Esquimalt Aquatic Centre
Energy Retrofit Opportunity

Energy Audit for:

Esquimalt Recreation Centre
Esquimalt, BC

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Esquimalt Recreation Centre

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1. Executive Summary

1.1 Background of the Project

Coral Engineering Limited and Quantum lighting have been asked to provide an Energy Audit on the Esquimalt Recreation Centre. This report is to provide a series of strategies and measures which when implemented will reduce each facility's energy consumption and green house gas emissions.

Aquatic Centre

This 4,828 m^2 (52,000 ft^2) predominantly single storey aquatic centre has a second floor mechanical room. This facility is comprised of a 25 meter indoor pool, leisure pool, hot tub, change rooms, meeting rooms, snack bar, and some office space. The heating and ventilation for the natatorium, lobby, and change rooms are provided by a series of air handling units. The facility currently produces **584.9** Tonnes of annual CO_2 emissions based on the following energy consumption data.

Natatorium

The Dectron pool dehumidification unit is not presently functioning. This unit is only four years old and has now been de-commissioned. We feel that it would be less than cost effective to remove this unit from the roof and replace it with another of equal cost.
We recommend the following:

- the removal of the old R22 compressors, the DX evaporators, the coaxial condensers, and the refrigerant condenser coil in the air stream.
- the replacement of these removed components with a more sophisticated state of the art, R-410a dehumidification reclaim system. The new system will extract heat from the natatorium return air stream, dehumidifying this air, and will use the heat extracted to heat the lap pool, the leisure pool, the tots pool, the swirl pool and pre heat the DHW. A new cooling coil will need to be installed in the air stream, that will need to have a corrosion resistant coating to increase lifespan of the coil. The new compressors and condensers will be located outside of the air handler and will not be subject to the corrosive salt and chlorine environment.
- solar preheating of the DHW system.
- power factor correction capacitance to be installed.
- the installation of an exhaust air reclaim system to augment this reclaim system. This system will extract the heat from the air that needs to be exhausted from the facility and use this heat to pre-heat the outdoor air that will be introduced into the natatorium as ventilation air and chloramines dilution air.

To control these new measures we will need to add to the existing Walker control system.

Normalized Annual Utility Costs (inc taxes) and Consumption for the Esquimalt Recreation Centre for 2007 and 2008 are:

Historical Data	Energy Use (GJ)		BEPI (MJ/m2)		BEPI (kWh/ft2)		Cost ($)	
	2008	2007	2008	2007	2008	2007	2008	2007
Gas	9,132	10,041	1,890	2,078	49	54	$ 115,851	$ 126,074
Electricity	7,173	7,131	1,484	1,476	38	38	$ 115,695	$ 112,087
Total	**16,306**	**17,172**	**3,374**	**3,553**	**87**	**92**	**$ 231,546**	**$ 238,161**

The aim or purpose of this report is to analyze the existing operation of this facility and to seek out opportunities to reduce its energy consumption, and to analyze the costs associated with these potential projects.

1.2 Précis of Project

We have identified a number of excellent opportunities to significantly cut the overall energy consumption for this facility. This accomplishment will require a major mechanical retrofit to the pool heating and ventilation systems.

1.3 Summary Report Table

The costs and benefits associated with this project are summarized below:

Project Summary						
	Capital	Savings	Electricity	Gas	Payback	GHG
	Cost $	$	(kWh)	(Gj)	years	(tonnes)
Dehumidification Reclaim System	**$ 299,553**	**$33,400**	**-175,141**	**2,420**	**8.9**	**119.4**
Exhaust Air Reclaim	**$ 110,129**	**$ 19,100**	**- 70,000**	**1,360**	**5.7**	**67.6**
Reclaim DHW Pre-heat	**$ 85,550**	**$ 28,600**	**- 60,225**	**1,920**	**3.0**	**96.5**
Demand Ventilation AHU-2,3,4	**$ 14,000**	**$ 5,330**	**28,500**	**256**	**2.6**	**13.7**
Power Factor Correction	**$ 10,000**	**$ 10,000**	**0**	**0**	**1.0**	**0**
Pump Room A/C used to heat the Swirl Pool	**$ 24,075**	**$ 4,946**	**-24,000**	**445**	**4.8**	**23.2**
Solar Heating of DHW Sub-Total	$ 64,766	$ 2,230	-8760	160	29	8
eco-Energy possible solar contribution	($16,191)					
Provincial possible solar contribution	($16,191)					
Solar Pre-heating of DHW Total	**$ 32,384**	**$ 2,230**	**-8,760**	**160**	**14.5**	**8.0**
Electrical and lighting Measures	**$ 47,812**	**$10,499**	**125,836**	**0**	**4.6**	**2.8**
Energy Consulting	$ 0					
Total	**$623,503**	**114,105**	**-183,790**	**6,561**	**5.46**	**331.2**
Projected Future Usage			1,852,500	4,606		253.7

Note:

1) **The capital costs listed for this project include engineering, implementation and project management, but does not include for hazardous waste removal or seismic upgrades of equipment.**
2) **The capital costs further assume that all of the equipment such as valves and controls are fully operational.**
3) **All of the above Numbers include PST on materials only.**

1.4 Limited Liability

This Recommendations Proposal is prepared by Coral Engineering Limited for the Township of Esquimalt and for grant applications.

The material in it reflects our professional judgment in light of the information available to us at the time of preparation. The savings' calculations are estimates of savings' potential and are not guaranteed. The impact of building changes, building use changes, and staff control changes, new equipment additions, change in the operation procedures, additional computers and weather need to be considered when evaluating savings.

Without the express written permission, any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. Coral Engineering will accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Please direct any questions to me directly at 778- 829- 9711. We await your further instructions on this matter and assure you of our co-operation at all times.

1.5 Allocation of Funds

This project has the potential to reduce the **energy footprint** of the facility by **35%** but reduced the GHG by **56.5%.**

If all of these recommendations meet with your approval, then we recommend that **$ 623,503** be budgeted for the implementation of capital projects. The Township of Esquimalt may want to have a contingency fund for items and controls that are found to be defective during the energy retrofit.

We estimate that these projects will increase the electrical load by 183,790 kWh or **662 GJ_e**, while saving **6,561 GJ** of natural gas.
The net result of this is **5,899 GJ** of annual energy savings. These energy saving strategies earn the Township of Esquimalt **331.2 Tonnes** reduction in annual greenhouse gas **(GHG)** emissions and will concurrently reduce the energy consumption by **$114,105** each year. Note that these savings are based on 2009 natural gas and electrical energy costs.
The capital costs indicated in this report are firm for a period of two months after which time it may need to be adjusted based on the Labour and Metals index and the possible adjustment in the relationship of the Canadian dollar.

2. Customer Information

Esquimalt Recreation Centre	527 Fraser Street Esquimalt, B.C. V9A 6H6
Contact Information:	Marlene Lagoa Sustainability Coordinator Township of Esquimalt. 1229 Esquimalt Road Phone: 1 (250) 414 7114 Email: marlene.lagoa@esquimalt.ca

The Esquimalt Recreation Centre is, predominantly a single story building with a second floor mechanical and electrical room. This facility is occupied seven days a week. The facility contains a large 25 m indoor pool, a leisure pool, tots pool and a swirl pool, some office space, a number of meeting rooms, a gymnasium, a kitchen, washrooms, and locker rooms.

Aquatic Centre

BC Hydro account	**0000 0537 0517**
BC Hydro rate	**1210**
Terasen gas account	**1422828**
Facility type	**Aquatic Centre**
Facility age	**Opened 1974 with an upgrade in 2005**
Total floor area and number of floors	**4,828 m^2 / predominantly a single** storey building

3. Administrative Issues

3.1 Sustainability

One of the key functions of this report is to provide measures that can be implemented with the re-use of the existing equipment as much as possible. This will minimize the capital cost of the retrofit as well as make the facility more sustainable in its energy consumption both embodied as well as direct usage. As part of this process we have included the following features:

- The recommended design should have optimal emphasis on static reclaim; reclaim through the use of super efficient air to air heat exchangers using a minimum of energy to reclaim the heat.
- In those cases where mechanical refrigeration is used, we only recommend the use of environmentally friendly refrigerants R410a and systems that can be maintained by the average licensed refrigeration technician.
- All air coils will need to have an industrial corrosive resistant coating to maintain their integrity over time.
- All water to refrigerant coils that are exposed to brackish pool water will be made of titanium, again to maintain longevity with the use of salt water.
- The low temperature antifreeze that we use is food grade propylene glycol with food grade inhibitors.

3.2 Green House Gas Reductions

The Esquimalt Recreation Centre can reduce its impact on the environment and reduce greenhouse gas emissions by implementing measures outlined in this opportunity report.
The implementation of the measures in this proposal will reduce the green house gas produced by your facility by the following:

Current Facility GHG production 584.9 Tonnes
New estimated GHG emissions 253.7 Tonnes
This equals a total green house gas saving 331.2 Tonnes of CO_2 emissions.

3.3 Verification

A proponent cannot guarantee the savings on this project because of their lack of control of the weather variables, the fluctuating cost of the utilities, lack of control of the bather load, and the possible changes made by the operation's staff.

The DDC system can provide a very good means of estimating the savings on an ongoing basis. The following calculations can be made by the computer to track and verify the savings on an ongoing base.

3.4 Maintenance

The designs of the new systems' recommendations are very sophisticated and require sophisticated control strategies. However, the equipment used is very standard HVAC industry equipment that any qualified refrigeration mechanic can service and maintain.

3.5 Project Benefits

All three facilities can reduce its impact on the environment and reduce green house gas emissions by implementing the recommended measures in this proposal.
Some of the benefits of this implementation are listed below:

- GHG reductions: Natatorium 331.2 Tonnes.
- Provide a total energy savings of approximately: Natatorium 5,899 Gj/year.
- Reduce the cost of the energy consumption of the facilities: Natatorium by $114,105/year (based on 2009 energy costs).
- Assure that the natatorium is at a slight negative pressure, improving the longevity of the building envelope.
- Improved relative humidity control will improve the environmental conditions for the patrons and staff.

4. Background Description of Facility, Hardware and Systems

4.1 Mechanical Systems

Aquatic Centre

Heating and ventilation for the natatorium at the Esquimalt Recreation Centre is provided by one Dry O Tron air handler. This air handler has a return air fan, a return air filter section, a DX cooling coil section, a mixing box with exhaust, return, and outdoor air dampers, a DX condenser coil section, a filter section, and a supply air fan section which contains the refrigeration equipment and the coaxial condenser coils. Further to this there are a number of re-heat coils in the supply ductwork to the natatorium.

The Dry O Tron unit has been problematic, loosing several charges of its refrigerant R-22. R-22 is not an environmentally friendly refrigerant and its production is slated to be terminated. Because of the continued failure of this unit dehumidification reclaim system's integrity and the subsequent loss of refrigerant to the environment; the system has been commendably mothballed.

Presently, the natatorium is dehumidified by what we call an outdoor air dehumidification system. An outdoor air dehumidification system brings in outdoor air, warms it up to increase its affinity for water vapour and then introduces this warm dry air into the natatorium. In the natatorium, the air picks up the water vapour produced by the pool surfaces and takes this warm, moist energy laden air and rejects it to atmosphere. This is a tremendous waste of energy.

These outdoor air dehumidification systems are very common in all of Canada because of their lowest capital cost. These systems however have significantly higher operating cost. The sad part of this system, installed, is that it was very expensive to save a significant amount of energy. It has had a useful life span of less than four years.

We have evaluated the condition of the compression system as well as the coils, the condensers and the fans and feel although the dehumidification reclaim system should be removed, the rest of the air handler is in reasonable condition and can be retrofitted. This strategy will significantly reduce the capital cost of the energy retrofit and improve the reclaim capability of this unit far greater than when it was operational.

Three Weil Mclean boilers, each with an approximately input of 1.7 million BTU, provide the heating for the pools, the DHW heating, and the air handlers' reheat coils. Each of these boilers is equipped with a modulation burner section and is providing a thermal efficiency that will be close to 70%.

The rest of the facility is heated and ventilated by two Sheldon air handlers and two Engineered Air, roof mounted HVAC units.

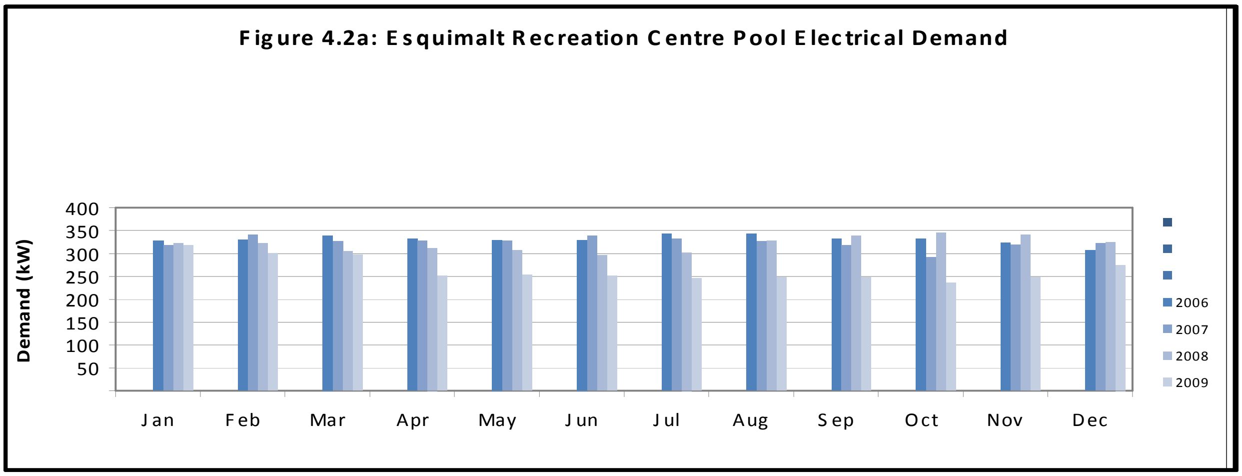
The domestic hot water for the complex is provided by a shell and tube heat exchanger, using the heat from the boiler water loop.

Esquimalt Recreation Centre Consumption and Demand Charts.

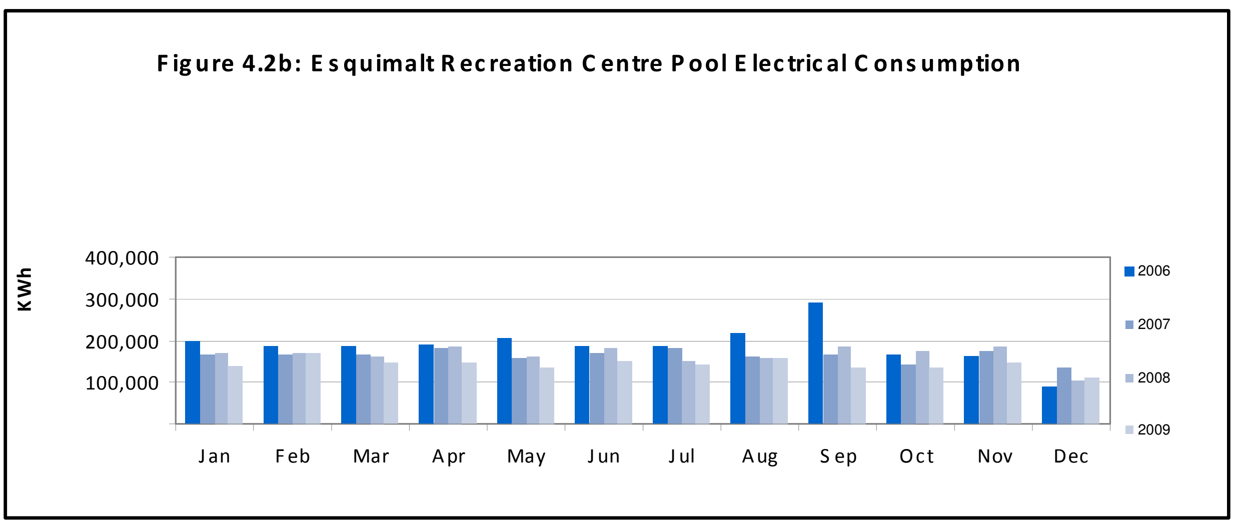
To understand the patterns of energy consumption, we have analyzed the natural gas and electrical consumption of the building.

The following energy analysis for the facility is based on the Terasen gas and BC Hydro utilities' records for this facility.

These graphs highlight trends in energy demand and consumption that help us identify areas for potential conservation.

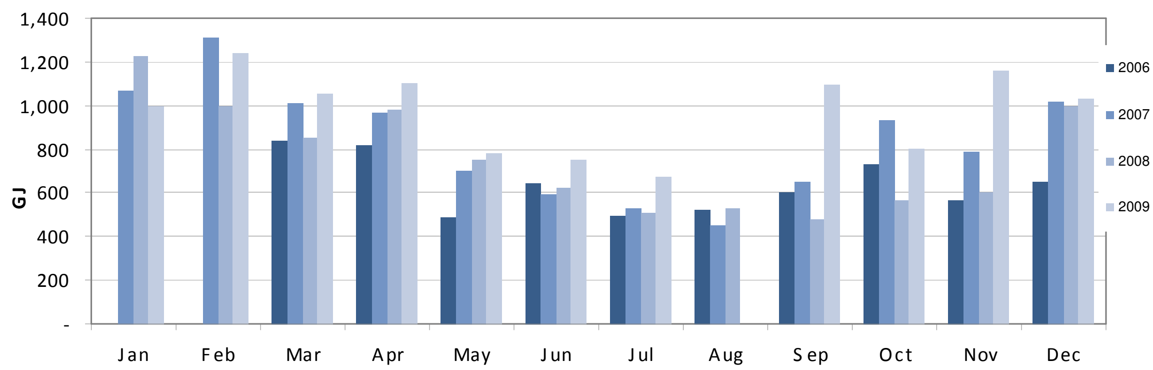


In Figure 4.2 a, we notice the facility's demand has had a relatively consistent load profile for the last several years with a peak load of approximately 345 kW. This reflects the relatively constant use of the facility, it appears that there is a slightly lower load during the summer which possible is relative to the reduction in use of the facility. It appears that the Dectron unit lost its charge in April of 2009



In Figure 4.2 b, we notice that the monthly electrical consumption is quite constant as well. Many of the pumps and fans are running long hours and the lighting has a small effect on this facility. It appears again that the Dry O Tron lost its charge in March or April.

Figure 4.2c: Esquimalt Recreation Centre Pool Monthly Gas Consumption Profile



In Figure 4.2 c, we can see a somewhat typical heating curve but also note that this graph to some extent confirms the failure of the dehumidification system in March or April.

Figure 4.2d: Esquimalt Recreation Centre Electricity Consumption

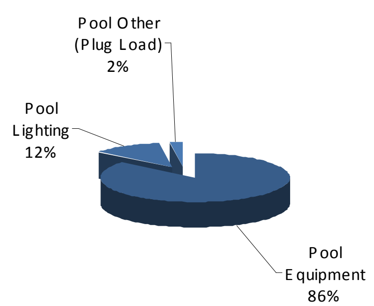
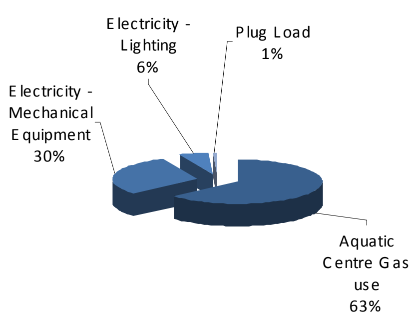


Figure 4.2 d We have calculated the breakdown of energy consumption by building systems in order to estimate the percentage of load each system represents.

Figure 4.2e: Esquimalt Recreation Centre Gas and Electricity



In Figure 4.2e, the overall energy consumption chart shows our estimate of the energy consumption breakdown associated with electrical usage and building heating. We see that the estimated natural gas usage accounts for 63% of the energy consumption for this facility, and will be the focus of this study.

5. Energy Conservation Opportunities

The primary purpose of this study was to identify energy conservation opportunities at the six key Esquimalt facilities. At the Esquimalt Recreation Centre we have identified and analyzed many potential opportunities to save energy and cost by modifying and upgrading mechanical systems at this facility. We will explain these ideas in detail in this section. For financial saving's estimates, we have used a base rate of **$14.89/GJ** for natural gas ,including an average cost of the BC Carbon Tax of $25 / Ton. For electricity, current BC Hydro electricity rates of $7.69 / kW for demand and $0.0370 / kWh for consumption have been used.

For greenhouse gas estimates, we have used emissions factors of 0.022 kg CO_2e / kWh of electricity in BC. For natural gas we have used the emissions factor of 51.0 kg CO_2e / GJ. Once again, we note for emphasis that we are assuming a baseline for a four year average natural gas consumption of roughly 10,722 GJ per year for all of these savings estimates.

The annual usage that we picked as a baseline for our report is the 2009 consumption of 10,722 Gj/year for the Recreation Complex.

5.1 Mechanical Upgrades

The following measures describe major upgrades recommended to most of the water heating and ventilation systems. The changes we propose will significantly improve the efficiency of the water and air heating, as well as providing better overall control of the ventilation and humidity in the facilities.

5.1.1 Pool Heat Reclaim

A large dehumidification device can be installed to extract heat from the warm moisture laden return air, upgrade this heat and use this heat to heat the pools from where the heat initially came. This process will provide the majority of the heating of the lap pool, leisure pool, and significantly reduce the load on the existing mid-efficiency boilers, which presently run a high percentage of the time. **Note: that the Dectron system when operating only extracted heat to heat the lap pool.**

When the dehumidifier, mentioned above, removes heat from the return air stream, a significant amount of the moisture in this moisture laden air stream is removed. This dehumidification that is taking place will significantly reduce the need for the outdoor air introduced into the AHU (air handling unit). Since this mechanical refrigeration used to extract heat from the return air removes so much moisture from the air, a lot less outdoor air will be needed to do the remaining amount of dehumidification.

This large reduction in the quantity of outdoor air will significantly reduce the amount of heat needed to heat this outdoor air and again take a huge heating load off the Dry O Tron air handlers' hot water re-heat coils and the respective boilers.

5.1.2 Solar Heating of DHW

We recommend the installation of a small solar DHW preheat system. This solar ,hot water preheat system will take water from a solar preheat tank and heat it via the solar panels. The cold water supplied to the DHW heating system will go through the solar preheat tank and pick up heat provided by the solar system. The tank is there to store the heat supplied by the panels during a time of low DHW use to supply the DHW system heat during the periods of low solar intensity at night when the demand for shower water is the greatest .

5.1.3 Pool Exhaust Air Reclaim

Although the quantity of outdoor air used for ventilation by the new mechanical dehumidification system is a fraction of what the present outdoor air dehumidification system uses, the design will still need to bring in ventilation air for dilution of chloramines and to supply O_2 to the patrons and staff.

The natatorium needs to have a slight negative pressure in order to prevent migration of moisture through the envelope of the building. In order to maintain this negative pressure and obtain ventilation air for the space, we recommend the installation of a very high efficiency exhaust reclaim system. This system will reclaim from 80% to as high as 92% of the heat that is exhausted. Interesting enough, this air to air is most efficient when the outdoor air is colder but above 15F.
The essential concept of this measure is to reclaim the heat from the very warm moisture laden air that is normally exhausted from the pool. The heat extracted from the exhaust air stream is transferred to the outdoor air ventilation air stream and the outdoor air that enters the building is preheated.

5.1.4 Dehumidification Reclaim for the DHW System

Some of the heat extracted from the return air stream discussed in measure 5.1.1 will be taken and upgraded to preheat the DHW. This measure will take a significant heating load off the existing boilers. This measure is used when there is insufficient solar to heat the DHW and during overcast periods and of course after the sun has gone down. This measure includes an additional storage tank to offset peak shower demand periods.

5.1.5 Demand Ventilation for AHU-2, 3, 4.

AHU-2,3,and 4 ,I was told run 24/7. The facility is closed from 6 1/2 to 10 hrs a day depending on the time of the week. There is a very good opportunity to shut down these air handlers and have their outdoor air dampers moved to closed position. If there is a demand to warm a particular area, the air handler can come on for a short period of time to meet the demand but keeping the outdoor air damper closed.
AHU-4 serves only one area, the gym, and the installations of a CO2 sensor, which can measure the magnitude of the occupancy of the space, could easily control the outdoor air damper to suit the needs of the space rather than have a minimum outdoor air position.

5.1.6 Pool Automated DDC System Expansion.

The existing control system is sophisticated but will need some additional strategies that a reclaim system needs. So as part of this energy retrofit, the expansion of the DDC control system is necessary to optimize savings for remote monitoring of energy consumption. The cost of this measure is spread amongst the measures above.

5.1.7 Pump Room air conditioning used to heat the Hot Tub.

We recommend the installation of a small air to water heat pump with a CuNi coaxial condenser. The heat extracted from the room will pick up all of the motor heat generated in the room and upgrade this heat to heat the Swirl Pool.

5.1.8 Mechanical Opportunity Summary

These measures are very complicated upgrades, and will require additional piping, ductwork, equipment, controls and electrical wiring that we estimate will cost $ 565,690. According to our analysis, this will result in savings of 6,561 GJ/year of natural gas, while adding 309,626 kWh (1118 GJ_e) for a net energy savings of 5,443 GJ. This translates into a net savings of $ 93,800 per year for a simple payback of 6.0 years. Estimated GHG savings from this item alone are 328 Tonnes per year.
Note: Although the measures proposed will reduce the ventilation rates of this facility, these rates will still remain well above ASHRAE's recommended levels for pool applications.

5.1	**Aquatic Centre Mechanical Measure Summary**			Savings			
Item	Description	Cost	Payback	$	GJ	kWh	GHG
5.1.1	Aquatic Centre Dehumidification Reclaim System	$ 299,553	9.0	$ 33,400	2,420	-175,141	120.0
5.1.2	Aquatic Centre Solar Heating of DHW	$ 32,383	14.5	$ 2,230	160	-8,760	8.0
5.1.3	Aquatic Centre Exhaust air Reclaim	$ 110,129	5.7	$ 19,200	1,360	-70,000	67.8
5.1.4	Dehumidification Reclaim DHW heating	$ 85,550	3.0	$ 28,700	1,920	-60,225	96.6
5.1.5	Demand Ventilation for AHU-2,3,4	$ 14,000	2.6	$ 5,330	256	28,500	13.7
5.1.6	Pump Room A/C used to heat Swirl Pool	$ 24,075	4.9	$ 4,940	445	-24,000	22.2
5.1	**Total Mechanical**	**$ 565,690**	**6.0**	**$ 93,800**	**6,561**	**(309,626)**	**328**

Note: Item 5.1.2 in the above chart has already deducted the possible contribution from eco Energy and BC solar.

6. Lighting Opportunity

Please find this under a separate cover.

7. Energy Consulting and Project Management

These estimated costs include the design costs, and project management time to help direct the implementation of the projects described.
We will further assist the Township of Esquimalt in obtaining grants for the solar component of the energy retrofit from eco-Energy and Solar BC.
It is important to note that the above estimated financial support needs to be applied for and we do not offer any guarantee that the township will qualify to receive this support from the Provincial and Federal agencies.

8. Appendix “A”

Appendix A-1 Projects

Mechanical Equipment Measures

5.1.1 **Aquatic Centre Dehumidification Reclaim System**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ		$	
Dehumidification Reclaim	2,987	567		175,141	$ 299,553	2,420	-175,141	$ 33,440	The pool return air will be dehumidified and the heat extracted is upgraded and used to heat the Leisure pool, the Lap pool the DHW system. Heat pumps have a COP of over 4.3 and extracts more than 240,000 BTU/hr from the return air.The old reclaim system used about 35000 kwh/ month. The new system has about the same electrical consumption but reclaims much more energy.
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Aquatic Centre Dehumidification Reclaim System		5.1.1	9.0	119.6	$ 299,553	2,420	(175,141)	$ 33,440	

5.1.2 **Aquatic Centre Solar Heating of DHW**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	The solar system will save about 160 Gj/year
Solar Heating	160			8,760	$ 64,766	160	-8,760	$ 2,234	
ecoEnergy					-$ 16,192				
Solar BC					-$ 16,192				
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Aquatic Centre Solar Heating of DHW		5.1.2	14.5	8.0	$ 32,383	160	(8,760)	$ 2,234	

5.1.3 **Aquatic Centre Exhaust air Reclaim**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	The air to air is of super high efficiency and reclaims from 80-93% of the heat exhausted.
Exhaust air reclaim	1,761	401		70,000	$ 110,129	1,360	-70,000	$ 19,169	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Aquatic Centre Exhaust air Reclaim		5.1.3	5.7	67.8	$ 110,129	1,360	(70,000)	$ 19,169	

5.1.4 **Dehumidification Reclaim DHW heating**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	This reclaim unit has a COP of over 5.3
DHW Heating	2,953	1,033		60,225	$ 85,550	1,920	-60,225	$ 28,652	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Dehumidification Reclaim DHW heating		5.1.4	3.0	96.6	$ 85,550	1,920	(60,225)	$ 28,652	

5.1.5 **Demand Ventilation for AHU-2,3,4**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	AHU-2 and 3 run 24/7 while the facility is only open on average for 16 hrs a day. There is an opportunity to disable AHU-2,3,and 4 for at least 6hrs a night and to install CO2 sensor to control the outdoor air damper of air handler AHU4 during the occupied hours to reduce the quantity of outdoor air introduced into the space.
Demand Ventilation for AHU2,3,4	256		113,953	85,465	$ 14,000	256	28,488	$ 5,325	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Demand Ventilation for AHU-2,3,4		5.1.5	2.6	13.7	$ 14,000	256	28,488	$ 5,325	

5.1.6 **Pump Room A/C used to heat Swirl Pool**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	
Pump Room A/C used to heat Swirl Pool	445			24,000	$ 24,075	445	-24,000	$ 4,945	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Pump Room A/C used to heat Swirl Pool		5.1.6	4.9	22.2	$ 24,075	445	(24,000)	$ 4,945	

Appendix A-2 Mechanical Inventories

ENERGY INVENTORY FORM - Mech Systems

BUILDING NAME: **Esquimalt Recreation Centre** **Inventory By:** J Groenewoud

System Name	Equipment Number	Location	Area Served	Monthly Profile	hp	Load kW	Load Factor	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Hrs	Annual kWh	% of Total	Schedule	hours / day
								Check Month Op. Hours Apply																
Air Handling Units																								
Dectron SF	AH-1	Roof	Natatorium	A	25.0	18.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	163,374	9.6	24/7	24
Dectron RF	AH-1	Roof	Natatorium	A	25.0	18.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	163,374	9.6	24/7	24
Sheldon	AH-2	Fan room	East Wing	A	5.0	3.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	32,675	1.9	24/7	24
Sheldon	AH-3	Fan room	West Wing	A	5.0	3.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	32,675	1.9	24/7	24
Eng-Air DJ40 (2876 cfm)	AH-4	Roof	Gymnasium	A	7.5	5.6	100%	527	476	527	510	527	510	527	527	510	527	510	527	6,205	34,717	2.0	24/7	17
Eng-Air DJ40 (2572 cfm)	RTU-4	Roof	Gymnasium	A	3.0	2.2	100%	527	476	527	510	527	510	527	527	510	527	510	527	6,205	13,887	0.8	24/7	17
Eng-Air DJ40 (3068 cfm)	AH-5	Roof	Fitness Area	A	7.5	5.6	100%	573.5	518	573.5	555	573.5	555	573.5	573.5	555	573.5	555	573.5	6,753	37,780	2.2	24/7	18.5
McQuay	AH-6	Ground	Pool Equipment room	A	10.0	7.5	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	65,350	3.9	24/7	24
Loren Cook Releif Air	REL2-1	Roof	AH-2 relief	A	0.5	0.4	100%	496	448	496	480	496	480	496	496	480	496	480	496	5,840	2,178	0.1	24/7	16
Loren Cook Releif Air	REL2-2	Roof	AH-2 relief	A	0.5	0.4	100%	565.75	511	565.75	547.5	565.75	547.5	565.75	565.75	547.5	565.75	547.5	565.75	6,661	2,485	0.1	24/7	18.25
Loren Cook Releif Air	REL2-3	Roof	AH-2 relief	A	0.5	0.4	100%	565.75	511	565.75	547.5	565.75	547.5	565.75	565.75	547.5	565.75	547.5	565.75	6,661	2,485	0.1	24/7	18.25
Loren Cook Releif Air	REL2-4	Roof	AH-2 relief	A	0.5	0.4	100%	581.25	525	581.25	562.5	581.25	562.5	581.25	581.25	562.5	581.25	562.5	581.25	6,844	2,553	0.2	24/7	18.75
Loren Cook Releif Air	REL3-1	Roof	AH-3 relief	A	0.5	0.4	100%	612.25	553	612.25	592.5	612.25	592.5	612.25	612.25	592.5	612.25	592.5	612.25	7,209	2,689	0.2	24/7	19.75
Loren Cook Releif Air	REL3-2	Roof	AH-3 relief	A	0.5	0.4	100%	643.25	581	643.25	622.5	643.25	622.5	643.25	643.25	622.5	643.25	622.5	643.25	7,574	2,825	0.2	24/7	20.75
Loren Cook Releif Air	REL3-3	Roof	AH-3 relief	A	0.5	0.4	100%	674.25	609	674.25	652.5	674.25	652.5	674.25	674.25	652.5	674.25	652.5	674.25	7,939	2,961	0.2	24/7	21.75
Loren Cook Releif Air	REL3-4	Roof	AH-3 relief	A	0.5	0.4	100%	705.25	637	705.25	682.5	705.25	682.5	705.25	705.25	682.5	705.25	682.5	705.25	8,304	3,097	0.2	24/7	22.75
Loren Cook Boiler Room SF	SF-1	Roof	Boiler Room	A	5.0	3.7	70%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	22,872	1.4	24/7	24
Loren Cook Baldor SF	SF-2	Roof	Elevator Room	A	1.5	1.1	100%	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0.0		0
EF	EF-1	Roof	Family change room	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24/7	24
EF	EF-2	Roof	Gym storage	A	0.1	0.1	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	817	0.0	24/7	24
EF	EF-3	Roof	Daycare washroom	A	0.1	0.1	100%	124	112	124	120	124	120	124	124	120	124	120	124	1,460	136	0.0	24/7	4
EF	EF-4	Roof	Public washroom	A	0.3	0.2	100%	31	28	31	30	31	30	31	31	30	31	30	31	365	91	0.0		1
EF	EF-5	Roof	Elevator room	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24/7	24
Propeller fan	TF-011	Ceiling	Room 11	A	0.8	0.6	100%	310	280	310	300	310	300	310	310	300	310	300	310	3,650	2,042	0.1	24/7	10
Gas Heating																								
Hot water heaters	FF-100a	Entrances	Entrance	H		0.5	50%	186	151.2	111.6	90	74.4	36	18.6	18.6	36	74.4	126	148.8	1,072	268	0.0	Demand	6
Hot water heaters	FF-100b	Entrances	Entrance	H		0.5	50%	186	151.2	111.6	90	74.4	36	18.6	18.6	36	74.4	126	148.8	1,072	268	0.0	Demand	6
Hot water heaters	FF-100g	Entrances	Entrance	H		0.5	50%	186	151.2	111.6	90	74.4	36	18.6	18.6	36	74.4	126	148.8	1,072	268	0.0	Demand	6
Weil McLain Boiler	B-1	Boiler rm	All heating loads	H		1.0	0%	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0.0	Demand	0
Weil McLain Boiler	B-2	Boiler rm	All heating loads	H		1.0	45%	1302	1058.4	781.2	630	520.8	252	130.2	130.2	252	520.8	882	1041.6	7,501	3,376	0.2	Demand	42
Weil McLain Boiler	B-3	Boiler rm	All heating loads	H		1.0	27%	744	604.8	446.4	360	297.6	144	74.4	74.4	144	297.6	504	595.2	4,286	1,157	0.1	Demand	24
Pumps																								
Boiler circulator	P-M1	Boiler rm	boiler water circulator	A	2.0	1.5	80%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	10,456	0.6	24 \ 7	24
Boiler circulator	P-M2	Boiler rm	boiler water circulator	A	2.0	1.5	80%	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0.0	Demand	0
Lap pool HX	P-M3	Boiler rm	lap pool heat	A	25.0	18.7	80%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	130,699	7.7	24 \ 7	24
DHW HX	P-M4	Boiler rm	dhw heat exchanger	A	2.0	1.5	50%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	6,535	0.4	24 \ 7	24
Pool reheat coils	P-M5	Boiler rm	pool air handler heating coils	A	3.0	2.2	50%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	4,901	0.3	24/7	12
Building circulator	P-M6	Boiler rm	building heat	A	0.8	0.6	60%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	2,941	0.2	Demand	24
DHW tank circulator	P-M7	Boiler rm	dhw tank circulator	A	0.1	0.1	50%	310	280	310	300	310	300	310	310	300	310	300	310	3,650	136	0.0	Demand	10
DHW recirc pump	P-M8	Boiler rm	dhw circulator	A	0.1	0.1	50%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	408	0.0	Demand	24
Control vacuum	PP-1	Pump room	vacuum system	A	0.5	0.4	10%	62	56	62	60	62	60	62	62	60	62	60	62	730	27	0.0	Demand	2
Whirlpool PWS	PP-2	Pump room	DHW & Pool Heating	A	15.0	11.2	50%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	49,012	2.9	24 \ 7	24
Whirlpool jets	PP-3	Pump room	whirlpool jets	A	15.0	11.2	50%	496	448	496	480	496	480	496	496	480	496	480	496	5,840	32,675	1.9	25 \ 7	16
Lifestyle features	PP-4	Pump room		A	10.0	7.5	60%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	13,070	0.8	24 \ 7	8
Tot's pool	PP-5	Pump room		A	10.0	7.5	80%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	26,140	1.5	24 \ 7	12
Tot's pool water feature	PP-9	Pump room		A	5.0	3.7	30%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	3,267	0.2	24 \ 7	8
Lazy river	PP-11	Pump room	Lazy river	A	25.0	18.7	60%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	49,012	2.9	25 \ 7	12
Vortex	PP11a	Pump room	Vortex	A	25.0	18.7	30%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	24,506	1.4	26 \ 7	12
Sheet flow	PP-12	Pump room	Sheet flow	A	5.0	3.7	30%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	3,267	0.2	27 \ 7	8
Popcorn	PP-14a	Pump room	Popcorn	A	1.5	1.1	30%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	980	0.1	28 \ 7	8
Lifestyle pool	PP-15	Pump room	Lifestyle pool	A	25.0	18.7	80%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	130,699	7.7	29 \ 7	24
25 Meter pool	PP-22	Pump room	Lap pool	A	25.0	18.7	80%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	130,699	7.7	30 \ 7	24
Whirlpoo WFS	PP-31	Pump room	Whirlpool	A	1.0	0.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	6,535	0.4	31 \ 7	24
Heat recovery	PP-21	Pump room	Heat reclaim system	A	0.8	0.6	0%	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0.0	32 \ 7	0
Chlorine pumps	typ of 4	Pump room	all the pools	A	frac	0.0	50%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	73	0.0	33 \ 7	12
Hydro air pump	PP-14b	Pump room		A	15.0	11.2	60%	310	280	310	300	310	300	310	310	300	310	300	310	3,650	24,506	1.4	34 \ 7	10
Miscellaneous																								
Dectron dehumidification	DU-1		AH-1 reclaim system	A	75.0	56.0	100%	93	84	93	90	93	90	93	93	90	93	90	93	1,095	61,265	3.6	Demand	3
Dectron dehumidification	DU-2		AH-1 reclaim system	A	75.0	56.0	100%	93	84	93	90	93	90	93	93	90	93	90	93	1,095	61,320	3.6	24 \ 7	3
Unit heater	UH-1	pump room		A	0.5	2.6	0%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	0	0.0	24 \ 7	24
Condensing Unit	CU-2	Roof	AH-1 reclaim system	A	5.0	3.7	100%	93	84	93	90	93	90	93	93	90	93	90	93	1,095	4,084	0.2	Demand	3
AHU-4	CU-3	Roof	Gym cooling	C2	22.0	16.4	80%	0	0	0	0	74.4	144	223.2	223.2	144	74.4	0	0	883	11,596	0.7	Demand	12
AHU-5	CU-4	Roof	Cardio Area	C2	22.0	16.4	80%	0	0	0	0	74.4	144	223.2	223.2	144	74.4	0	0	883	11,596	0.7	Demand	12
Lighting																								
			Totals			390.3														315,613	1,403,342	81		
																	actual				1,693,700			

Totals by System Type

	hp	kW	Hrs	kWh	
Ventilation	101	75	160,509	597,597	35
Heating	-	5	15,002	5,337	0
Pumps	214	159	126,290	650,547	38
AC Units	49	37	1,978	15,680	-
Dehumidifier	150	112	2,190	122,585	7
Sub Total	514	388	305,969	1,391,746	81
Plug Loads		10	4,800	48,000	
Lighting		48.4		258,573	
Total		436		1,698,319	
			actual	1,693,700	

Appendix A-3 Utility Information

Premise:	527 FRASER STREET	ESQUIMALT	BC V9A 3P1	
Service:	1 - Gas			
Start Date:	03/06/06			
End Date:	10/09/09			

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
06-Mar	837.4	9881.45	229.73	6.48
06-May	821.8	9697.35	229.73	9.21
06-May	485.9	5733.69	229.73	12.83
06-Jun	645.4	7615.82	229.73	16
06-Jul	494.2	5780.47	227.71	18.17
06-Aug	523.5	6123.19	227.71	16.66
06-Sep	604.9	7075.29	227.71	14.52
06-Oct	734.5	8591.18	227.71	10.13
06-Nov	567.9	6642.51	136.62	8.06
06-Dec	653.4	7642.57	227.71	3.59
Total 2006	**6368.9**	**74783.52**	**2194.09**	**11.565**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
07-Jan	1071.6	12862.86	227.71	3.48
07-Feb	1310.6	16123.41	227.71	5
07-Mar	1012.4	12454.86	227.71	6.17
07-Apr	970.6	11940.62	227.71	7.97
07-May	701.8	8633.77	227.71	10.54
07-Jun	593.5	7301.42	227.71	13.67
07-Jul	529.9	6518.99	227.71	16.97
07-Aug	450.5	5542.19	227.71	16.83
07-Sep	654.7	8069.47	228.51	15.62
07-Oct	936.4	11560.67	228.51	10.57
07-Nov	792.7	9786.56	228.51	8.3
07-Dec	1016	12543.39	228.51	3.29
Total 2007	**10040.7**	**123338.21**	**2735.72**	**9.8675**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
08-Feb	2225.3	28204.04	452.99	3.69
08-Mar	855	10994.07	226.5	5.62
08-Apr	981	12614.25	226.5	5.85
08-May	751.2	9659.36	226.5	8.48
08-Jun	623.1	8012.16	226.5	13.41
08-Jul	511.4	6718.06	226.5	16.57
08-Aug	532.9	7130.2	226.5	16.77
08-Sep	484.3	6479.93	226.5	15.91
Total 2008	**6964.2**	**89812.07**	**2038.49**	**10.7875**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
09-Jan	3168.2	42729.92	905.98	6.95
09-Feb	1242.6	17429.08	226.51	3.03
09-Mar	1056.7	14821.59	226.51	4.11
09-Apr	1107.4	15532.71	226.51	6.84
09-May	780.1	10941.9	226.51	9.86
09-Jun	754.4	10581.45	226.51	15.28
09-Jul	678.3	9602.51	226.51	16
09-Sep	1101.1	15731.43	453.01	17.31
09-Oct	805.7	11511.04	226.51	12.1
09-Nov	1164.3	16634.36	226.51	8
09-Dec	1031.1	14731.34	226.51	3.79
Total 2009	**12889.9**	**180247.33**	**3397.58**	**103.27**

Appendix C-1

Acknowledgements

Coral Engineering Limited would like to acknowledge the valuable assistance of the following personnel in providing the necessary information for this report. Thanks John Johnston, and Larry Braes for their assistance at the various job sites.