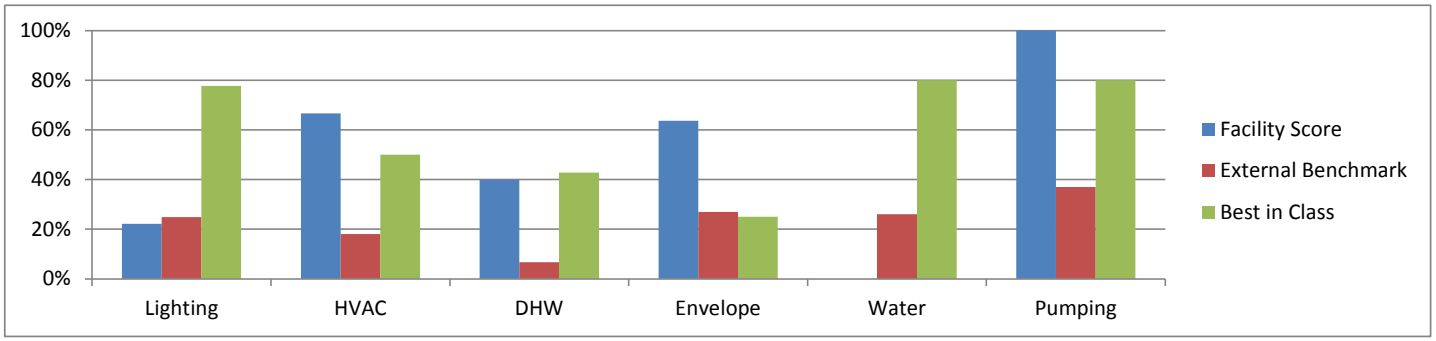
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Energy Performance Benchmarking Report

Facility Information

Facility Name	Strickland Lift Station	**Floor Area**	560	ft^2
Address	Strickland at First Avenue		52	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

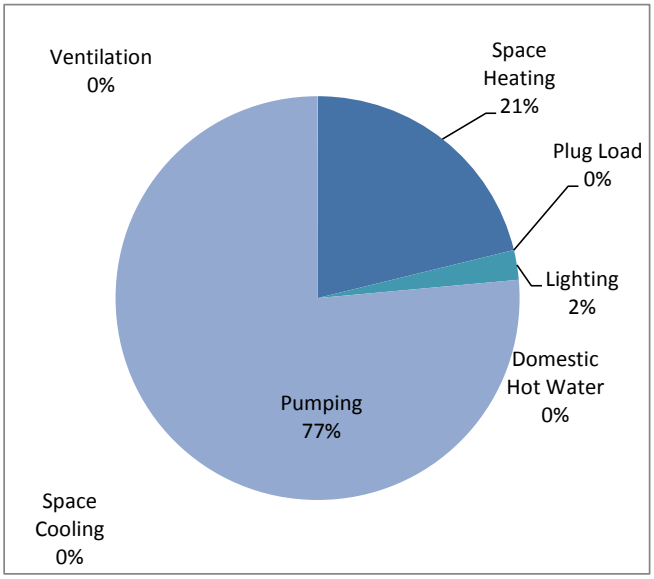
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	85	$5,656	100%
Propane	0	$0	0%
Fuel Oil	0	$0	0%
Total	85	$5,656	

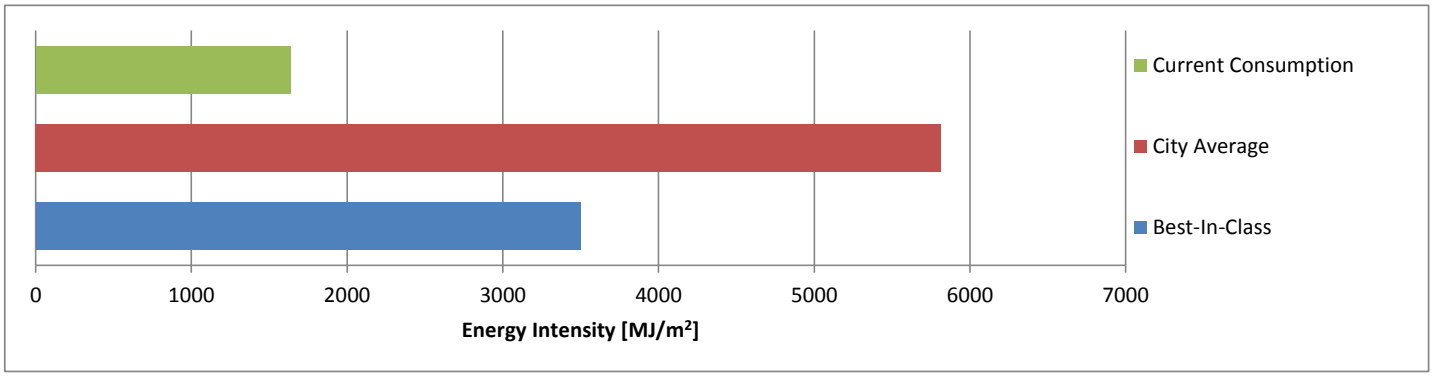
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	18	346.4	21%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	0	N/A	N/A
Lighting	2	38.8	2%
Domestic Hot Water	0	N/A	N/A
Pumping	65	1249.8	76%
Total	**85**	**1,635**	**100%**

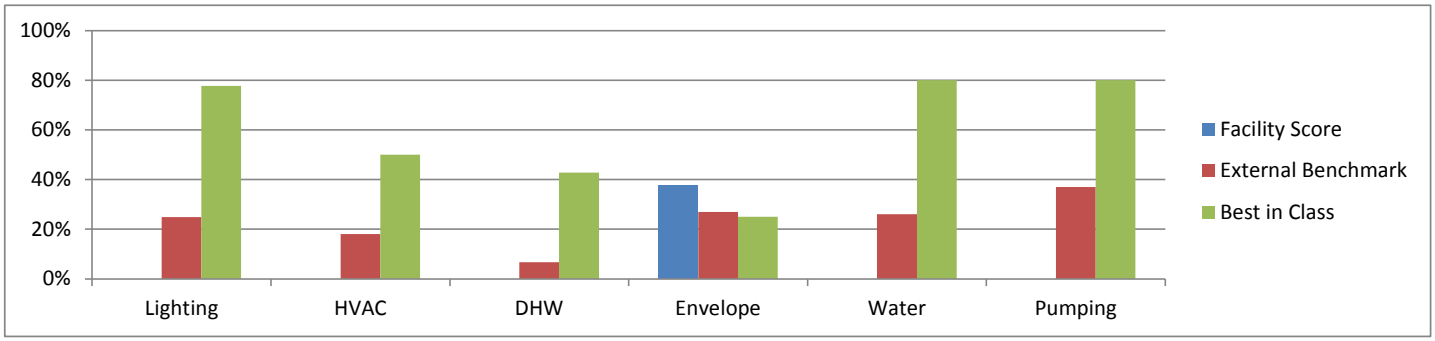
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Whitehorse

Energy Performance Benchmarking Report

Facility Information

Facility Name	McIntyre Creek Pump Station	**Floor Area**	1,264	ft^2
Address	Mountain View Drive		117	m^2
Facility Type	Water/Wastewater Infrastructure			

Facility Energy Profile

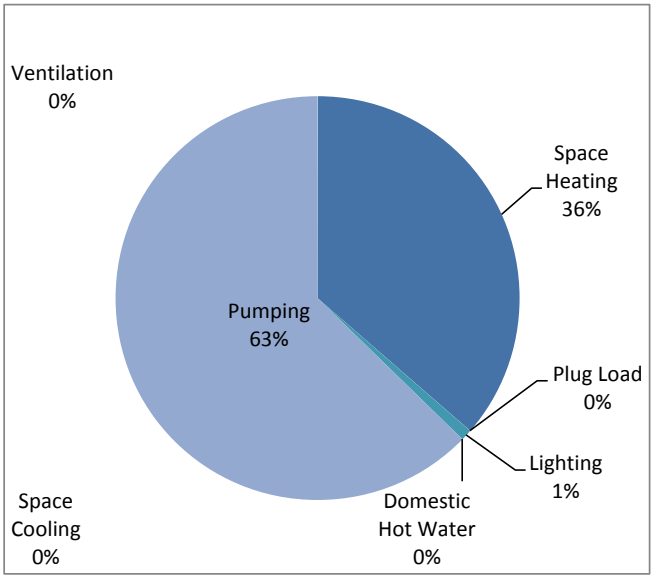
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	679	$30,621	76%
Propane	0	$0	0%
Fuel Oil	347	$9,917	24%
Total	1,026	$40,537	

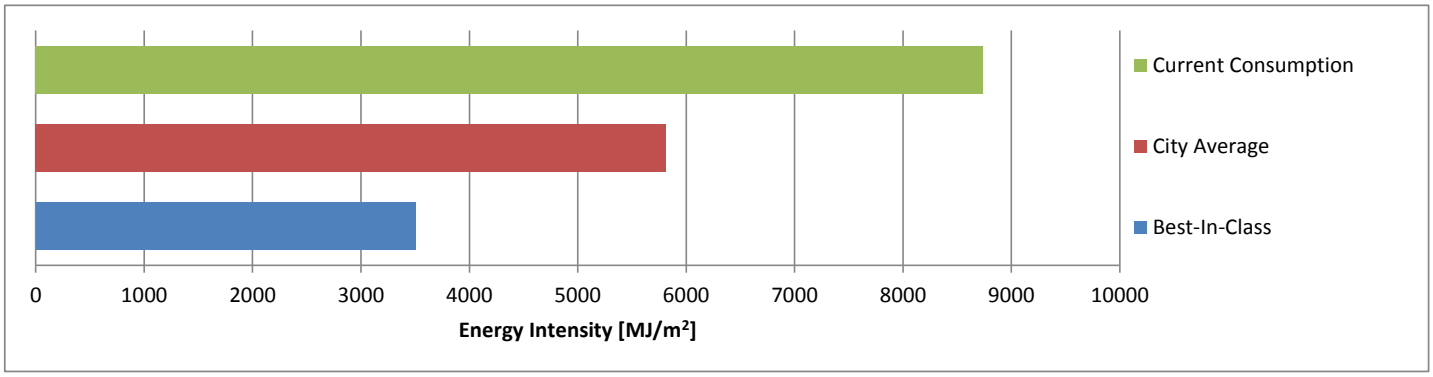
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	373	3178.8	36%
Space Cooling	0	N/A	N/A
Ventilation	0	N/A	N/A
Plug Load	0	N/A	N/A
Lighting	9	78.0	1%
Domestic Hot Water	0	N/A	N/A
Pumping	643	5475.7	63%
Total	**1,026**	**8,732**	**100%**

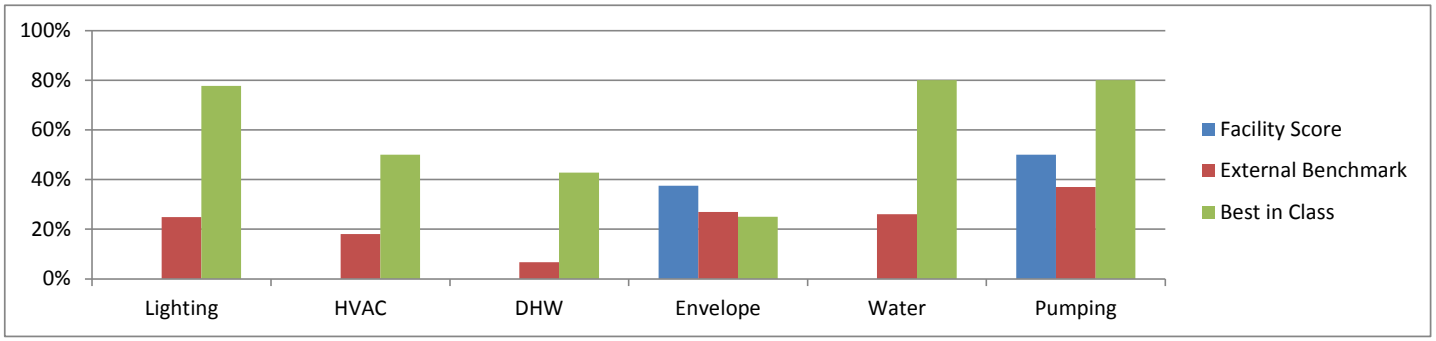
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Whitehorse

Energy Performance Benchmarking Report

Facility Information

Facility Name	Parks Warehouse	**Floor Area**	6,000	ft^2
Address	9043 Quartz Road		558	m^2
Facility Type	Parks			

Facility Energy Profile

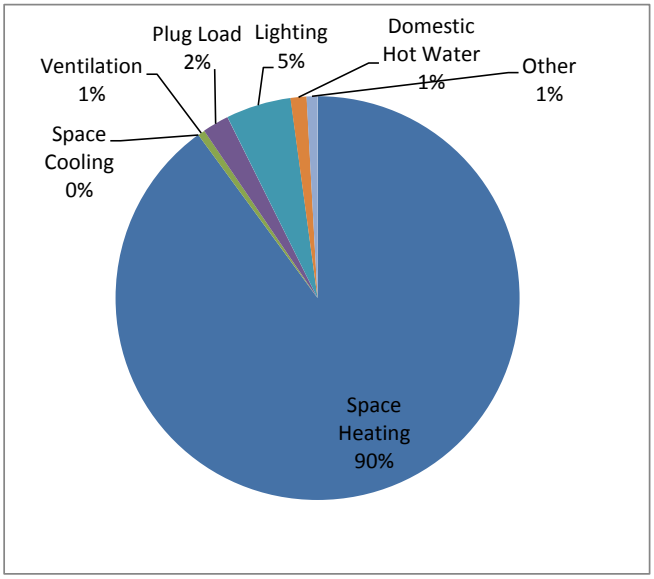
Energy Use

	GJ/year	Cost/year	% of Costs
Electricity	140	$0	0%
Propane	0	$0	0%
Fuel Oil	626	$14,655	100%
Total	766	$14,655	

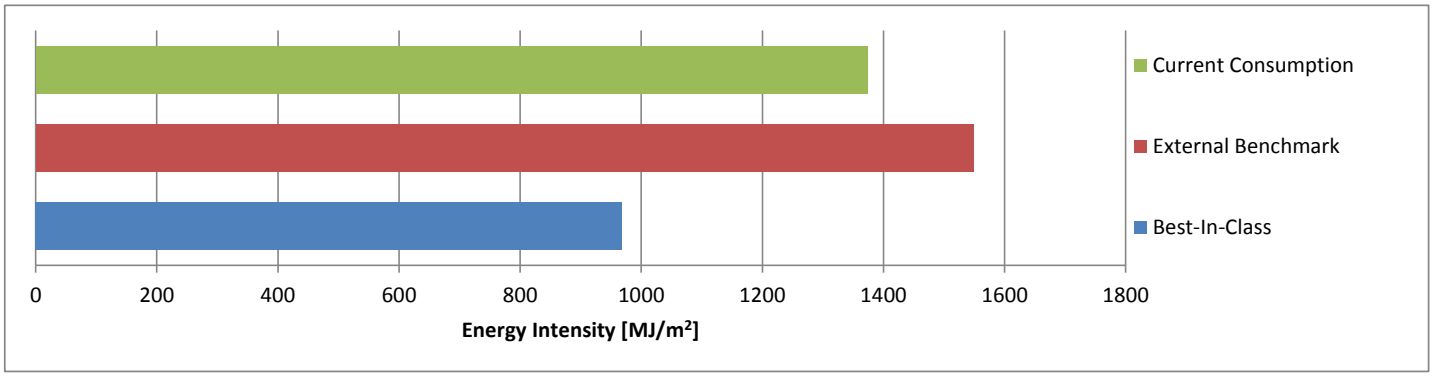
Energy End-Use Breakdown

	GJ	MJ/m^2	%
Space Heating	689	1235.4	90%
Space Cooling	0	N/A	N/A
Ventilation	4	7.9	1%
Plug Load	16	29.0	2%
Lighting	40	71.6	5%
Domestic Hot Water	10	17.4	1%
Other	7	12.0	1%
Total	**766**	**1,373**	**100%**

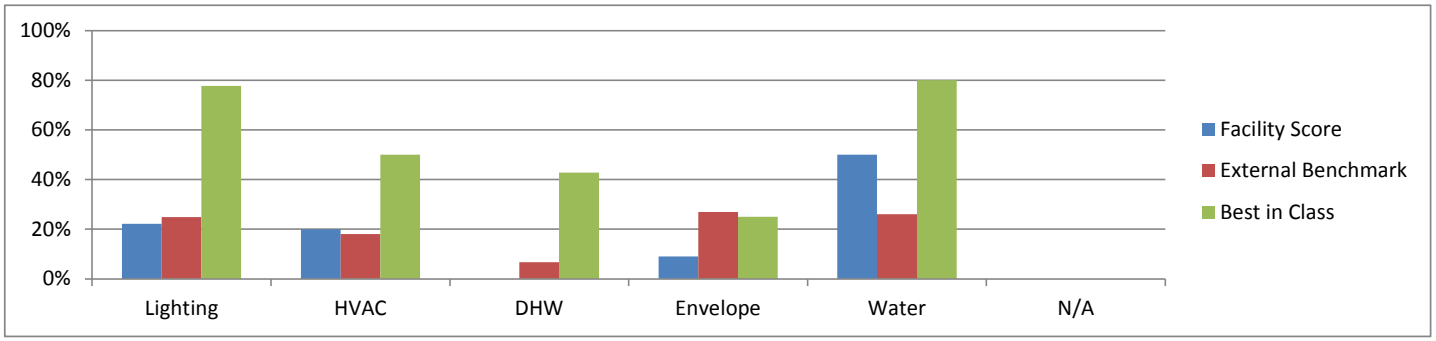
Facility Energy Summary



Comparative Energy Intensity



Technical Profile



Appendix B OBP Benchmarking Survey

City-Level Organizational Best Practice Survey

			Actual Score	Average Score	Best Score
1	**Energy Management Policy**				
1.1	The municipality has made a documented commitment to implementing sustainable energy policies and plans.	Partial	50%	50%	100%
	The municipality has a documented energy management policy, which:				
1.2	defines long-term strategic energy management commitments and goals;	Partial	50%	50%	100%
1.3	specifies responsibilities and sets targets for controlling energy use, cost, and GHG emissions;	Partial	50%	50%	100%
1.4	includes in scope; energy efficiency and conservation, and demand management;	Partial	50%	50%	100%
1.5	includes in scope; high performance standards for new building construction;	Partial	50%	50%	100%
1.6	includes in scope; energy procurement, and energy management purchasing guidelines.	Partial	50%	50%	100%
			50%	**50%**	**100%**
2	**Energy Management Planning**				
2.1	The municipality has adopted a formal energy management plan.	Partial	50%	50%	100%
	The City has a documented energy management planning process, which annually:				
2.2	conducts energy performance benchmarking;	Partial	50%	50%	100%
2.3	reviews facility and portfolio-level energy performance reports;	Partial	50%	50%	100%
2.4	sets targets for reducing energy use and cost in facilities/operations;	No	0%	50%	100%
2.5	defines actions to reduce energy costs and achieve the energy performance targets in facilities/operations;	Partial	50%	50%	100%
2.6	identifies candidate facilities for energy audits.	Partial	50%	50%	100%
			42%	**50%**	**100%**
3	**Energy Management Financing**				
3.1	The municipality has formalized procedures for funding energy management projects.	No	0%	50%	100%
3.2	The procedures enable capital and operating financial allocations for energy management projects to have the same level of authority and importance as other municipal capital and operating financial allocations.	No	0%	50%	100%
3.3	The municipality requires the business case development for all energy management projects to include an assessment of energy cost avoidance, maintenance cost reduction, and greenhouse gas emissions.	Partial	50%	50%	100%
3.4	The municipality requires energy management investments to be assessed based on a life-cycle cost methodology.	No	0%	50%	100%
			13%	**50%**	**100%**

4	**Organization and Accountability**				
4.1	The municipality has assigned accountability to a designated senior manager to implement the corporate energy management plan and meet the energy use performance targets.	Partial	50%	50%	100%
4.2	The municipality additionally spreads the accountability to implement the energy management plan among other managers including facility managers.	Partial	50%	50%	100%
4.3	The municipality has documented standards for measurement and verification of energy initiatives in accordance with accepted standards such as the International Performance Measurement and Verification Protocol (IPMVP), or equivalent standards.	No	0%	50%	100%
4.4	The municipality has sufficient resources in place to adequately measure, track and report its energy performance.	Partial	50%	50%	100%
			38%	**50%**	**100%**
5	**Energy Management Information Systems**				
5.1	The municipality employs an Energy Management Information System to record and track energy consumption, demand and cost, for each facility.	Yes	100%	50%	100%
5.2	Data is gathered and input on a monthly basis.	Partial	50%	50%	100%
5.3	Energy consumption is normalized to floor area and adjusted for weather variables.	No	0%	50%	100%
5.4	Facility energy performance is reported monthly to the appropriate personnel accountable for energy budgets and facility operations.	Partial	50%	50%	100%
5.5	Variances between actual and targeted energy consumption levels are investigated and corrective actions taken.	Partial	50%	50%	100%
			50%	**50%**	**100%**
6	**Communications**				
6.1	The energy management policy and plan is communicated externally; for instance, it is posted on the municipality's web-site.	Partial	50%	50%	100%
6.2	The municipality uses a consistent communications and reporting protocol to channel key performance indicator results and relevant energy use information to Council, managers and employees.	No	0%	50%	100%
6.3	The municipality actively encourages and supports staff awareness and participation in energy management at all organizational levels.	No	0%	50%	100%
6.4	Energy saving and other energy management ideas are actively solicited from employees.	Partial	50%	50%	100%
			25%	**50%**	**100%**
7	**Training and Capacity Development**				
7.1	The municipality maintains a budget and plan for energy management training for employees.	Partial	50%	50%	100%
7.2	The training plan for energy management includes both management and technical training competencies.	Partial	50%	50%	100%
7.3	Senior-staff, accountable for energy use and cost performance targets, are trained to conduct energy management planning processes.	No	0%	50%	100%
7.4	Senior-staff are trained to prepare and submit a financial business case evaluation of energy initiates in terms relevant to the financial criteria of the project approval process.	No	0%	50%	100%
7.5	Senior-staff are trained to budget and manage pre-feasibility and investment grade studies and project implementation.	Partial	50%	50%	100%
			30%	**50%**	**100%**

Facility-Level Organizational Best Practices Survey

			Actual Score	Average Score	Best Score
1	**Energy Management Planning**				
1.1	The facility has an up to date energy management action plan including energy performance targets, key energy use performance indicators, staff responsibilities/accountabilities, and a plan to implement specific projects/actions, as applicable	Partial	50%	50%	100%
1.2	Other departments in the municipality participated in the planning process and adhere to the plan.	Partial	50%	50%	100%
1.3	Energy use performance improvements are defined and scheduled as actions in an annual facility planning process.	Yes	100%	50%	100%
1.4	Energy performance benchmarking is carried out at least once per year.	No	0%	50%	100%
1.5	An energy audit of appropriate effort and scope is carried out at least every 5 years.	Partial	50%	50%	100%
			50%	**50%**	**100%**
2	**Organization and Accountability**				
2.1	The facility management organizational structure clearly delegates responsibility and accountability for energy management budgets, actions, and targets.	No	0%	50%	100%
2.2	The facility has an energy leader who is empowered, recognized and has full support from senior management.	Partial	50%	50%	100%
2.3	The facility has an energy committee that actively promotes energy awareness and opportunity identification.	Partial	50%	50%	100%
2.4	The energy committees, or employees, receive energy awareness training, workshops at least once per year.	Partial	50%	50%	100%
2.5	Facility employees are aware of energy performance targets and commitments to energy use performance improving actions.	No	0%	50%	100%
			30%	**50%**	**100%**
3	**Opportunity Identification**				
	The scope of energy management opportunities considered at this facility includes:				
3.1	Energy efficiency and conservation	Yes	100%	50%	100%
3.2	Peak load and demand management	No	0%	50%	100%
3.3	Fuel substitution and/or use of renewable energy sources	Partial	50%	50%	100%
3.4	Utility data management	Yes	100%	50%	100%
	The following approaches/tools are used to identify energy management opportunities:				
3.5	Suggestions/proposals by energy leader, energy committee, employees, etc.	Partial	50%	50%	100%
3.6	Energy performance benchmarking	No	0%	50%	100%
3.7	Energy audits or feasibility studies	Partial	50%	50%	100%
3.8	Maintenance activities	Yes	100%	50%	100%
3.9	Life-cycle replacement, asset renewal, or renovations	No	0%	50%	100%
3.10	Existing metering, additional sub-metering if required, and monitoring of building automation system (as applicable)	Partial	50%	50%	100%
			50%	**50%**	**100%**

4	**Project Management and Implementation**				
4.1	The facility uses standardized procedures to manage the implementation of energy management projects.	No	0%	50%	100%
4.2	The facility uses a designated project manager to oversee the implementation of energy management projects.	Yes	100%	50%	100%
4.3	Project measurement and verification plans (of appropriate scale) are normally carried out as part of the project design for energy performance improvement projects.	No	0%	50%	100%
4.4	The measurement and verification plan references standards such as the International Performance Measurement and Verification Protocol (IPMVP); or ASHRAE Guideline 14-2002, Measurement of Energy and Demand Savings; or equivalent standards.	No	0%	50%	100%
			25%	**50%**	**100%**
5	**Reporting and Communication**				
5.1	The facility has metering or sub-metering equipment for all energy utilities.	Yes	100%	50%	100%
5.2	Facility utility information is gathered and recorded on a monthly basis and key performance metrics are generated.	Partial	50%	50%	100%
5.3	Reports on energy use performance are actively used to support decision making at the corporate level, and to action tasks and training and awareness at the facility level.	Partial	50%	50%	100%
5.4	A variety of tools are used to display performance and targets as part of an ongoing facility energy awareness campaign.	No	0%	50%	100%
			50%	**50%**	**100%**

Appendix C Business Case Assessments

Facility: Canada Games Centre

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	45.2	383,079	$53,272	-8,192	-$8,111					$45,162	$234,717	5.2	$97,678	14%	4.4
Refrigeration and HVAC		21,783	$2,801	13,500	$13,365					$16,166	$55,000	3.4	$24,495	19%	38.4
RCx and Controls Optimization		173,050	$22,254	20,680	$20,473					$42,727	$137,500	3.2	$176,978	29%	68.7
Operations and Maintenance		21,000	$2,701	3,010	$2,980			1,500	$2,520	$8,201	$23,750	2.9	$31,721	69%	9.7
Water Efficient Fixtures				8,888	$8,799			1,310	$2,201	$11,001	$3,856	0.4	$77,111	285%	24.3
Total	**45.2**	**598,912**	**$81,029**	**37,886**	**$37,507**	**0**	**$0**	**2,810**	**$4,721**	**$123,257**	**$454,823**	**3.7**	**$407,983**		**145.5**
Baseline Consumption		4,250,400	$670,968	517,626	$518,589	5,225	$3,098	22,200	$36,906	$1,229,561					1,721
Estimated Savings			12%		7%		0%		13%	10%					8%
Post-Retrofit Target		3,651,488	$589,939	479,740	$481,082	5,225	$3,098	19,390	$32,185	$1,106,304					1,576

Facility: Takhini Arena

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	14.7	79,793	$11,569			-2,806	-$2,477		$0	$9,092	$59,475	6.5	$7,442	9%	1.3
Refrigeration and HVAC						23,300	$20,574		$0	$20,574	$70,625	3.4	$41,425	13%	35.2
RCx and Controls Optimization		74,450	$9,574			4,760	$4,203		$0	$13,777	$25,188	1.8	$76,215	54%	12.4
Operations and Maintenance		19,300	$2,482			1,360	$1,201	1,000	$1,680	$5,363	$7,000	1.3	$32,471	76%	3.4
Water Efficient Fixtures						963	$850	1,760	$2,957	$3,808	$20,358	5.3	$7,666	13%	1.5
Total	**14.7**	**173,543**	**$23,625**	**0**	**$0**	**27,577**	**$24,351**	**2,760**	**$4,637**	**$52,614**	**$182,646**	**3.5**	**$165,220**		**53.8**
Baseline Consumption		965,040	$160,950	0	$0	68,153	$41,015	9,700	$16,098	$218,063					170
Estimated Savings			15%				59%		29%	24%					32%
Post-Retrofit Target		791,497	$137,324	0	$0	40,576	$16,664	6,940	$11,461	$165,449					117

Facility: Mount MacIntyre Rec Centre

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	14.8	77,642	$11,293	-1,660	-$1,644					$9,649	$31,035	3.2	$39,985	29%	0.9
Refrigeration and HVAC															0.0
RCx and Controls Optimization		83,000	$10,674	6,320	$6,257					$16,931	$44,375	2.6	$80,236	36%	23.1
Operations and Maintenance		6,000	$772	790	$782			500	$840	$2,394	$3,750	1.6	$13,868	63%	2.6
Water Efficient Fixtures				570	$564			383	$644	$1,209	$10,931	9.0	-$2,036	2%	1.6
Total	**14.8**	**166,642**	**$22,739**	**6,020**	**$5,959**	**0**	**$0**	**883**	**$1,484**	**$30,182**	**$90,091**	**3.0**	**$132,052**		**28.1**
Baseline Consumption		668,965	$86,029	79,761	$79,162	0	$0	5,490	$9,160	$174,351					265
Estimated Savings			26%		8%				16%	17%					11%
Post-Retrofit Target		502,323	$63,290	73,741	$73,202	0	$0	4,607	$7,676	$144,169					237

Facility: Municipal Services Building

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	7.6	37,253	$5,461	-797	-$789					$4,672	$58,674	12.6	-$24,289	-4%	0.4
Refrigeration and HVAC															0.0
RCx and Controls Optimization		55,435	$7,129	17,160	$16,988				$0	$24,117	$106,875	4.4	$70,631	18%	50.8
Operations and Maintenance		22,000	$2,829	7,150	$7,079				$0	$9,908	$15,625	1.6	$57,297	63%	21.1
Water Efficient Fixtures			$0	345	$341			193	$324	$666	$515	0.8	$4,385	129%	0.9
Total	**7.6**	**114,688**	**$15,419**	**23,858**	**$23,620**	**0**	**$0**	**193**	**$324**	**$39,363**	**$181,688**	**4.6**	**$108,023**		**73.3**
Baseline Consumption		442,494	$69,127	143,545	$142,736	0	$0	1,861	$3,111	$214,973					424
Estimated Savings			22%		17%				10%	18%					17%
Post-Retrofit Target		327,806	$53,708	119,687	$119,116	0	$0	1,668	$2,786	$175,610					350

Facility: Public Safety Building

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	2.3	11,612	$1,697			-408	-$361			$1,336	$16,300	12.2	-$6,463	-3%	0.2
Refrigeration and HVAC															0.0
RCx and Controls Optimization		17,780	$2,287			3,266	$2,884			$5,170	$18,000	3.5	$20,053	26%	6.2
Operations and Maintenance		4,000	$514							$514	$2,500	4.9	$1,286	16%	0.3
Water Efficient Fixtures						266	$235	59	$98	$334	$183	0.5	$2,273	182%	0.4
Total	**2.3**	**33,391**	**$4,498**	**0**	**$0**	**3,124**	**$2,758**	**59**	**$98**	**$7,355**	**$36,983**	**5.0**	**$17,149**		**7.1**
Baseline Consumption		355,599	$53,340	0	$0	43,544	$26,268	439	$901	$80,509					91
Estimated Savings			8%				11%		11%	9%					8%
Post-Retrofit Target		322,207	$48,842	0	$0	40,420	$23,509	380	$802	$73,154					84

Facility: City Hall/Fire Hall #1

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	3.0	14,465	$2,126	-309	-$306					$1,820	$16,507	9.1	-$3,115	2%	0.2
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		21,900	$2,816	6,455	$6,391					$9,207	$59,469	6.5	$8,295	9%	19.2
Operations and Maintenance		6,500	$836	480	$475					$1,311	$3,875	3.0	$5,775	32%	1.8
Water Efficient Fixtures		2,250	$289					101	$170	$460	$6,369	13.9	-$2,985	-6%	0.2
Total	**3.0**	**45,115**	**$6,067**	**6,626**	**$6,560**	**0**	**$0**	**101**	**$170**	**$12,797**	**$86,220**	**6.7**	**$7,970**		**21.3**
Baseline Consumption		255,360	$32,839	53,793	$53,508	0	$0	1,261	$2,206	$88,552					165
Estimated Savings			18%		12%				8%	14%					13%
Post-Retrofit Target		210,245	$26,772	47,167	$46,948	0	$0	1,159	$2,035	$75,755					144

Facility: Transit Garage

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	2.9	12,580	$1,878	-269	-$266					$1,612	$18,118	11.2	-$6,256	-2%	0.1
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		6,500	$836	2,360	$2,336					$3,172	$11,219	3.5	$12,129	25%	6.9
Operations and Maintenance		12,750	$1,640	472	$467					$2,107	$3,875	1.8	$11,632	54%	2.2
Water Efficient Fixtures		2,250	$289					114	$192	$481	$3,244	6.7	$296	8%	0.2
Total	**2.9**	**34,080**	**$4,643**	**2,563**	**$2,537**	**0**	**$0**	**114**	**$192**	**$7,372**	**$36,456**	**4.9**	**$17,801**		**9.4**
Baseline Consumption		152,160	$23,559	44,620	$44,068	0	$0	1,850	$3,052	$70,679					133
Estimated Savings			20%		6%				6%	10%					7%
Post-Retrofit Target		118,080	$18,916	42,057	$41,531	0	$0	1,736	$2,861	$63,308					123

Facility: Frank Slim Building

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.8	4,062	$589	-87	-$86					$503	$5,148	10.2	-$1,442	0%	0.0
Refrigeration and HVAC															0.0
RCx and Controls Optimization		1,500	$193	1,201	$1,189					$1,382	$5,000	3.6	$5,168	25%	3.4
Operations and Maintenance		3,100	$399							$399	$1,000	2.5	$1,934	38%	0.2
Water Efficient Fixtures		540	$69					6	$10	$80	$50	0.6	$536	159%	0.0
Total	**0.8**	**9,202**	**$1,250**	**1,114**	**$1,103**	**0**	**$0**	**6**	**$10**	**$2,363**	**$11,198**	**4.7**	**$6,196**		**3.7**
Baseline Consumption		46,320	$7,748	12,006	$11,883	1,841	$1,106	377	$690	$21,427					39
Estimated Savings			16%		9%		0%		1%	11%					9%
Post-Retrofit Target		37,118	$6,498	10,893	$10,780	1,841	$1,106	371	$680	$19,063					35

Facility: Robert Service Campground Office

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.1	444	$68							$68	$519	7.6	-$15	5%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance										$0					0.0
Water Efficient Fixtures				500	$495			222	$373	$868	$7,567	8.7	-$1,181	3%	1.4
Total	**0.1**	**444**	**$68**	**500**	**$495**	**0**	**$0**	**222**	**$373**	**$936**	**$8,086**	**8.6**	**-$1,196**		**1.4**
Baseline Consumption		0	$0	0	$0	0	$0	0	$0	$0					0
Estimated Savings															#DIV/0!
Post-Retrofit Target		-444	-$68	-500	-$495	0	$0	-222	-$373	-$936					-1

Note: No utility data was available for Robert Service Campground Office

Facility: Crestview Pumphouse

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.3	833	$131							$131	$2,365	18.1	-$1,404	-10%	0.1
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		10,460	$1,345							$1,345	$750	0.6	$9,150	179%	0.7
Water Efficient Fixtures										$0					0.0
Total	**0.3**	**11,293**	**$1,476**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,476**	**$3,115**	**2.1**	**$7,747**		**0.8**
Baseline Consumption		160,760	$18,052	0	$0	0	$0	0	$0	$18,052					11
Estimated Savings			8%							8%					7%
Post-Retrofit Target		149,467	$16,576	0	$0	0	$0	0	$0	$16,576					10

Facility: Lift Station #1

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.8	1,706	$294		$0		$0			$294	$5,000	17.0	-$2,832	-9%	0.1
Refrigeration and HVAC			$0		$0		$0			$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		8,010	$1,030		$0		$0			$1,030	$1,030	1.0	$6,644	110%	0.6
Water Efficient Fixtures			$0		$0		$0			$0					0.0
Total	**0.8**	**9,716**	**$1,325**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,325**	**$6,030**	**4.6**	**$3,812**		**0.7**
Baseline Consumption		134,320	$20,843	0	$0	0	$0	0	$0	$20,843					9
Estimated Savings			6%							6%					7%
Post-Retrofit Target		124,604	$19,519	0	$0	0	$0	0	$0	$19,519					9

Facility: Lift Station #3

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.2	702	$108							$108	$2,014	18.7	-$1,219	-10%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		9,010	$1,159							$1,159	$1,188	1.0	$7,341	97%	0.6
Water Efficient Fixtures										$0					0.0
Total	**0.2**	**9,712**	**$1,267**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,267**	**$3,201**	**2.5**	**$6,121**		**0.7**
Baseline Consumption		55,120	$6,759	0	$0	0	$0	0	$0	$6,759					4
Estimated Savings			19%							19%					18%
Post-Retrofit Target		45,408	$5,492	0	$0	0	$0	0	$0	$5,492					3

Facility: Hamilton Blvd Pumphouse

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.4	939	$159							$159	$3,086	19.5	-$1,919	-11%	0.1
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		15,690	$2,018							$2,018	$750	0.4	$14,101	269%	1.1
Water Efficient Fixtures		244	$31					8	$13	$45	$1,058	23.7	-$730	-13%	0.0
Total	**0.4**	**16,873**	**$2,208**	**0**	**$0**	**0**	**$0**	**8**	**$13**	**$2,221**	**$4,894**	**2.2**	**$11,452**		**1.2**
Baseline Consumption		234,720	$30,207	0	$0	0	$0	0	$0	$30,207					16
Estimated Savings			7%							7%					7%
Post-Retrofit Target		217,847	$27,999	0	$0	0	$0	-8	-$13	$27,986					15

Facility: Selkirk Station

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit			$0		$0		$0		$0	$0					0.0
Refrigeration and HVAC			$0		$0		$0		$0	$0					0.0
RCx and Controls Optimization			$0		$0		$0		$0	$0					0.0
Operations and Maintenance			$0		$0		$0		$0	$0					0.0
Water Efficient Fixtures			$0		$0		$0		$0	$0					0.0
Total	**0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**	**$0**		**$0**		**0.0**
Baseline Consumption		7,410	$1,725	0	$0	0	$0	0	$0	$1,725					1
Estimated Savings		0%	0%							0%					0%
Post-Retrofit Target		7,410	$1,725	0	$0	0	$0	0	$0	$1,725					1

Facility: Animal Shelter

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.4	2,072	$302	-44	-$44					$258	$3,173	12.3	-$1,270	-4%	0.0
Refrigeration and HVAC															0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		7,000	$900					144	$242	$1,142	$1,000	0.9	$7,404	114%	0.5
Water Efficient Fixtures				238	$236			22	$37	$273	$1,094	4.0	$917	21%	0.7
Total	**0.4**	**9,072**	**$1,203**	**194**	**$192**	**0**	**$0**	**166**	**$279**	**$1,673**	**$5,267**	**3.1**	**$7,050**		**1.2**
Baseline Consumption		27,860	$3,825	10,441	$10,394	0	$0	1,438	$2,380	$16,599					31
Estimated Savings			31%		2%				12%	10%					4%
Post-Retrofit Target		18,788	$2,623	10,247	$10,202	0	$0	1,272	$2,101	$14,926					29

Facility: Stores Warehouse

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	6.2	20,541	$3,195	-439	-$435					$2,760	$31,321	11.3	-$11,006	-2%	0.2
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		1,200	$154	960	$950					$1,105	$4,156	3.8	$3,975	23%	2.7
Operations and Maintenance		6,800	$874	112	$111					$985	$2,250	2.3	$5,002	43%	0.8
Water Efficient Fixtures		1,575	$203					20	$33	$236	$1,058	4.5	$677	18%	0.1
Total	**6.2**	**30,116**	**$4,426**	**633**	**$626**	**0**	**$0**	**20**	**$33**	**$5,086**	**$38,785**	**7.6**	**-$1,352**		**3.8**
Baseline Consumption		31,410	$5,579	8,689	$8,641	0	$0	0	$0	$14,220					26
Estimated Savings			79%		7%					36%					15%
Post-Retrofit Target		1,294	$1,152	8,056	$8,015	0	$0	-20	-$33	$9,134					22

Facility: Copper Ridge Pumphouse

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.4	1,204	$189							$189	$3,129	16.6	-$1,929	-10%	0.1
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		22,380	$2,878	800	$792					$3,670	$1,250	0.3	$25,762	294%	3.8
Water Efficient Fixtures		180	$23					3	$5	$28	$888	31.7	-$681	-17%	0.0
Total	**0.4**	**23,764**	**$3,090**	**800**	**$792**	**0**	**$0**	**3**	**$5**	**$3,887**	**$5,266**	**1.4**	**$23,152**		**3.9**
Baseline Consumption		223,560	$36,688	12,556	$12,809	0	$0	0	$0	$49,497					50
Estimated Savings			8%		6%					8%					8%
Post-Retrofit Target		199,796	$33,599	11,756	$12,017	0	$0	-3	-$5	$45,610					46

Facility: Marwell Lift Station

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	1.2	1,588	$310	-34	-$34					$276	$5,564	20.1	-$3,531	-11%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		6,864	$883	779	$772					$1,654	$1,921	1.2	$2,483	7%	2.6
Operations and Maintenance		4,000	$514	1,100	$1,089					$1,603	$2,188	1.4	$9,614	73%	3.3
Water Efficient Fixtures		525	$68					14	$24	$92	$888	9.7	-$212	1%	0.0
Total	**1.2**	**12,977**	**$1,775**	**1,845**	**$1,827**	**0**	**$0**	**14**	**$24**	**$3,626**	**$10,560**	**2.9**	**$8,353**		**6.0**
Baseline Consumption		1,027,500	$167,116	22,763	$21,346	0	$0	0	$0	$188,462					134
Estimated Savings			1%		9%					2%					4%
Post-Retrofit Target		1,014,523	$165,342	20,918	$19,519	0	$0	-14	-$24	$184,836					128

Facility: Two Mile Hill Booster Stn

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.8	2,927	$451	-63	-$62					$389	$4,151	10.7	-$1,287	-1%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		17,520	$2,253	2,300	$2,277					$4,530	$29,063	6.4	$4,279	9%	7.5
Operations and Maintenance		12,000	$1,543	900	$891					$2,434	$3,938	1.6	$13,978	61%	3.3
Water Efficient Fixtures				756	$748			19	$32	$781	$781	1.0	$4,619	69%	2.1
Total	**0.8**	**32,447**	**$4,247**	**3,893**	**$3,854**	**0**	**$0**	**19**	**$32**	**$8,134**	**$37,932**	**4.7**	**$21,590**		**12.9**
Baseline Consumption		878,400	$143,921	29,459	$27,584	0	$0	0	$0	$171,505					142
Estimated Savings			3%		14%					5%					9%
Post-Retrofit Target		845,953	$139,674	25,565	$23,729	0	$0	-19	-$32	$163,371					129

Facility: Strickland Lift Station

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.1	380	$60							$60	$1,139	19.0	-$699	-10%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		1,100	$141							$141	$406	2.9	$635	33%	0.1
Water Efficient Fixtures										$0					0.0
Total	**0.1**	**1,480**	**$201**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$201**	**$1,545**	**7.7**	**-$64**		**0.1**
Baseline Consumption		23,640	$5,656	0	$0	0	$0	0	$0	$5,656					2
Estimated Savings			4%							4%					6%
Post-Retrofit Target		22,160	$5,455	0	$0	0	$0	0	$0	$5,455					2

Facility: McIntyre Creek Pump Station

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	0.3	599	$103	-13	-$13					$90	$1,584	17.6	-$922	-9%	0.0
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization										$0					0.0
Operations and Maintenance		22,380	$2,878	800	$792					$3,670	$563	0.2	$26,450	652%	3.8
Water Efficient Fixtures										$0					0.0
Total	**0.3**	**22,979**	**$2,981**	**787**	**$779**	**0**	**$0**	**0**	**$0**	**$3,760**	**$2,146**	**0.6**	**$25,528**		**3.8**
Baseline Consumption		188,680	$30,621	8,239	$9,917	0	$0	0	$0	$40,537					36
Estimated Savings			10%		8%					9%					11%
Post-Retrofit Target		165,701	$27,640	7,452	$9,137	0	$0	0	$0	$36,777					32

Facility: Parks Warehouse

Energy Management Oppurtunity	Annual Savings										Estimated Total Cost	Simple Payback	NPV	ROI	GHG Reduction
	Electricity			Fuel Oil		Propane		Water		Total					
	[kW]	[kWh/yr]	[$]	[L/yr]	[$]	[L/yr]	[$]	[m^3]	[$]	[$]	[$]	[years]	[$]	[%]	[$teCO_2$]
Lighting Retrofit	5	10,419	$1,763	-223	-$221					$1,542	$7,223	4.7	$4,129	17%	0.1
Refrigeration and HVAC										$0					0.0
RCx and Controls Optimization		9,070	$1,166	1,200	$1,188					$2,354	$3,344	1.4	$13,985	70%	3.9
Operations and Maintenance		2,500	$322	460	$455					$777	$1,625	2.1	$4,093	47%	1.4
Water Efficient Fixtures		1,080	$139					11	$18	$157	$56	0.4	$1,354	341%	0.1
Total	**5**	**23,069**	**$3,390**	**1,437**	**$1,423**	**0**	**$0**	**11**	**$18**	**$4,831**	**$12,248**	**2.5**	**$23,561**		**5.5**
Baseline Consumption		38,920	$0	14,870	$14,655	0	$0	417	$901	$15,557					43
Estimated Savings		59%			10%				2%	31%					13%
Post-Retrofit Target		15,851	-$3,390	13,433	$13,233	0	$0	406	$883	$10,726					38

Facility: Historic Buildings (@ Frank Slim)

Energy Management Oppurtunity	Annual Savings: Electricity [kW]	Electricity [kWh/yr]	Electricity [$]	Fuel Oil [L/yr]	Fuel Oil [$]	Propane [L/yr]	Propane [$]	Water [m^3]	Water [$]	Total [$]	Estimated Total Cost [$]	Simple Payback [years]	NPV [$]	ROI [%]	GHG Reduction [$teCO_2$]
Lighting Retrofit			$0		$0		$0		$0	$0					0.0
Refrigeration and HVAC			$0		$0		$0		$0	$0					0.0
RCx and Controls Optimization			$0		$0		$0		$0	$0					0.0
Operations and Maintenance			$0		$0		$0		$0	$0					0.0
Water Efficient Fixtures			$0		$0		$0		$0	$0					0.0
Total	**0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**	**$0**		**$0**		**0.0**
Baseline Consumption		0	$0	0	$0	0	$0	0	$0	$0					0
Estimated Savings															#DIV/0!
Post-Retrofit Target		0	$0	0	$0	0	$0	0	$0	$0					0

Facility: All Buildings

Energy Management Oppurtunity	Annual Savings: Electricity [kW]	Electricity [kWh/yr]	Electricity [$]	Fuel Oil [L/yr]	Fuel Oil [$]	Propane [L/yr]	Propane [$]	Water [m^3]	Water [$]	Total [$]	Estimated Total Cost [$]	Simple Payback [years]	NPV [$]	ROI [%]	GHG Reduction [$teCO_2$]
Lighting Retrofit	107	664,840	$95,018	-12,131	-$12,009	-3,214	-$2,838	0	$0	$80,171	$510,239	6.4	$79,637	9%	8.5
Refrigeration and HVAC	0	21,783	$2,801	13,500	$13,365	23,300	$20,574	0	$0	$36,740	$125,625	3.4	$65,920	26%	73.6
RCx and Controls Optimization	0	468,269	$60,219	59,415	$58,821	8,026	$7,087	0	$0	$126,127	$446,108	3.5	$474,426	25%	207.4
Operations and Maintenance	0	215,980	$27,775	16,074	$15,913	1,360	$1,201	3,144	$5,282	$50,171	$78,311	1.6	$286,157	64%	61.1
Water Efficient Fixtures	0	8,644	$1,112	11,297	$11,184	1,229	$1,086	4,246	$7,134	$20,515	$58,896	2.9	$92,007	33%	33.4
Total	**107**	**1,379,516**	**$186,925**	**88,156**	**$87,274**	**30,701**	**$27,109**	**7,390**	**$12,415**	**$313,724**	**$1,219,179**	**3.9**	**$998,147**		**384.0**
Baseline Consumption		10,168,638	$1,575,552	958,367	$955,290	118,763	$71,486	45,033	$75,405	$2,677,734					3,512
Estimated Savings			12%		9%		38%		16%	12%					11%
Post-Retrofit Target		8,789,121	$1,388,627	870,211	$868,016	88,062	$44,377	37,642	$62,990	$2,364,010					3,128

Energy Management Oppurtunity	Annual Savings: Electricity [$]	Fuel Oil [$]	Propane [$]	Water [$]	Total [$]	Estimated Total Cost [$]	Simple Payback [years]	NPV [$]	ROI [%]	GHG Reduction [$teCO_2$]
Lighting Retrofit	$95,018	-$12,009	-$2,838	$0	$80,171	$510,239	6.4	$79,637	9%	8.5
Refrigeration and HVAC	$2,801	$13,365	$20,574	$0	$36,740	$125,625	3.4	$65,920	26%	73.6
RCx and Controls Optimization	$60,219	$58,821	$7,087	$0	$126,127	$446,108	3.5	$474,426	25%	207.4
Operations and Maintenance	$27,775	$15,913	$1,201	$5,282	$50,171	$78,311	1.6	$286,157	64%	61.1
Water Efficient Fixtures	$1,112	$11,184	$1,086	$7,134	$20,515	$58,896	2.9	$92,007	33%	33.4

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp and 3-lamp F32T8 fixtures provide most general area lighting
- T5HO high bay lighting in the Field House and Flexihall
- HID high bay lighting in the NHL and Olympic arenas
- HID flood lights in the lobby
- HID lighting in the Natatorium
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all HID fixtures in the arenas with 4-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts
- Replace all HID fixtures in the Natatorium with LED fixtures
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$157,274
Labour:	$30,500
Sub-Total:	$187,774
(15%) Eng. & Proj. Man.:	$28,166
(10%) Contingency:	$18,777
Total Cost:	$234,717
Annual Savings:	$45,162
Service Life (Years):	10
Simple Payback:	5.20
Net Present Value:	$97,678
ROI:	``

Assumptions:

- F28T8 Lamps: $3.60
- F54T5HO Lamps: $7.65
- HE Electronic Ballast: $12.25
- 4 lamp T5HO High Bay Fixtures: $175/fixture, 1 hour of labour to replace fixture
- 80W HID replacement LED: $250
- 175W/250W HID replacement LED : $700
- 400W/500W HID replacement LED: $1,500
- 500W underwater HID replacement LED: $2,000
- Labour rate assumed at $100/hr

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **Lighting Retrofit**

- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Management Opportunity	Electricity			Fuel Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kW]	[kWh]	[$]	[L]	[$]				
Lighting Retrofit	45.20	383,079	$53,272	-8,192	-$8,111	$45,162	$234,717	5.2	4.4

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **HVAC Upgrades**

Existing:

Two HVAC Upgrades are currently being undertaken in the Aquatic Centre:

- Installation of VSDs on AS2 and AS3 serving the pool ventilation requirements including VAV operation, recirculation and new Delta Controls retrofit
- Expansion of the low temperature condenser system to preheat make up to the domestic hot water system.

Proposed:

The following HVAC measure is proposed:

Install a thermal pool blanket at night (10:30 pm to 5:00 am) to reduce the evaporation rate from the pool and consequently the ventilation requirements and pool heating requirements.

Cost:

Material:	$40,000
Labour:	$4,000
Sub-Total:	$44,000
(15%) Eng. & Proj. Man.:	$6,600
(10%) Contingency:	$4,400
Total Cost:	$55,000
Annual Savings:	$16,166
Service Life (Years):	6
Simple Payback:	3.40
Net Present Value:	$24,495
ROI:	19%

Assumptions:

- Three blankets to the 25 m competitive pool and three blankets for the leisure pool, and blanket for the hot tub

- Budget estimate for the pool ``
- Pool cover material last 6 years.

Savings:

Energy Management Opportunity	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Pool Cover	21,783	$2,801	13,500	$13,365	$16,166	$55,000	3.4	38.4

Impact on Operations and Maintenance:

Pool staff will be required to install/remove the cover daily.

Measure Cost and Savings Work-Up Sheet	
Facility:	**Canada Games Centre**

Measure: **HVAC Upgrades**

And, there are considerable benefits to the structure by lowering the humidity levels at night.

Measures For Future Consideration:

- Following the installation of the VAV retrofit and pool cover, it is recommended that air-to-air heat recovery be assessed as a possbile measure to AS2 and AS 3 to achieve further savings.

- Following the RCx measure and installation of the DCW preheat to the DHW measure, it is recommended that any excess available from the low temperature condenser system be considered for the following sinks: MUA 1 serving the fan coils; make up water for the pool system, then consider AS2 and AS 3.

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building lighting, HVAC and refrigeration systems identified the following opportunties for energy savings:
- Lighting systems recomissioning process
- HVAC systems recommissing process
- Refrigeration systems recommissing process
- Controls upgrade and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Recommission AHU1 (Fieldhouse) fan speed and minimum outside air to allow the system to operate on low speed with OA damper closed during "silent hours"within the existing core occupied hours/weekly schedule.
- Integrate the centralized lighting controller with the Delta BAS and schedule the operation of all major air handling systems/lighting based on actual programmed activities for each space to achieve tighter operating schedules, reduced fan/ventilation/lighting operation and improve space temperature reset. Install push-button overrides/occupancy sensors to initiate "occupied mode" in the event of unscheduled use of the space. Provide multiple light levels based on programming requirements (eg public skating vs hockey).
- Replace and integrate the Honeywell control system serving the Aquatic Centre with the Delta BAS and reprogram and recommission with integrated energy management control strategies (controls retrofit)
- Operate AS 2 and AS 3 serving the Aquatic Centre as mixed air VAV systems to control humidity instead of as 100% make up air units. (VAV/control retrofit in process)
- Install (3) variable speed drives on pumping systems with variable loads or bypass control to reduce pumping energy

- Expand the Delta BAS to control the Aquatic Centre lighting systems based on programmed activities.
- Rewire/recommission the lighting occupancy controls in the changerooms to provide individual room control

- Recommission/optimize existing refrigeration plant controls based on integrated infrared/slab control to facililate scheduling of ice temperature based on activity and improved reset.
- Optimize the generation and use of the low temperature condenser system including resetting (lower) the space temperature in the arenas to control the loading of the compressors to minimize the amount of heat being rejected by the cooling towers.
- Install spring-wound timers or push button controls to control the operation of large pumps serving lazy river, water slides, spray bear.
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance as required

Cost:

Material:	$60,250
Labour:	$49,750
Sub-Total:	$110,000
(15%) Eng. & Proj. Man.:	$16,500
(10%) Contingency:	$11,000
Total Cost:	$137,500

``

Annual Savings: $42,727

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **RCx & Controls Optimization**

Service Life (Years):	10
Simple Payback:	3.22
Net Present Value:	$176,978
ROI:	29%

Assumptions:

- Estimate for new controls including controller, rewiring, new points, programming commisioning is $48,000. Does not include costs for current energy management initiatives being undertaken in the Aquatic Centre

- Installation of 3 VSDs including one 10 hp and two 5 hp, controls, commissioning is budgeted at $24,500.
- $0.15 per square foot for RCx for recommisioning process

Savings:

Energy Management Opportunity	Electricity		Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting	67,500	$8,680		$0	$8,680		0.0	4.7
HVAC	59,000	$7,587	20,680	$20,473	$28,061		0.0	60.7
Refrigeration	46,550	$5,986		$0	$5,986		0.0	3.3
	173,050	$22,254	20,680	$20,473	$42,727	$137,500	3.2	68.7

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:

Consider lowering the temperature of the pool water to minimize the generation of of humidity and consequently the ventilation requirements for the Aquatic Centre

Measure Cost and Savings Work-Up Sheet

Facility: **Canada Games Centre**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$1,860
Labour:	$1,225
Sub-Total:	$3,085
(15%) Eng. & Proj. Man.:	$463
(10%) Contingency:	$309
Total Cost:	$3,856
Annual Savings:	$11,001
Service Life (Years):	10
Simple Payback:	0.35
Net Present Value:	$77,111
ROI:	285%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Management Opportunity	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	8,888	$8,799	1,310	$2,201	$11,001	$3,856	0.4	24.3

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- incandescent lamps in various spaces
- HID lighting in the Arena
- T12 fluorescent lighting in the Arena
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all high bay HID fixtures with 4-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts

- Replace all high bay T12 lighting with 2-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts, 2 T5HO replacement fixtures for each existing 8' T12 fixture
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$31,050
Labour:	$16,530
Sub-Total:	$47,580
(15%) Eng. & Proj. Man.:	$7,137
(10%) Contingency:	$4,758
Total Cost:	$59,475
Annual Savings:	$9,092
Service Life (Years):	10
Simple Payback:	6.54
Net Present Value:	$7,442
ROI:	9%

Assumptions:

- F28T8 Lamps: $3.60
- F54T5HO Lamps: $7.65
- CFL: $3.00
- HE Electronic Ballast: $12.25
- 4 lamp T5HO High Bay Fixtures: $175/fixture, 1 hour of labour to replace fixture
- 2 lamp T5HO High Bay Fixtures: $80/fixture, 1 hour of labour to replace fixture
- LED Wallpack: $250
- LED Poletop: $700
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **Lighting Retrofit**

Savings:

Energy Management	Electricity [kW]	[kWh]	[$]	Propane [L]	[$]	Total [$]	Estimated [$]	Simple [Years]	GHG [$teCO_2$]
Lighting Retrofit	14.75	79,793	$11,569	-2,806	-$2,477	$9,092	$59,475	6.5	1.3

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **Refrigeration Plant**

Existing:

The existing refrigeration plant operates seasonally between Sept and April
- two 75 hp rotary screw compressors c/w Delta Controls infrared/slab sensors, 21 F setpoint
- 25 hp brine pump continuous operations, 5 hp underfloor heating system
- No desuperheater for DHW preheating
- two 65 USG standard efficiency propane storage tank heaters

Proposed:

The following refrigeration plant measures are proposed:
- Install a desuperheater heat exchanger, piping, controls to preheat DHW for flooding and showers.
- Replace the existing storage tank heaters with high efficiency (94%) condensing storage tank heaters.

Cost:

Material:	$28,250
Labour:	$28,250
Sub-Total:	$56,500
(15%) Eng. & Proj. Man.:	$8,475
(10%) Contingency:	$5,650
Total Cost:	$70,625
Annual Savings:	$14,160
Service Life (Years):	10
Simple Payback:	4.99
Net Present Value:	$33,596
ROI:	15%

Assumptions:

- Desuperheater is capable of displacing 80% of flooding and shower loads
- Condensing storage tank heaters at at least 94% efficient
- Budget estimate for desuperheater system including heat exchanger, piping, storage, installation is $40,000
- Budget estimate for installation of two 65 gallon condensing hot water heaters is $16,500

Savings:

Energy Management Opportunity	Propane [L]	Propane [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [teCO_2]
Water Heaters	4,195	$3,704	$3,704			6.3
Desuperheater	11,842	$10,456	$10,456			17.9
Refrigeration Plant	16,037	$14,160	$14,160	$70,625	5.0	24.2

Impact on Operations and Maintenance:
- New equipment and controls will require scheduled maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **HVAC Upgrades**

Existing:

The dressing rooms are served by three 125,000 Btu/hr gas-fired make-up air units which draw cold air from the arena to make up the shower/washroom exhaust.

Proposed:

The following HVAC measure is proposed:
- Install three high efficiency condensing (95%) condensing furnaces to heat the changerooms and modify ductwork to operate as a recirc system with minimum outside air as per ASHRAE guidelines/exhaust air requirements.

Cost:

Material:	$19,500
Labour:	$12,000
Sub-Total:	$31,500
(15%) Eng. & Proj. Man.:	$4,725
(10%) Contingency:	$3,150
Total Cost:	$39,375
Annual Savings:	$6,414
Service Life (Years):	10
Simple Payback:	6.14
Net Present Value:	$7,829
ROI:	10%

Assumptions:

- New furnaces are high efficiency condensing (95%).
- Interlock fresh air ventilation with demand (exhaust fan operation)
- Existing ductwork modifications from 100% (drawing from arena) to recirc with min OA
- Budget estimate of $10,500 per furnace installed including ductwork and controls.

Savings:

Energy Management Opportunity	Propane [L]	Propane [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
HE Furnaces	7,263	$6,414	$6,414	$39,375	6.1	11.0

Impact on Operations and Maintenance:

- New equipment and controls will require scheduled maintenance as per manufacturer's recommendations

Measures For Future Consideration:

- Install high efficiency condensing furnaces to replace the ICE units serving the lobby and mezzanine when they reach end of service life.
- Install high efficiency condensing unit heaters (> 90%) when the existing units reach the end of service life

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **RCx & Controls Optimization**

Existing:

A review of the building HVAC and refrigeration systems identified the following opportunities for energy savings:
- HVAC and refrigeration recommissioning process coupled with controls upgrades and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Install demand control ventilation on the two ICE furnaces serving the lobby and mezzanine to control OA ventilation use
- Install occupancy sensors and/or push button overrides to schedule the operation of all 5 furnaces and facilitate space temperature setback.
- Install spring-wound timers on radiant heaters, unit heaters, and miscellaneous exhaust fans to control hours of operation.

- Install occupancy sensors on washroom/changeroom exhaust fans (or interlock with lighting operation) to shut off during unoccupied periods.
- Setback space temperature on all unit heaters (including electric) and install locking thermostat covers to prevent tampering.
- Recommission/optimize existing refrigeration plant controls based on integrated infrared/slab control to facilitate scheduling of ice temperature based on activity, improved reset, and sequencing of brine pump with compressor operation.

- Tune up/inspect all ventilation and heating equipment.
- Air balance.

Cost:

Material:	$4,750
Labour:	$15,400
Sub-Total:	$20,150
(15%) Eng. & Proj. Man.:	$3,023
(10%) Contingency:	$2,015
Total Cost:	$25,188
Annual Savings:	$13,777
Service Life (Years):	10
Simple Payback:	1.83
Net Present Value:	$76,215
ROI:	54%

Assumptions:

- 7 BAS points at $1000 per point
- 15 timers/occ sensors and 15 t'stat covers
- $0.35 per square foot for RCx

Savings:

Energy Management Opportunity	Electricity		Propane		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
HVAC RCx	28,950	$3,723	4,760	$4,203	$7,926	$25,188	3.2	9.2
Refrigeration RCx	45,500	$5,851		$0	$5,851	$0	0.0	3.2

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **RCx & Controls Optimization**

RCx & Controls Optimization	74,450	$9,574	4,760	$4,203	$13,777	$25,188	1.8	12.4

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintenance.

Measures For Future Consideration:

- Install a VSD to control the speed of the brine pump in sequence with the compressors instead of on/off control

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:
- Free cooling: use existing arena exhaust fans to "free cool" the arena and reduce the refrigeration load on the ice.
- Air seal the perimeter wall-roof joint and other penetrations to control infiltration
- Repair and replace the door weather-stripping as needed
- Get rid of the old fridge that uses 3x more energy than a new one today.
- Control trace heating/shut off at end of season
- Install smart block heater receptacles in parking lot area.
- Install solenoid valve to control cold water "bleeders" or use trace heating or bypass to save water
- Eliminate/minimize the use of domestic cold water for supplemental condenser cooling
- Install water submeters on major loads including cooling tower make-ups and irrigation to track consumption
- Rationalize the need for irrigation and/or install a moisture sensor to efficiently control irrigation system

Cost:

Material:	$2,600
Labour:	$3,000
Sub-Total:	$5,600
(15%) Eng. & Proj. Man.:	$840
(10%) Contingency:	$560
Total Cost:	$7,000
Annual Savings:	$5,363
Service Life (Years):	10
Simple Payback:	1.31
Net Present Value:	$32,471
ROI:	76%

Assumptions:

- Air sealing and weather-stripping $1500
- Twelve block heater receptacles at $200 each installed
- Submeters $900 installed

Savings:

Energy Management Opportunity	Electricity		Propane		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[L]	[$]	[m^3]	[$]				
O&M	19,300	$2,482	1,360	$1,201	1,000	$1,680	$5,363	$7,000	1.3	3.4

Impact on Operations and Maintenance:
- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measure Cost and Savings Work-Up Sheet

Facility: **Takhini Arena**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are a mix of 13 L per flush and 6 L per flush units.
- Faucets are generally equipped with low flow aerators.
- Showers use high flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow showerheads.

Cost:

Material:	$9,820
Labour:	$6,467
Sub-Total:	$16,287
(15%) Eng. & Proj. Man.:	$2,443
(10%) Contingency:	$1,629
Total Cost:	$20,358
Annual Savings:	$3,808
Service Life (Years):	10
Simple Payback:	5.35
Net Present Value:	$7,666
ROI:	13%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Management Opportunity	Propane		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	963	$850	1,760	$2,957	$3,808	$20,358	5.3	1.5

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Mount MacIntyre Rec Centre**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- incandescent lamps in various spaces, most notably the main hall
- HID lighting in curling arena
- HID poletop lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all curling arena HID fixtures with 4-lamp T5HO high bay fixtures coupled with HE electronic ballasts
- Replace all poletop HID lighting with LED fixtures

Cost:

Material:	$16,938
Labour:	$7,890
Sub-Total:	$24,828
(15%) Eng. & Proj. Man.:	$3,724
(10%) Contingency:	$2,483
Total Cost:	$31,035
Annual Savings:	$9,649
Service Life (Years):	10
Simple Payback:	3.22
Net Present Value:	$39,985
ROI:	29%

Assumptions:

- F28T8 Lamps: $3.60; F54T5HO Lamps: $7.65
- CFL: $3.00
- HE Electronic Ballast: $12.25
- 4 lamp T5HO High Bay Fixtures: $175/fixture, 1 hour of labour to replace fixture
- LED Poletop: $700
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kW]	[kWh]	[$]	[L]	[$]				
Lighting Retrofit	14.75	77,642	$11,293	-1,660	-$1,644	$9,649	$31,035	3.2	0.9

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Mount MacIntyre Rec Centre**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are a mix of 13 L per flush and 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$5,220
Labour:	$3,525
Sub-Total:	$8,745
(15%) Eng. & Proj. Man.:	$1,312
(10%) Contingency:	$875
Total Cost:	$10,931
Annual Savings:	$1,209
Service Life (Years):	10
Simple Payback:	9.04
Net Present Value:	-$2,036
ROI:	2%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	570	$564	383	$644	$1,209	$10,931	9.0	1.6

Impact on Operations and Maintenance:
- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Mount Mac Recreation Centre**

Measure: **RCx & Controls Optimization**

Existing:

A review of the building lighting, HVAC and refrigeration systems identified the following opportunities for energy savings:

- HVAC systems recommissing process
- Refrigeration systems recommissing process
- Controls upgrade and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Recommission/optimize existing refrigeration plant controls including arena space temperature reset, unoccupied ice temperature reset, brine pump cycling, and potentially the use of the existing ventilation fans to "freecool" the ice

Expand the existing BAS to control the heating system including boiler reset, perimeter zone temperature and major zones to facilitate space temperature setpback during unoccupied hours
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance as required

Cost:

Material:	$12,500
Labour:	$23,000
Sub-Total:	$35,500
(15%) Eng. & Proj. Man.:	$5,325
(10%) Contingency:	$3,550
Total Cost:	$44,375
Annual Savings:	$16,931
Service Life (Years):	10
Simple Payback:	2.62
Net Present Value:	$80,236
ROI:	36%

Assumptions:

- Budget for 25 new BAS points to control heating system at $1000 per point installed.
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
HVAC		$0	6,320	$6,257	$6,257			17.3
Refrigeration	83,000	$10,674		$0	$10,674			5.8
Total	83,000	$10,674	6,320	$6,257	$16,931	$44,375	2.6	23.1

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measure Cost and Savings Work-Up Sheet

Facility: **Mount Mac Recreation Centre**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:
- Air seal the perimeter walls and other penetrations to control infiltration
- Repair and replace the door weather-stripping as needed
- Control trace heating/shut off at end of season
- Install smart block heater receptacles and vending misers on beverage vending machines
- Install a solenoid valve to control the "bleeder" on the sanitary drain line
- Eliminate/minimize the use of domestic cold water for supplemental condenser cooling
- Eliminate the old fridge that is using 3x more electricity than a new fridge

Cost:

Material:	$1,500
Labour:	$1,500
Sub-Total:	$3,000
(15%) Eng. & Proj. Man.:	$450
(10%) Contingency:	$300
Total Cost:	$3,750
Annual Savings:	$2,394
Service Life (Years):	10
Simple Payback:	1.57
Net Present Value:	$13,868
ROI:	63%

Assumptions:

- Air sealing and weather-stripping $1500
- Three block heater receptables and 3 vending misers at $200 each installed.
- Solenoid control on bleeder - $300

Savings:

Energy Reduction Measure	Electricity		Oil		Water		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[m^3]	[$]	[$]	[$]	[Years]	[$te CO_2$]
O&M	6,000	$772	790	$782	500	$840	$2,394	$3,750	1.6	2.6

Impact on Operations and Maintenance:
These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:
Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **MSB**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp and 4-lamp F32T8 fixtures provide most general area lighting
- 2-lamp T12 fixtures provide some general area lighting
- HID lighting in some storage and maintenance areas
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all 8' T12 fixtures with reduced wattage 4' F28T8 fixtures coupled with high efficiency electronic ballasts, 2 T8 4' replacement fixtures for each existing 8' fixture
- Replace all interior HID fixtures with LED fixtures
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$34,726
Labour:	$12,213
Sub-Total:	$46,939
(15%) Eng. & Proj. Man.:	$7,041
(10%) Contingency:	$4,694
Total Cost:	$58,674
Annual Savings:	$4,672
Service Life (Years):	10
Simple Payback:	12.56
Net Present Value:	-$24,289
ROI:	-4%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- 2 lamp T8 Fixtures: $80/fixture, 1 hour of labour to replace fixture
- 100W LED Wallpack: $250
- 150W LED Wallpack: $500
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	7.55	37,253	$5,461	-797	-789	$4,672	$58,674	12.6	0.4

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **MSB**

Measure: **RCx & Controls Optimization**

Existing:

A review of the building lighting and HVAC systems identified the following opportunties for energy savings:
- HVAC systems recommissing process
- Controls upgrade and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Install a central BAS and control the operation of the various heating systems to facilitate space temperature setback during unocupied hours, U/H control based on garage door status and occupancy, perimeter heating control of major zones, AHU scheduling based on occupancy, boiler control, electric heater control.
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance to the extent that it is possible to address all of the heating issues in the facility.

Cost:

Material:	$37,500
Labour:	$48,000
Sub-Total:	$85,500
(15%) Eng. & Proj. Man.:	$12,825
(10%) Contingency:	$8,550
Total Cost:	$106,875
Annual Savings:	$24,117
Service Life (Years):	10
Simple Payback:	4.43
Net Present Value:	$70,631
ROI:	18%

Assumptions:

- Budget for 75 new BAS points to control HVAC systems at $1000 per point installed.
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]
RCx & Controls Optimization	55,435	$7,129	17,160	$16,988	$24,117	$106,875	4.4	50.8

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measure Cost and Savings Work-Up Sheet

Facility: **MSB**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemen

Proposed:

The following O&M opportunities are proposed:
- Air seal the perimeter walls and other penetrations to control infiltration
- Repair and replace the door weather-stripping as needed
- Control trace heating/shut off at end of season
- Install smart block heater receptacles and vending misers on beverage vending machines
- Repair insulation on steam pipes and condensate tank
- Install locking thermostat covers in garage area.
- Shut down air compressor at night/ review pressure requirement and check for leaks.

Cost:

Material:	$6,250
Labour:	$6,250
Sub-Total:	$12,500
(15%) Eng. & Proj. Man.:	$1,875
(10%) Contingency:	$1,250
Total Cost:	$15,625
Annual Savings:	$9,908
Service Life (Years):	10
Simple Payback:	1.58
Net Present Value:	$57,297
ROI:	63%

Assumptions:

- Air sealing and weather-stripping $4500
- Twelve block heater receptables and 8 vending misers at $200 each i
- Insulation repair $3500
- Thermostat covers - $500

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	22,000	$2,829	7,150	$7,079	$9,908	$15,625	1.6	21.1

Impact on Operations and Maintenance:
These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating

Measures For Future Consideration:
Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **MSB**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$220
Labour:	$192
Sub-Total:	$412
(15%) Eng. & Proj. Man.:	$62
(10%) Contingency:	$41
Total Cost:	$515
Annual Savings:	$666
Service Life (Years):	10
Simple Payback:	0.77
Net Present Value:	$4,385
ROI:	129%

Assumptions:

- Labour at $100/hour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	345	$341	193	$324	$666	$515	0.8	0.9

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Public Safety**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- T5HO lighting in high bay areas
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$9,110
Labour:	$3,930
Sub-Total:	$13,040
(15%) Eng. & Proj. Man.:	$1,956
(10%) Contingency:	$1,304
Total Cost:	$16,300
Annual Savings:	$1,336
Service Life (Years):	10
Simple Payback:	12.20
Net Present Value:	-$6,463
ROI:	-3%

Assumptions:

- F28T8 Lamps: $3.60
- LED Wallpack: $700
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Propane		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	2.30	11,612	$1,697	-408	-$361	$1,336	$16,300	12.2	0.2

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Public Safety Building**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building systems identified opportunities for energy savings as follows:
 - Recommission HVAC controls
 - Recommision lighting controls
- Optimize the control of the solar wall preheat system

Proposed:

The following RCx/controls optimization measures are proposed:
- Recommission the HVAC controls to facilitate space temperature setback during unoccupied hours.
- Recommision the lighting controls that are currently set on "manual" to provide photocell and dimming control.

-Install a "bypass" on the solar wall preheat ventilation system to prevent overheating and the unneccessary operation of the cooling systems.

Cost:

Material:	$3,750
Labour:	$10,650
Sub-Total:	$14,400
(15%) Eng. & Proj. Man.:	$2,160
(10%) Contingency:	$1,440
Total Cost:	$18,000
Annual Savings:	$5,170
Service Life (Years):	10
Simple Payback:	3.48
Net Present Value:	$20,053
ROI:	26%

Assumptions:

- Budget estimate of $7500 for ducwork and control modification to the solar wall preheat system.
 - $0.20 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Propane		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[L]	[$]				
RCx	17,780	$2,287	3,266	$2,884	$5,170	$18,000	3.5	10.2

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:

Measure Cost and Savings Work-Up Sheet

Facility: **Public Safety Building**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:
- Install a timer on the "gear" drying equipment
- Install vending misers on beverage vending machines
- Install a water meter on the service to the bulk filling station and track consumption

Cost:

Material:	$1,000
Labour:	$1,000
Sub-Total:	$2,000
(15%) Eng. & Proj. Man.:	$300
(10%) Contingency:	$200
Total Cost:	$2,500
Annual Savings:	$514
Service Life (Years):	10
Simple Payback:	4.86
Net Present Value:	$1,286
ROI:	16%

Assumptions:

- Install spring-wound timer $300
- 2 vending misers at $200 each installed.
- Install water meter $1500

Savings:

Energy Reduction Measure	Electricity		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	4,000	$514	$514	$2,500	4.9	0.3

Impact on Operations and Maintenance:
These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating

Measures For Future Consideration:
Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Public Safety Building**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.

Proposed:

The following water efficiency measures are proposed:
- Install new low-flow faucet aerators.

Cost:

Material:	$55
Labour:	$92
Sub-Total:	$147
(15%) Eng. & Proj. Man.:	$22
(10%) Contingency:	$15
Total Cost:	$183
Annual Savings:	$334
Service Life (Years):	10
Simple Payback:	0.55
Net Present Value:	$2,273
ROI:	182%

Assumptions:

- Labour at $100/hour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Propane		Water		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[L]	[$]	[m^3]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Water Efficient Fixtures	266	$235	59	$98	$334	$183	0.5	0.4

Impact on Operations and Maintenance:
- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **City Hall/Fire Hall #1**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- F32T8 fixtures provide most general area lighting
- 2-lamp T12 fixtures provide some general area lighting
- incandescent lamps in various spaces
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$8,456
Labour:	$4,750
Sub-Total:	$13,206
(15%) Eng. & Proj. Man.:	$1,981
(10%) Contingency:	$1,321
Total Cost:	$16,507
Annual Savings:	$1,820
Service Life (Years):	10
Simple Payback:	9.07
Net Present Value:	-$3,115
ROI:	2%

Assumptions:

- F28T8 Lamps: $3.60; CFL Lamps: $3.00
- HE Electronic Ballast: $12.25
- LED Wallpack: $250
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour; lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	2.99	14,465	$2,126	-309	-$306	$1,820	$16,507	9.1	0.2

Impact on Operations and Maintenance:

Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: City Hall/Fire Hall #1

Measure: Water Efficient Fixtures

Existing:

The following conditions were noted on site:
- Toilets are a mix of 13 L per flush and 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$3,045
Labour:	$2,050
Sub-Total:	$5,095
(15%) Eng. & Proj. Man.:	$764
(10%) Contingency:	$510
Total Cost:	$6,369
Annual Savings:	$460
Service Life (Years):	10
Simple Payback:	13.85
Net Present Value:	-$2,985
ROI:	-6%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	2,250	$289	101	$170	$460	$6,369	13.9	0.2

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **City Hall**

Measure: **RCx & Controls Optimization**

Existing:

A review of the building HVAC systems identified HVAC systems recommissioning and controls upgrades.

Proposed:

The following RCx/controls optimization measures are proposed:
- Expand the existing BAS and control the operation of the the multizone AHU based on a time of use schedule including CO2 demand control ventilation, space temperature setback, and a push button override for unscheduled use of the space.
- Recommision the AHU1 to control based on a time of day schedule including the installation of a push-button override for unscheduled use of the space
- Expand the existing BAS to control the heating system including boiler reset, perimeter zone temperature and major zones to facilitate space temperature setpback during unoccupied hours
- Control washroom exhaust fans with occupancy sensors
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance

Cost:

Material:	$21,000
Labour:	$26,575
Sub-Total:	$47,575
(15%) Eng. & Proj. Man.:	$7,136
(10%) Contingency:	$4,758
Total Cost:	$59,469
Annual Savings:	$9,207
Service Life (Years):	10
Simple Payback:	6.46
Net Present Value:	$8,295
ROI:	9%

Assumptions:

- Budget for 42 new BAS points to control HVAC systems at $1000 per point installed.
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	21,900	$2,816	6,455	$6,391	$9,207	$59,469	6.5	19.2

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:

- When the boiler reaches the end of its service life, consider replacing it with a high efficiency boiler such as the
- Upgrade the roof insulation to R50 at time of re-roofing

Measure Cost and Savings Work-Up Sheet

Facility: **City Hall**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles and vending misers on beverage vending machines
- Repair insulation on heating pipes and fitting in the boiler room
-Install a moisture sensor to control the Rainbird irrigation system

Cost:

Material:	$1,550
Labour:	$1,550
Sub-Total:	$3,100
(15%) Eng. & Proj. Man.:	$465
(10%) Contingency:	$310
Total Cost:	$3,875
Annual Savings:	$1,311
Service Life (Years):	10
Simple Payback:	2.96
Net Present Value:	$5,775
ROI:	32%

Assumptions:

- Air sealing and weather-stripping $500
- Six block heater receptables and 2 vending misers at $200 each insta
- Insulation repair $500
- Thermostat covers - $500

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[L]	[$]				
O&M	6,500	$836	480	$475	$1,311	$3,875	3.0	1.8

Impact on Operations and Maintenance:

These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Transit Garage**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp and 4-lamp F32T8 fixtures provide most general area lighting
- 2-lamp and 4-lamp T12 fixtures provide some general area lighting
- incandescent lamps in various spaces
- HID lighting in high bay areas
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all 8' T12 fixtures with reduced wattage 4' F28T8 fixtures coupled with high efficiency electronic ballasts, 2 T8 4' replacement fixtures for each existing 8' fixture
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$9,185
Labour:	$5,310
Sub-Total:	$14,495
(15%) Eng. & Proj. Man.:	$2,174
(10%) Contingency:	$1,449
Total Cost:	$18,118
Annual Savings:	$1,612
Service Life (Years):	10
Simple Payback:	11.24
Net Present Value:	-$6,256
ROI:	-2%

Assumptions:

- F28T8 Lamps: $3.60; CFL lamps: $3.00
- HE Electronic Ballast: $12.25
- 2 lamp T8 Fixtures: $80/fixture, 1 hour of labour to replace fixture
- LED Wallpack: $250
- LED Poletop: $700
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour; lamp and ballast replacmeent: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]

Measure Cost and Savings Work-Up Sheet

Facility: **Transit Garage**

Measure: **Lighting Retrofit**

Lighting Retrofit	2.94	12,580	$1,878	-269	-$266	$1,612	$18,118	11.2	0.1

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Transit Garage**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are a mix of 13 L per flush and 6 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$1,545
Labour:	$1,050
Sub-Total:	$2,595
(15%) Eng. & Proj. Man.:	$389
(10%) Contingency:	$260
Total Cost:	$3,244
Annual Savings:	$481
Service Life (Years):	10
Simple Payback:	6.75
Net Present Value:	$296
ROI:	8%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	2,250	$289	114	$192	$481	$3,244	6.7	0.2

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Transit Garage**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunties for energy savings:
 - HVAC systems recommissing process
 - Installation of programmable thermostats

Proposed:

The following RCx/controls optimization measures are proposed:
- Install programmable thermostats on 5 furnaces and one AC unit to facilitate equipment operation during core occupied hours only and space temperature setback.
- Install a shut-off damper on the outside air duct of two furnaces to allow ventilation during core occupied hours only (no ventilation during unoccupied operation of furnace)
- Control washroom exhaust fans with occupancy sensors
- Tune up/inspect all HVAC equipment and check/adjust air balance

Cost:

Material:	$2,450
Labour:	$6,525
Sub-Total:	$8,975
(15%) Eng. & Proj. Man.:	$1,346
(10%) Contingency:	$898
Total Cost:	$11,219
Annual Savings:	$3,172
Service Life (Years):	10
Simple Payback:	3.54
Net Present Value:	$12,129
ROI:	25%

Assumptions:

- 6 programmable thermostats at $600 each installed
- 2 outside air dampers and controls at $650 each installed
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]
RCx	6,500	$836	2,360	$2,336	$3,172		0.0	6.9
	6,500	$836	2,360	$2,336	$3,172	$11,219	3.5	6.9

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:

Measure Cost and Savings Work-Up Sheet

Facility: **Transit Garage**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles
- Install locking thermostat covers
- Shut of the 1 hp domestic cold water circulation pump during the summer months

Cost:

Material:	$1,550
Labour:	$1,550
Sub-Total:	$3,100
(15%) Eng. & Proj. Man.:	$465
(10%) Contingency:	$310
Total Cost:	$3,875
Annual Savings:	$2,107
Service Life (Years):	10
Simple Payback:	1.84
Net Present Value:	$11,632
ROI:	54%

Assumptions:

- Air sealing and weather-stripping $750
- Twelve block heater receptables at $200 each installed.
- Thermostat covers - $450

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[L]	[$]				
O&M	12,750	$1,640	472	$467	$2,107	$3,875	1.8	2.2

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Frank Slim**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$2,668
Labour:	$1,450
Sub-Total:	$4,118
(15%) Eng. & Proj. Man.:	$618
(10%) Contingency:	$412
Total Cost:	$5,148
Annual Savings:	$503
Service Life (Years):	10
Simple Payback:	10.2
Net Present Value:	-$1,442
ROI:	0%

Assumptions:

- F28T8 Lamps: $3.60
- LED Wallpack: $250
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.76	4,062	$589	-87	-$86	$503	$5,148	10.2	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Frank Slim**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunties for energy savings:
 - HVAC and BAS recommissing process
 - Installation of occupancy sensor to control HVAC operation (already done by City)

Proposed:

The following RCx/controls optimization measures are proposed:
- Recommission the existing HVAC systems and Excell 500 BAS to optimize energy performance including CO2 demand control ventilation, closing of ventilation damper during unoccupied hours of operation, space temperature setback of perimeter heating, and occupancy control of washroom exhaust fan
- Tune up/inspect all HVAC equipment and check/adjust air balance

Cost:

Material:	$1,500
Labour:	$2,500
Sub-Total:	$4,000
(15%) Eng. & Proj. Man.:	$600
(10%) Contingency:	$400
Total Cost:	$5,000
Annual Savings:	$1,382
Service Life (Years):	10
Simple Payback:	3.62
Net Present Value:	$5,168
ROI:	25%

Assumptions:

- Installation of 3 new BAS points at $1000 each
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction	Electricity		Oil		Total	Estimated	Simple	GHG
Measure	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	1,500	$193	1,201	$1,189	$1,382	$5,000	3.6	3.4

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:
- Consider replacing or upgrading the BAS with a web-accessable system for improved oversight and monitoring of energy management.

Measure Cost and Savings Work-Up Sheet

Facility: **Frank Slim**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Install smart block heater receptacles
- Install vending misers
- Control of trace heating

Cost:

Material:	$400
Labour:	$400
Sub-Total:	$800
(15%) Eng. & Proj. Man.:	$120
(10%) Contingency:	$80
Total Cost:	$1,000
Annual Savings:	$399
Service Life (Years):	10
Simple Payback:	2.51
Net Present Value:	$1,934
ROI:	38%

Assumptions:

- Install two vending misers at $200 each installed.
- Two block heater receptables at $200 each installed.
- Shut off trace heating during summer months

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]
O&M	3,100	$399	0	$0	$399	$1,000	2.5	0.2

Impact on Operations and Maintenance:
These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:
Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Frank Slim Building**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 6 L per flush units.
- Faucets are not equipped with aerators.

Proposed:

The following water efficiency measures are proposed:
- Install new low-flow faucet aerators.

Cost:

Material:	$15
Labour:	$25
Sub-Total:	$40
(15%) Eng. & Proj. Man.:	$6
(10%) Contingency:	$4
Total Cost:	$50
Annual Savings:	$80
Service Life (Years):	10
Simple Payback:	0.63
Net Present Value:	$536
ROI:	159%

Assumptions:

- Labour at $100/hour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	540	$69	6	$10	$80	$50	0.6	0.0

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Robert Service Campground Office**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- incandescent lamps in various spaces

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$285
Labour:	$130
Sub-Total:	$415
(15%) Eng. & Proj. Man.:	$62
(10%) Contingency:	$42
Total Cost:	$519
Annual Savings:	$68
Service Life (Years):	10
Simple Payback:	7.58
Net Present Value:	-$15
ROI:	5%

Assumptions:

- F28T8 Lamps: $3.60
- CFL: $3.00
- HE Electronic Ballast: $12.25
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity [kW]	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
Lighting Retrofit	0.13	444	$68	$68	$519	7.6	0.0

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Robert Service Campground Office**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 13 L per flush units.
- Faucets are not equipped with aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$3,620
Labour:	$2,433
Sub-Total:	$6,053
(15%) Eng. & Proj. Man.:	$908
(10%) Contingency:	$605
Total Cost:	$7,567
Annual Savings:	$868
Service Life (Years):	10
Simple Payback:	8.72
Net Present Value:	-$1,181
ROI:	3%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	500	$495	222	$373	$868	$7,567	8.7	1.4

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Crestview Pumphouse**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide most general area lighting
- 2-lamp F32T8 fixtures provide some general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$1,182
Labour:	$710
Sub-Total:	$1,892
(15%) Eng. & Proj. Man.:	$284
(10%) Contingency:	$189
Total Cost:	$2,365
Annual Savings:	$131
Service Life (Years):	10
Simple Payback:	18.10
Net Present Value:	-$1,404
ROI:	-10%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- LED Wallpack: $250
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.26	833	$131	$131	$2,365	18.1	0.1

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Crestview Pump House**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Install smart block heater receptacles
- Setback of space temperature
- Air sealing and weatherstripping
- Consider shutting down of circulation pump 4/5 during summer months (to be confirmed) when frost risk is low.

Cost:

Material:	$300
Labour:	$300
Sub-Total:	$600
(15%) Eng. & Proj. Man.:	$90
(10%) Contingency:	$60
Total Cost:	$750
Annual Savings:	$1,345
Service Life (Years):	10
Simple Payback:	0.56
Net Present Value:	$9,150
ROI:	179%

Assumptions:

- Air sealing and weather-stripping - $250
- One block heater receptable at $200 installed.
- Two thermostat covers at $75 each installed.

Savings:

Energy Reduction Measure	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
O&M	10,460	$1,345	$1,345	$750	0.6	0.7

Impact on Operations and Maintenance:

These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.
Instead of shutting down P4/P5 during summer when risk of freezing is low - consider the application of a VSD
Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **Lift Station #1**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- 2-lamp T12HO fixtures provide some general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 8' T12HO fixtures with reduced wattage 4' F28T8 fixtures coupled with high efficiency electronic ballasts, 2 T8 4' replacement fixtures for each existing 8' fixture
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$2,280
Labour:	$1,720
Sub-Total:	$4,000
(15%) Eng. & Proj. Man.:	$600
(10%) Contingency:	$400
Total Cost:	$5,000
Annual Savings:	$294
Service Life (Years):	10
Simple Payback:	16.98
Net Present Value:	-$2,832
ROI:	-9%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- 2 lamp T8 Fixtures: $80/fixture, 1 hour of labour to replace fixture
- LED Wallpack: $250
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.85	1,706	$294	$294	$5,000	17.0	0.1

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Lift Station # 1**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
- Existing pumps consist of 3X35hp with VSD - one pump generally operates on demand at 90% speed to handle load.

Proposed:

The following O&M opportunities are proposed:

- Install smart block heater receptacles
- Setback of space temperature
- Air sealing and weatherstripping

Cost:

Material:	$375
Labour:	$375
Sub-Total:	$750
(15%) Eng. & Proj. Man.:	$113
(10%) Contingency:	$75
Total Cost:	$938
Annual Savings:	$1,030
Service Life (Years):	10
Simple Payback:	0.91
Net Present Value:	$6,644
ROI:	110%

Assumptions:

- Air sealing and weather-stripping - $400
- One block heater receptable at $200 installed.
- Two thermostat covers at $75 each installed.

Savings:

Energy Reduction Measure	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
O&M	8,010	$1,030	$1,030	$938	0.9	0.6

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Lift Station #3**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with HE electronic ballasts
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$1,078
Labour:	$533
Sub-Total:	$1,611
(15%) Eng. & Proj. Man.:	$242
(10%) Contingency:	$161
Total Cost:	$2,014
Annual Savings:	$108
Service Life (Years):	10
Simple Payback:	18.65
Net Present Value:	-$1,219
ROI:	-10%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- LED Wallpack: $250
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity [kW]	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
Lighting Retrofit	0.20	702	$108	$108	$2,014	18.7	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Lift Station # 3**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
- Existing pumps consist of 3X20hp - one pump generally operates on demand to handle load.

Proposed:

The following O&M opportunities are
- Install smart block heater receptacles
- Setback of space temperature
- Air sealing and weatherstripping

Cost:

Material:	$475
Labour:	$475
Sub-Total:	$950
(15%) Eng. & Proj. Man.:	$143
(10%) Contingency:	$95
Total Cost:	$1,188
Annual Savings:	$1,159
Service Life (Years):	10
Simple Payback:	1.02
Net Present Value:	$7,341
ROI:	97%

Assumptions:

- Air sealing and weather-stripping - $400
- Two block heater receptables at $200 each
- Two thermostat covers at $75 each installed.

Savings:

Energy Reduction Measure	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
O&M	9,010	$1,159	$1,159	$1,188	1.0	0.6

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.
Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **Hamilton Blvd Pumphouse**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting
- incandescent lamps in various spaces
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$1,392
Labour:	$1,077
Sub-Total:	$2,469
(15%) Eng. & Proj. Man.:	$370
(10%) Contingency:	$247
Total Cost:	$3,086
Annual Savings:	$159
Service Life (Years):	10
Simple Payback:	19.46
Net Present Value:	-$1,919
ROI:	-11%

Assumptions:

- F28T8 Lamps: $3.60
- CFL: $3.00
- HE Electronic Ballast: $12.25
- LED Wallpack: $250
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.43	939	$159	$159	$3,086	19.5	0.1

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Hamilton Blvd Pumphouse**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilet is 13 L per flush unit.
- Faucet is not equipped with an aerator.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.

Cost:

Material:	$505
Labour:	$342
Sub-Total:	$847
(15%) Eng. & Proj. Man.:	$127
(10%) Contingency:	$85
Total Cost:	$1,058
Annual Savings:	$45
Service Life (Years):	10
Simple Payback:	23.72
Net Present Value:	-$730
ROI:	-13%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings	Estimated Cost	Simple Payback
	[kWh]	[$]	[m^3]	[$]	[$]	[$]	[Years]
Water Efficient Fixtures	244	$31	8	$13	$45	$1,058	23.7

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

GHG Reduction [$teCO_2$]
0.0

Measure Cost and Savings Work-Up Sheet

Facility: **Hamilton Blvd**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
-Existing pumps consist of 3X50 hp main pumps (w/ Nema Premium motors) and 2X7.5 hp circulation for frost and freshness (both circ pumps were on)

Proposed:

The following O&M opportunities are proposed:

- Install a smart block heater receptacle
- Setback of space temperature on electric furnace
- Air sealing and weatherstripping
- Consider shutting down one or both circulation pumps during summer months when risk of freezing is low.

Cost:

Material:	$300
Labour:	$300
Sub-Total:	$600
(15%) Eng. & Proj. Man.:	$90
(10%) Contingency:	$60
Total Cost:	$750
Annual Savings:	$2,018
Service Life (Years):	10
Simple Payback:	0.37
Net Present Value:	$14,101
ROI:	269%

Assumptions:

- Air sealing and weather-stripping - $250
- One block heater receptable at $200 installed.
- One thermostat covers at $75 installed.

Savings:

Energy Reduction Measure	Electricity		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	15,690	$2,018	$2,018	$750	0.4	1.1

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors on two 7.5 hp circ pumps as replacement motors at end of motor life.

Instead of shutting down two 7.5 hp circ pumps during summer when risk of freezing is low - consider the application of a VSD
Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **Animal Shelter**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- 2-lamp T12 fixtures provide some general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$1,572
Labour:	$967
Sub-Total:	$2,538
(15%) Eng. & Proj. Man.:	$381
(10%) Contingency:	$254
Total Cost:	$3,173
Annual Savings:	$258
Service Life (Years):	10
Simple Payback:	12.28
Net Present Value:	-$1,270
ROI:	-4%

Assumptions:

- F28T8 Lamps: $3.60; HE Electronic Ballast: $12.25; Occupancy Sensors: $100 installed
- LED Wallpack: $250
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour; lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.41	2,072	$302	-44	-$44	$258	$3,173	12.3	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Animal Shelter**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 13 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$525
Labour:	$350
Sub-Total:	$875
(15%) Eng. & Proj. Man.:	$131
(10%) Contingency:	$88
Total Cost:	$1,094
Annual Savings:	$273
Service Life (Years):	10
Simple Payback:	4.00
Net Present Value:	$917
ROI:	21%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	238	$236	22	$37	$273	$1,094	4.0	0.7

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Animal Shelter**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunities for energy savings:
 - HVAC recommisionning to reduce a high oil energy intensity

Proposed:

The following RCx/controls optimization measures are proposed:
- Recommission the existing HVAC systems and controls to optimize energy performance including space temperature setback of heating, and timed or occupancy control of exhaust fans
- Tune up/inspect all HVAC equipment and check/adjust air balance

Cost:

Material:	$1,000
Labour:	$1,250
Sub-Total:	$2,250
(15%) Eng. & Proj. Man.:	$338
(10%) Contingency:	$225
Total Cost:	$2,813
Annual Savings:	$2,337
Service Life (Years):	10
Simple Payback:	1.20
Net Present Value:	$33,149
ROI:	29%

Assumptions:

- addition of controls including occupancy sensors, timers - $900
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	2,100	$270	2,088	$2,067	$2,337	$2,813	1.2	5.9

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measure Cost and Savings Work-Up Sheet

Facility: **Animal Shelter**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implem

Proposed:

The following O&M opportunities are proposed:

- Install smart block heater receptacles
- Install solenoid valve to control a "bleeder"
- Control of trace heating

Cost:

Material:	$400
Labour:	$400
Sub-Total:	$800
(15%) Eng. & Proj. Man.:	$120
(10%) Contingency:	$80
Total Cost:	$1,000
Annual Savings:	$1,142
Service Life (Years):	10
Simple Payback:	0.88
Net Present Value:	$7,404
ROI:	114%

Assumptions:

- Seven block heater receptables at $200 each installed.
- Install solenoid valve and controls - $300

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[m^3]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	7,000	$900	144	$242	$1,142	$1,000	0.9	0.5

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Stores Warehouse**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide most general area lighting
- 2-lamp F32T8 fixtures provide some general area lighting
- HID lighting in high bay areas
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 8' T12 fixtures with reduced wattage 4' F28T8 fixtures coupled with high efficiency electronic ballasts, 2 T8 4' replacement fixtures for each existing 8' fixture
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all high bay HID fixtures with 2-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$18,876
Labour:	$6,180
Sub-Total:	$25,056
(15%) Eng. & Proj. Man.:	$3,758
(10%) Contingency:	$2,506
Total Cost:	$31,321
Annual Savings:	$2,760
Service Life (Years):	10
Simple Payback:	11.35
Net Present Value:	-$11,006
ROI:	-2%

Assumptions:

- F28T8 Lamps: $3.60; F54T5HO lamps: $7.65; HE Electronic Ballast: $12.25
- 2 lamp T5HO High Bay Fixtures: $80/fixture, 1 hour of labour to replace fixture
- LED Shoebox Fixture: $1,500; Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour; lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	6.24	20,541	$3,195	-439	-$435	$2,760	$31,321	11.3	0.2

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Stores Warehouse**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are 13 L per flush units.
- Faucets are equipped with standard flow aerators.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.

Cost:

Material:	$505
Labour:	$342
Sub-Total:	$847
(15%) Eng. & Proj. Man.:	$127
(10%) Contingency:	$85
Total Cost:	$1,058
Annual Savings:	$236
Service Life (Years):	10
Simple Payback:	4.49
Net Present Value:	$677
ROI:	18%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	1,575	$203	20	$33	$236	$1,058	4.5	0.1

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Stores Warehouse**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunities for energy savings:
 - HVAC systems recommissing process
 - Installation of programmable thermostats

Proposed:

The following RCx/controls optimization measures are proposed:
- Install programmable thermostats on 2 oil furnaces and one electric U/H to facilitate equipment operation during core occupied hours only and provide space temperature setback.
- Install a shut-off damper on the outside air duct of one furnace to allow ventilation during core occupied hours only (no ventilation during unoccupied operation of furnace)
- Control washroom exhaust fan with an occupancy sensors
- Tune up/inspect all HVAC equipment and check/adjust air balance

Cost:

Material:	$1,225
Labour:	$2,100
Sub-Total:	$3,325
(15%) Eng. & Proj. Man.:	$499
(10%) Contingency:	$333
Total Cost:	$4,156
Annual Savings:	$1,105
Service Life (Years):	10
Simple Payback:	3.76
Net Present Value:	$3,975
ROI:	23%

Assumptions:

- 3 programmable thermostats at $600 each installed
- 1 outside air dampers and controls at $650 each installed
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[L]	[$]				
RCx	1,200	$154	960	$950	$1,105	$4,156	3.8	2.7

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measure Cost and Savings Work-Up Sheet

Facility: **Stores Warehouse**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles
- Install locking thermostat covers
- Shut off trace heating during the summer

Cost:

Material:	$900
Labour:	$900
Sub-Total:	$1,800
(15%) Eng. & Proj. Man.:	$270
(10%) Contingency:	$180
Total Cost:	$2,250
Annual Savings:	$985
Service Life (Years):	10
Simple Payback:	2.28
Net Present Value:	$5,002
ROI:	43%

Assumptions:

- Air sealing and weather-stripping $150
- Six block heater receptables at $200 each installed.
- Thermostat covers - $450

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	6,800	$874	112	$111	$985	$2,250	2.3	0.8

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Copper Ridge Pumphouse**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$1,470
Labour:	$1,033
Sub-Total:	$2,503
(15%) Eng. & Proj. Man.:	$375
(10%) Contingency:	$250
Total Cost:	$3,129
Annual Savings:	$163
Service Life (Years):	10
Simple Payback:	19.19
Net Present Value:	-$1,929
ROI:	-10%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- LED Wallpack: $250
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kW]	[kWh]	[$]	[L]	[$]				
Lighting Retrofit	0.38	1,204	$189	-26	-$25	$163	$3,129	19.2	0.0

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Copper Ridge Pumphouse**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are 13 L per flush units.
- Faucets are equipped with standard flow aerators.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.

Cost:

Material:	$505
Labour:	$205
Sub-Total:	$710
(15%) Eng. & Proj. Man.:	$107
(10%) Contingency:	$71
Total Cost:	$888
Annual Savings:	$28
Service Life (Years):	10
Simple Payback:	31.70
Net Present Value:	-$681
ROI:	-17%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	180	$23	3	$5	$28	$888	31.7	0.0

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Copper Ridge**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
-Existing pumps consist of 3X25 hp booster pumps used to fill reservoir (w/ Nema Premium motors) and 3X15 hp circulation for frost and freshness (two circ pumps were on)

Proposed:

The following O&M opportunities are proposed:

- Install three smart block heater receptacles
- Setback of space temperature and install thermostat cover
- Air sealing and weatherstripping
- Consider shutting down one or both circulation pumps during summer months when risk of freezing is low.

Cost:

Material:	$500
Labour:	$500
Sub-Total:	$1,000
(15%) Eng. & Proj. Man.:	$150
(10%) Contingency:	$100
Total Cost:	$1,250
Annual Savings:	$3,670
Service Life (Years):	10
Simple Payback:	0.34
Net Present Value:	$25,762
ROI:	294%

Assumptions:

- Air sealing and weather-stripping - $250
- Three block heater receptables at $200 installed.
- One thermostat covers at $75 installed.

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	22,380	$2,878	800	$792	$3,670	$1,250	0.3	3.8

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors on three 15 hp circ pumps as replacement motors at end of motor life.
Instead of shutting down circ pumps during summer when risk of freezing is low - consider the application of a VSD

Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **Marwell Lift Station**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide most general area lighting
- 2-lamp T12 fixtures provide some general area lighting
- HID lighting in high bay areas
- LED exterior lighting

Proposed:

The following lighting measures are proposed:
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all high bay HID fixtures with 2-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts

Cost:

Material:	$2,191
Labour:	$2,260
Sub-Total:	$4,451
(15%) Eng. & Proj. Man.:	$668
(10%) Contingency:	$445
Total Cost:	$5,564
Annual Savings:	$276
Service Life (Years):	10
Simple Payback:	20.14
Net Present Value:	-$3,531
ROI:	-11%

Assumptions:

- F28T8 Lamps: $3.60
- F54T5HO Lamps: $7.65
- HE Electronic Ballast: $12.25
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kW]	[kWh]	[$]	[L]	[$]				
Lighting Retrofit	1.19	1,588	$310	-34	-$34	$276	$5,564	20.1	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

Measure Cost and Savings Work-Up Sheet

Facility: **Marwell Lift Station**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are 13 L per flush units.
- Faucets are equipped with standard flow aerators.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.

Cost:

Material:	$505
Labour:	$205
Sub-Total:	$710
(15%) Eng. & Proj. Man.:	$107
(10%) Contingency:	$71
Total Cost:	$888
Annual Savings:	$92
Service Life (Years):	10
Simple Payback:	9.67
Net Present Value:	-$212
ROI:	1%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	525	$68	14	$24	$92	$888	9.7	0.0

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Marwell Lift**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunities for energy savings:
 - HVAC systems recommissing process
 - Controls upgrade and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Install a small BAS to control the HVAC systems including AHU scheduling and a push button override for unscheduled use of the space.
- The BAS will also control the heating system including boiler reset, perimeter zone temperature and major zones to facilitate space temperature setback during unoccupied hours.
- Control washroom exhaust fans with occupancy sensors
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance

Cost:

Material:	$16,000
Labour:	$17,250
Sub-Total:	$33,250
(15%) Eng. & Proj. Man.:	$4,988
(10%) Contingency:	$3,325
Total Cost:	$41,563
Annual Savings:	$5,984
Service Life (Years):	10
Simple Payback:	6.95
Net Present Value:	$2,483
ROI:	7%

Assumptions:

- Budget includes 32 BAS points to control HVAC systems at $1000 per point installed.
 - $0.25 per square foot for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	21,900	$2,816	3,200	$3,168	$5,984	$41,563	6.9	10.3

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:
Consider installing Viessman Vitorond high efficiency (88%) boilers when the existing boilers reach the end of their life-cycle.

Measure Cost and Savings Work-Up Sheet

Facility: **Marwell Lift**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staf

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles
- Install thermostat covers

Cost:

Material:	$875
Labour:	$875
Sub-Total:	$1,750
(15%) Eng. & Proj. Man.:	$263
(10%) Contingency:	$175
Total Cost:	$2,188
Annual Savings:	$1,603
Service Life (Years):	10
Simple Payback:	1.36
Net Present Value:	$9,614
ROI:	73%

Assumptions:

- Air sealing and weather-stripping $500
- Four block heater receptables at $200 each installed.
- Six thermostat covers - $450

Savings:

Energy Reduction Measure	Electricity		Oil		Water		Total Savings	Estimated Cost	Simple Payback
	[kWh]	[$]	[L]	[$]	[m^3]	[$]	[$]	[$]	[Years]
O&M	4,000	$514	1,100	$1,089	0	$0	$1,603	$2,188	1.4

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors (as applicable) as replacement motors at end of motor life.

ff.

GHG Reduction [$teCO_2$]
3.3

Measure Cost and Savings Work-Up Sheet

Facility: **Two Mile Hill Booster Stn**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting
- HID lighting in high bay areas
- LED exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all high bay HID fixtures with 4-lamp T5HO high bay fixtures coupled with high efficiency electronic ballasts
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$1,388
Labour:	$1,933
Sub-Total:	$3,321
(15%) Eng. & Proj. Man.:	$498
(10%) Contingency:	$332
Total Cost:	$4,151
Annual Savings:	$389
Service Life (Years):	10
Simple Payback:	10.67
Net Present Value:	-$1,287
ROI:	-1%

Assumptions:

- F28T8 Lamps: $3.60
- F54T5HO Lamps: $7.65
- HE Electronic Ballast: $12.25
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	0.84	2,927	$451	-63	-$62	$389	$4,151	10.7	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Two Mile Hill Booster Stn**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are generally 13 L per flush units.
- Faucets are generally equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Replace all high flow toilets with 6 LPF units.
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$545
Labour:	$358
Sub-Total:	$903
(15%) Eng. & Proj. Man.:	$136
(10%) Contingency:	$90
Total Cost:	$1,129
Annual Savings:	$781
Service Life (Years):	10
Simple Payback:	1.45
Net Present Value:	$4,619
ROI:	69%

Assumptions:

- Labour at $100/hour
- Toilets at $500/each materials and $333/each installation labour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Fuel Oil		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[L]	[$]	[m^3]	[$]				
Water Efficient Fixtures	756	$748	19	$32	$781	$1,129	1.4	2.1

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Two Mile**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunties for energy savings:
 - HVAC systems recommissing process
 - Controls upgrade and optimization

Proposed:

The following RCx/controls optimization measures are proposed:
- Install a small BAS to control the HVAC systems including AHU scheduling and a push button override for unscheduled use of the space.
- The BAS will also control the heating system including boiler reset, perimeter zone temperature and major zones to facilitate space temperature setpback during unoccupied hours.
- Control washroom exhaust fans with occupancy sensors
- Tune up/inspect all ventilation and heating equipment and check/adjust air and water balance

Cost:

Material:	$11,000
Labour:	$12,250
Sub-Total:	$23,250
(15%) Eng. & Proj. Man.:	$3,488
(10%) Contingency:	$2,325
Total Cost:	$29,063
Annual Savings:	$4,530
Service Life (Years):	10
Simple Payback:	6.42
Net Present Value:	$4,279
ROI:	9%

Assumptions:

- Budget includes 22 BAS points to control HVAC systems at $1000 per point installed.
- $0.25 per square foot for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	17,520	$2,253	2,300	$2,277	$4,530	$29,063	6.4	7.5

Impact on Operations and Maintenance:

RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measure Cost and Savings Work-Up Sheet

Facility: **Two Mile**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles and vending misers on beverage vending machines
- Install thermostat covers

Cost:

Material:	$1,575
Labour:	$1,575
Sub-Total:	$3,150
(15%) Eng. & Proj. Man.:	$473
(10%) Contingency:	$315
Total Cost:	$3,938
Annual Savings:	$2,434
Service Life (Years):	10
Simple Payback:	1.62
Net Present Value:	$13,978
ROI:	61%

Assumptions:

- Air sealing and weather-stripping $400
- Twelve block heater receptables at $200 each installed.
- Two thermostat covers - $150

Savings:

Energy Reduction	Electricity		Oil		Total	Estimated	Simple	GHG
Measure	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	12,000	$1,543	900	$891	$2,434	$3,938	1.6	3.3

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors (as applicable) as replacement motors at end of motor life.

Measure Cost and Savings Work-Up Sheet

Facility: **Strickland Lift Station**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic
- Replace all exterior HID lighting with LED fixtures

Cost:

Material:	$578
Labour:	$333
Sub-Total:	$911
(15%) Eng. & Proj. Man.:	$137
(10%) Contingency:	$91
Total Cost:	$1,139
Annual Savings:	$60
Service Life (Years):	10
Simple Payback:	19.04
Net Present Value:	-$699
ROI:	-10%

Assumptions:

- F28T8 Lamps: $3.60; HE Electronic Ballast: $12.25; LED \
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity [kW]	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
Lighting Retrofit	0.12	380	$60	$60	$1,139	19.0	0.0

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Strickland Storm**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
Existing pumps consist of 2X30 and one 14 hp storm pumps - that operate in sequence on demand

Proposed:

The following O&M opportunities are

- Setback of space temperature and thermostat cover
- Air sealing and weatherstripping

Cost:

Material:	$163
Labour:	$163
Sub-Total:	$325
(15%) Eng. & Proj. Man.:	$49
(10%) Contingency:	$33
Total Cost:	$406
Annual Savings:	$141
Service Life (Years):	10
Simple Payback:	2.87
Net Present Value:	$635
ROI:	33%

Assumptions:

- Air sealing and weather-stripping - $250
- Thermostat cover at $75 installed.

Savings:

Energy Reduction Measure	Electricity [kWh]	Electricity [$]	Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
O&M	1,100	$141	$141	$406	2.9	0.1

Impact on Operations and Maintenance:
- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:
Install premium efficiency motors when equipment reaches the end of its life-cycle.
Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **McIntyre Creek Pump Station**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp T12 fixtures provide all general area lighting

Proposed:

The following lighting measures are proposed:
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts

Cost:

Material:	$467
Labour:	$800
Sub-Total:	$1,267
(15%) Eng. & Proj. Man.:	$190
(10%) Contingency:	$127
Total Cost:	$1,584
Annual Savings:	$90
Service Life (Years):	10
Simple Payback:	17.62
Net Present Value:	-$922
ROI:	-9%

Assumptions:

- F28T8 Lamps: $3.60
- HE Electronic Ballast: $12.25
- Labour rate assumed at $100/hr
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]
Lighting Retrofit	0.29	599	$103	-13	-$13	$90	$1,584	17.6	0.0

Impact on Operations and Maintenance:
- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M
- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **McIntyre Creek**

Measure: **O&M**

Existing:

- A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.
-Existing pumps consist of 2X50 and one 75 hp booster pumps (with standard efficiency motors) - one pump generally runs to meet load.

Proposed:

The following O&M opportunities are proposed:

- Setback of space temperature and thermostat covers on oil furnace and electric unit heater
- Air sealing and weatherstripping

Cost:

Material:	$225
Labour:	$225
Sub-Total:	$450
(15%) Eng. & Proj. Man.:	$68
(10%) Contingency:	$45
Total Cost:	$563
Annual Savings:	$3,670
Service Life (Years):	10
Simple Payback:	0.15
Net Present Value:	$26,450
ROI:	652%

Assumptions:

- Air sealing and weather-stripping - $300
- Two thermostat covers at $75 installed.

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[teCO_2]
O&M	22,380	$2,878	800	$792	$3,670	$563	0.2	3.8

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating procedures

Measures For Future Consideration:

Install premium efficiency motors and high efficiency pumps when equipment reaches the end of its life-cycle.
Consider upgrading building envelope to current standard at time of major facility renewal.

Measure Cost and Savings Work-Up Sheet

Facility: **Parks Warehouse**

Measure: **Lighting Retrofit**

Existing:

The facility is currently illuminated by the following fixtures:
- 2-lamp F32T8 fixtures provide some general area lighting
- 2-lamp T12 fixtures provide most general area lighting
- incandescent lamps in various spaces
- HID lighting in high bay areas
- HID exterior lighting

Proposed:

The following lighting measures are proposed:
- Replace all incandescent lamps with CFLs
- Relamp all F32T8 fixtures with reduced wattage F28T8 lamps
- Replace all 4' T12 fixtures with reduced wattage F28T8 lamps coupled with high efficiency electronic ballasts
- Replace all high bay HID fixtures with 8-lamp T5HO high bay fixtures coupled with HE electronic ballasts
- Replace all exterior HID lighting with LED fixtures
- Install occupancy sensors in infrequently used areas such as washrooms

Cost:

Material:	$3,521
Labour:	$2,257
Sub-Total:	$5,778
(15%) Eng. & Proj. Man.:	$867
(10%) Contingency:	$578
Total Cost:	$7,223
Annual Savings:	$1,542
Service Life (Years):	10
Simple Payback:	4.68
Net Present Value:	$4,129
ROI:	17%

Assumptions:

- F28T8 Lamps: $3.60; F54T5HO Lamps: $7.65; CFL Lamps: $3.00
- HE Electronic Ballast: $12.25; LED Wallpack: $250
- 8 lamp T5HO High Bay Fixtures: $350/fixture, 1 hour of labour to replace fixture
- Occupancy Sensors: $100 installed
- Labour rate assumed at $100/hr
- Labour for lamp replacement: 1/6 hour
- Labour for lamp and ballast replacement: 1/2 hour

Savings:

Energy Reduction Measure	Electricity			Fuel Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kW]	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
Lighting Retrofit	4.77	10,419	$1,763	-223	-$221	$1,542	$7,223	4.7	0.1

Impact on Operations and Maintenance:

- Lamps: lamp life is expected to be equal to, or greater than, the existing lamps so there will be no significant impact on O&M

- Controls: occupancy sensors will require periodic maintenance as per manufacturer's recommendations

Measure Cost and Savings Work-Up Sheet

Facility: **Parks Warehouse**

Measure: **Water Efficient Fixtures**

Existing:

The following conditions were noted on site:
- Toilets are 6 L per flush units.
- Faucets are equipped with standard flow aerators.
- Showers use medium flow showerheads.

Proposed:

The following water efficiency measures are proposed:
- Install new low-flow faucet aerators.
- Install new low-flow showerheads.

Cost:

Material:	$30
Labour:	$15
Sub-Total:	$45
(15%) Eng. & Proj. Man.:	$7
(10%) Contingency:	$5
Total Cost:	$56
Annual Savings:	$192
Service Life (Years):	10
Simple Payback:	0.29
Net Present Value:	$1,354
ROI:	341%

Assumptions:

- Labour at $100/hour
- Aerators at $5/each materials and $8.33/each installation labour
- Showerheads at $20/each materials and $8.33/each installation labour

Savings:

Energy Reduction Measure	Electricity		Water		Total Savings [$]	Estimated Cost [$]	Simple Payback [Years]	GHG Reduction [$teCO_2$]
	[kWh]	[$]	[m^3]	[$]				
Water Efficient Fixtures	1,080	$174	11	$18	$192	$56	0.3	0.1

Impact on Operations and Maintenance:

- No major changes to operations and maintenance

Measure Cost and Savings Work-Up Sheet

Facility: **Parks Warehouse**

Measure: **RCx & Controls Optimization**

Existing:

- A review of the building HVAC systems identified the following opportunities for energy savings:
 - HVAC systems recommissing process
 - Installation of programmable thermostats

Proposed:

The following RCx/controls optimization measures are proposed:
- Install programmable thermostats on 2 oil furnaces and one electric furnace to facilitate equipment operation during core occupied hours only and provide space temperature setback.
- Control washroom exhaust fan with an occupancy sensors
- Tune up/inspect all HVAC equipment and check/adjust air balance

Cost:

Material:	$900
Labour:	$1,775
Sub-Total:	$2,675
(15%) Eng. & Proj. Man.:	$401
(10%) Contingency:	$268
Total Cost:	$3,344
Annual Savings:	$2,354
Service Life (Years):	10
Simple Payback:	1.42
Net Present Value:	$13,985
ROI:	70%

Assumptions:

- 3 programmable thermostats at $600 each installed
- $0.25 per square foot for RCx for recommisioning process

Savings:

Energy Reduction Measure	Electricity		Oil		Total Savings	Estimated Cost	Simple Payback	GHG Reduction
	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
RCx	9,070	$1,166	1,200	$1,188	$2,354	$3,344	1.4	3.9

Impact on Operations and Maintenance:
RCx will reduce the operating time of equipment therefore extend life and reduce scheduled maintance.

Measures For Future Consideration:
- Consider updgrading building envelope components as part of a major renewal of the facility

Measure Cost and Savings Work-Up Sheet

Facility: **Parks Warehouse**

Measure: **O&M**

Existing:

A review of the building's O&M practices identified a number of low cost operational improvements that can be implemented by staff.

Proposed:

The following O&M opportunities are proposed:

- Air seal penetrations and repair and replace the door weather-stripping as needed
- Install smart block heater receptacles
- Install locking thermostat covers
- Shut off trace heating during the summer

Cost:

Material:	$650
Labour:	$650
Sub-Total:	$1,300
(15%) Eng. & Proj. Man.:	$195
(10%) Contingency:	$130
Total Cost:	$1,625
Annual Savings:	$777
Service Life (Years):	10
Simple Payback:	2.09
Net Present Value:	$4,093
ROI:	47%

Assumptions:

- Air sealing and weather-stripping $450
- Two block heater receptables at $200 each installed.
- Thermostat covers - $450

Savings:

Energy Reduction	Electricity		Oil		Total	Estimated	Simple	GHG
Measure	[kWh]	[$]	[L]	[$]	[$]	[$]	[Years]	[$teCO_2$]
O&M	2,500	$322	460	$455	$777	$1,625	2.1	1.4

Impact on Operations and Maintenance:

- These measures can be undertaken by City maintenance staff within existing maintenance budgets and operating

Measures For Future Consideration:

Install premium efficiency motors as replacement motors at end of motor life.

Appendix D MSB Energy Cost Analysis

MSB Energy Cost Scenarios

During the process of this study, the City of Whitehorse has identified five buildings which are candidates for amalgamation, both due to high energy costs, maintenance issues, and placing city services under one roof. These five buildings are as follows:

- Municipal Services Building
- Transit Garage
- Animal Shelter
- Stores Building
- Parks Warehouse

To help the city in this decision making process, we have studied four separate scenarios which encompass the potential outcomes. These scenarios are described as follows:

- **Scenario 1 – Business as Usual**
  - This scenario assumes that no retrofits are implemented and the buildings use energy as they do currently.
- **Scenario 2 – Implement Recommended Energy Retrofits**
  - This scenario assumes that all retrofits recommended in the main report are implemented.
- **Scenario 3 – Major Renovations**
  - This scenario assumes that major renovations of all buildings are undertaken, bringing them up to or as near as possible to current standards and the Whitehorse Energy Code.
- **Scenario 4 – New High-Efficient Building**
  - This scenario assumed that the five facilities are amalgamated and housed in a new high-efficient building.

Consistent with high-level analyses, these calculations carry several assumptions:

- Utility cost escalation rate of 3%
- All buildings included in this list can last 30 years
- Maintenance costs have been omitted – this analysis includes only energy costs

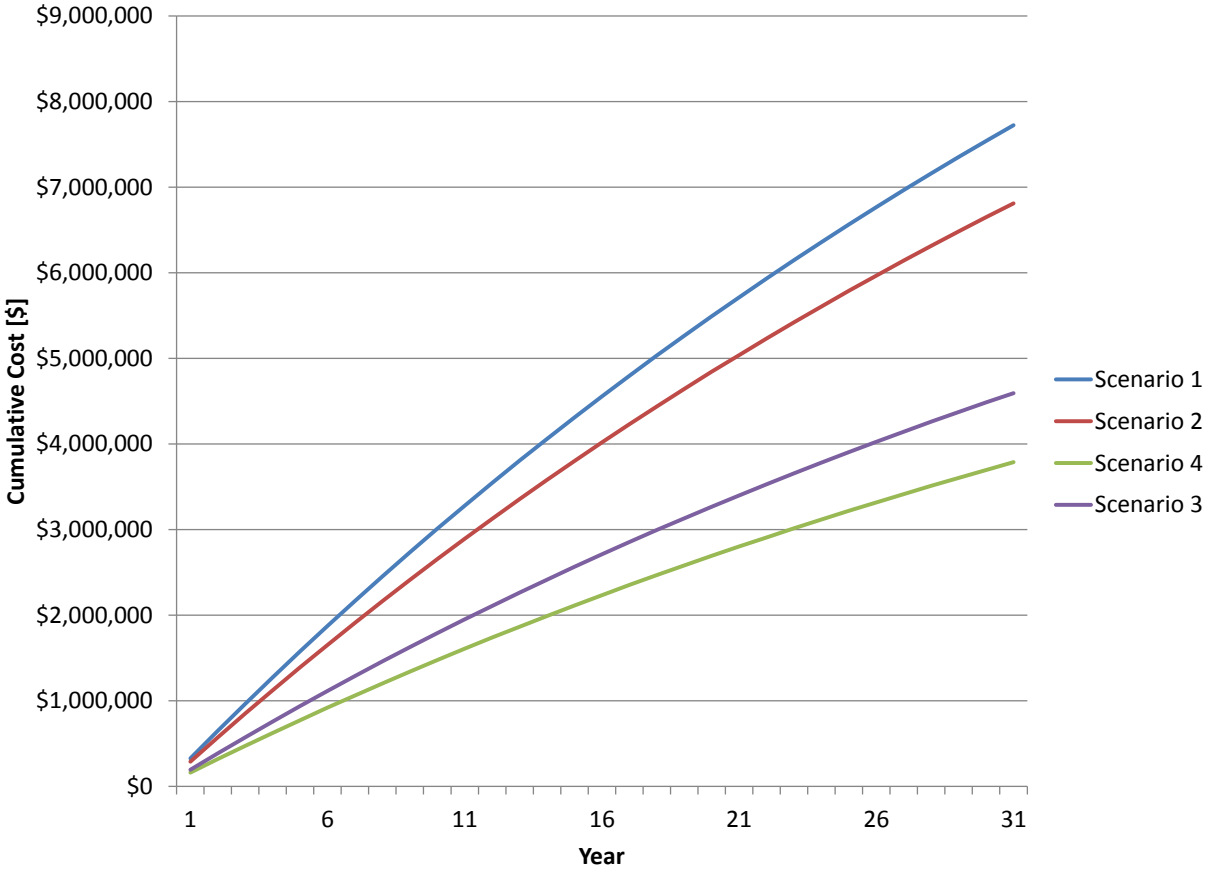
The analysis results are shown below:

Exhibit 1

Scenario	Year 0 Utility Costs	Difference From Baseline
1 - Business as Usual	$327,589	N/A
2 - Recommended Energy Retrofits	$288,876	11.8%
3 – Major Renovations	$194,845	40.5%
4 - New High-Efficient Building	$160,591	51.0%

Extrapolating these results over a life-cycle period defined as 30 years long, these result in the following cumulative energy costs. Please note that all terms are today's dollars and net present value calculations are shown:

Exhibit 2 30-Year Cost Curve



The conclusions from this graph are as follows:

- **Scenario 1 Business As Usual** – This "do nothing" baseline scenario will result in $7.7 million in cumulative energy costs over the next 30 years.
- **Scenario 2 Implement Recommended Energy Retrofits** - Implementing the retrofits recommended in the Energy Management Plan will result in $6.8 million in energy costs - a savings of $912,748 over the baseline.
- **Scenario 3 Major Renovations** – Undertaking major renovations to bring the buildings up to current codes and energy standards will result in energy costs of $4.6 million – a savings of $3.1 million relative to the baseline.
- **Scenario 4 New High-Efficient Building** – Constructing a new high-efficient building to house the operations of all 5 buildings will result in $3.7 million in cumulative energy costs – a savings of $3.9 million over the baseline.

Therefore the option with the highest savings potential is Scenario 4 High-Efficient Building. The best efficiency outcomes generally occur with a 'clean slate' design and construction process using life-cycle costing principles. In addition, this scenario would be expected to generate the least maintenance costs than the other options.