Making a difference...together

Water Use Audit

University of Victoria

3800 Finnerty Road, Victoria, BC

October 3, 2011

Prepared by: Kevin Reilly, C. Tech
Demand Management Coordinator – ICI
Environmental Partnerships

Capital Regional District
625 Fisgard Street, Victoria, BC, V8W 2S6
www.crd.bc.ca

IMPORTANT NOTICE – DISCLAIMER – PLEASE READ CAREFULLY

PLEASE BE SURE TO READ THE MEMORANDUM OF UNDERSTANDING AND ESPECIALLY THE DISCLAIMER IN SECTION 9

The Capital Regional District ("CRD") does not warrant or represent that the information contained in the final audit report (the "Information") is free from errors or omissions. The Information is made available to the Client on the condition that the CRD will not be liable to the Client for any loss, damage, cost or expense whatsoever incurred by the Client or any other person or entity using or relying on the Information, whether it is caused by or results from any error, negligent act, omission or misrepresentation by the CRD, its officers, employees, agents, contractors or consultants. The use of the Information by the Client or any other person or entity, will be entirely at their sole risk.

1 Introduction

The University of Victoria (UVIC) is one of Canada's leading universities and is located within the District of Saanich. The UVIC main campus encompasses 133 buildings, and is provided water service via 14 connections to the Greater Victoria Drinking Water System. Water distribution throughout the UVIC campus is accomplished through a distribution network that is operated and maintained by UVIC operations staff. Water use within each building as well as building type varies widely; the major water consuming activities include food services, irrigation, laboratory operation, and residential uses.

In accordance with UVIC's strategic plan[1] and UVIC's desire to reduce energy and water consumption at the campus, UVIC engaged the Capital Regional District (CRD) to complete a water use audit in each of the buildings located within the main UVIC campus. The purpose of the water audit is to determine water use efficiency within each building and the surrounding grounds as well as provide recommendations to improve UVIC water use efficiency. The audit was completed in three phases:

Phase 1	Historical review of water consumption Fixture inventory Mechanical upgrade recommendations for priority buildings
Phase 2	Full scale audit of the Outdoor Research Facility
Phase 3	Review of irrigation practices and recommendations for campus grounds

Phase 1 of the project was completed over a 10 week period during the winter of 2010/2011 while Phase 2 & Phase 3 of the project commenced in April, 2011. Phase 2 onsite investigations continued into October 2011. This report summarizes the audit procedure, discusses the findings and provides recommendations to improve UVIC water use.

1.1.1 UVIC Operating Hours and Full Time Equivalent Employees

UVIC employs 5,028 staff to provide post-secondary education services to residents of Victoria. The university operates year round and operations are typical of most universities. The majority of students attend the campus between September and April and in 2011, approximately 19,300 students attended UVIC.

2 Audit Procedure

The Water Use Audit is the process of investigating the water use quantities and practices of a specific facility or operation and to identify a list of measures or actions that once implemented, will use water as efficiently as possible. The Water Audit is an important tool that assists facility managers in making decisions that impact current and future water use such as equipment repair or replacement as well as employee training.

[1] A Vision for the Future – Building on Strength (2007)

The general process followed by the CRD in conducting a water audit is:

- Review of historic water use (retail data)
- Consultation with facility manager and relevant staff
- Thorough review of water using equipment and fixtures, and recording of specifications
- Review of mechanical plans, specifications and manuals if available
- Data logging of revenue meter to determine actual water use patterns, including irrigation if possible
- Construction of a theoretical water balance and daily or weekly use pattern
- Calibration of water balance based on actual meter data
- Further measurement of individual water flows as required
- Final analysis and report preparation, including recommendations
- Follow-up consultation with facility manager

Specific to UVIC, the water audit was developed as a three phase project that included a fixture inventory for all buildings connected to the water distribution system. This first phase of the audit was conducted to meet the objectives outlined within Option 1. (see appendix A). The work included a fixture inventory of all water consuming fixtures within the UVIC main campus buildings and recorded all fixture types. Furthermore, all fixture flow rates were measured and documented for each identified fixture.

The second phase of the project consisted of a full scale audit of the aquatic outdoor facility (OAF). This work was similar to that of phase 1 but was augmented with staff interviews, sand filter operation optimization as well as investigations into water re-use applications (see Appendix A – Option 2). Phase 2 works also included water balance worksheet development to identify OAF end uses and their respective percentages relative to total amount of water consumed within the OAF.

Finally, the third phase of the project investigated outdoor water use was completed. Phase 3 work included discussions with facility maintenance staff as well as report preparation.

3 Project Location & Water Servicing

A map indicating the University of Victoria's location follows this page.

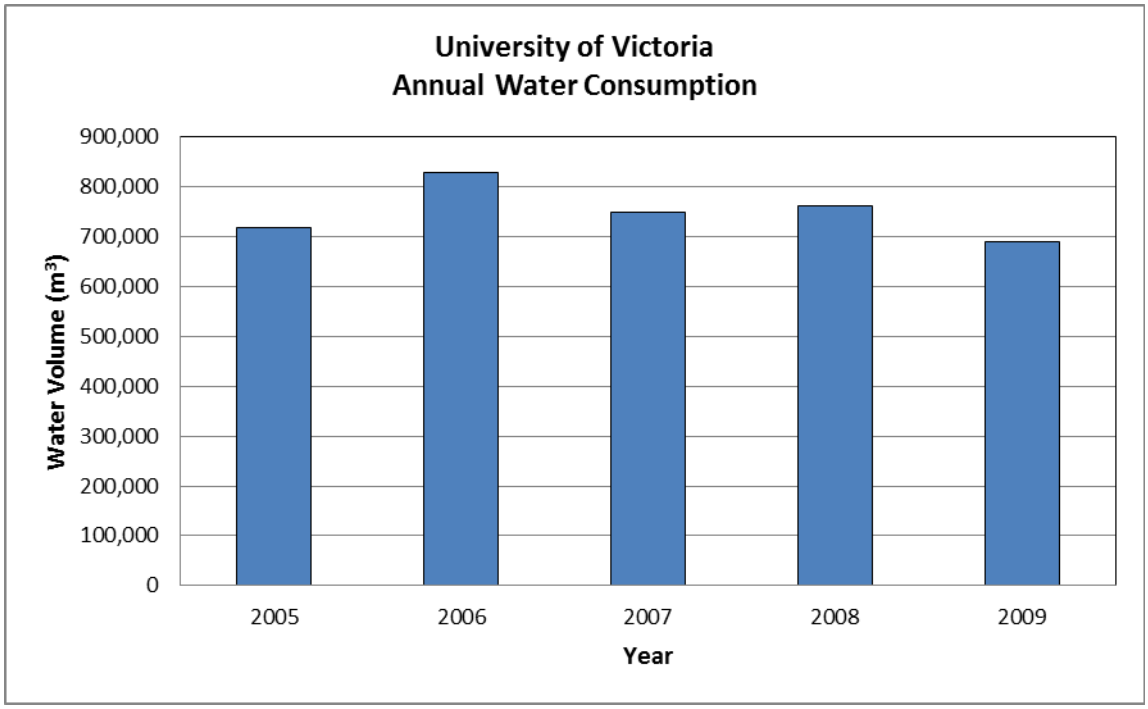
UVIC receives water service from the District of Saanich (DNS) via 14 water services of various sizes. Based on the data provided by DNS, water service to UVIC is primarily provided through two water meters (Gordon Head-Midgard and Sinclair-Clarndon Residences). Please note the largest water consumer within the campus, OAF is located within the vicinity of the Gordon Head-Midgard meter. Residential buildings and dormitories are located near the Sinclair-Clarndon meter.


McKenzie Ave
Gabriola Rd
Finnerty Rd
McGill Rd
Ring Rd
Sinclair Rd
Gordon Head Rd
West Campus Way
Ring Rd
West Campus Gate
University Dr
Cedar Hill Cross Rd
1:7,000
Metres
0 50 100 200 300
N
W E
S
UTM Zone 10N NAD 1983
Important: This map is for general information purposes only. The Capital Regional District (CRD) makes no representations or warranties regarding the accuracy or completeness of this map or the suitability of the map for any purpose. This map is not for navigation.
The CRD will not be liable for any damage, loss or injury resulting from the use of the map or information on the map and the map may be changed by the CRD at any time.
Figure 1
November 2011
UVIC
Water Audit
Making a difference...together

4 Historic Water Use

Meters are identified by their location in the following table. For each service meter, annual water consumption for 2005 - 2009 as well as the average percentage contribution to the total consumption is noted below and presented graphically in the figure below:

Meter Location	Annual Water Consumption (m^3)					Contribution to Total (%)
	2005	2006	2007	2008	2009	
2424 Sinclair	250	232	191	205	91	0.0%
Finnerty - Lot 2	2,364	2,819	2,523	2,228	2,114	0.3%
Concession Washrooms	24,030	20,480	16,988	18,198	24,162	2.8%
3964 Gordon Head	17,093	20,616	20,139	19,775	19,730	2.6%
2260 MCCoy	7,769	8,751	6,987	6,237	7,405	1.0%
Finnerty Saunders Building	1,932	1,773	1,546	1,637	1,546	0.2%
2625 Sinclair	77	68	59	123	73	0.0%
Finnerty - Playfield by S Hut	56,761	56,070	63,258	64,349	59,189	8.0%
Sinclair Clarndon - Residences	118,801	125,047	122,356	131,698	122,674	16.6%
Gordon Head at Midgard	464,397	569,341	500,787	507,561	441,485	66.2%
3889 Finnerty Road - Childcare	2,228	1,996	1,923	2,228	2,132	0.3%
Mackenzie - Stadium East	20,775	19,571	12,411	8,001	8,387	1.8%
3891 Finnerty -FSH Low	341	727	659	250	205	0.1%
Sinclair Road at Haro Road	-	23	-	-	-	0.0%
Total Consumption (m^3)	**716,818**	**827,513**	**749,826**	**762,487**	**689,192**	



Notes & Observations:

- Over the past 5 years, UVIC has consumed approximately 750,000 m^3 annually on a consistent basis. The maximum amount of water was consumed in 2006 (827,513 m^3) while the minimum amount of water consumed was in 2009 (689,192 m^3).

- Historical water consumption data provides only a total consumption figure for the campus. Individual campus buildings are not sub-metered and therefore, historical water consumption for each building cannot be determined nor monitored.

- UVIC is primarily serviced through two DNS meters (Gordon Head - Midgard and Sinclair-Clarndon). These meters provide 82% of all water entering the UVIC property.

5 Fixture Inventory and Water Use Analysis

In general terms, fixture inventory and water use analysis are critical steps undertaken to develop a water balance worksheet. Fixture inventories of the work place accurately determine the location and water consumption flow rates of each fixture or device while staff interviews assist the auditor in determining the quantity of water consumed.

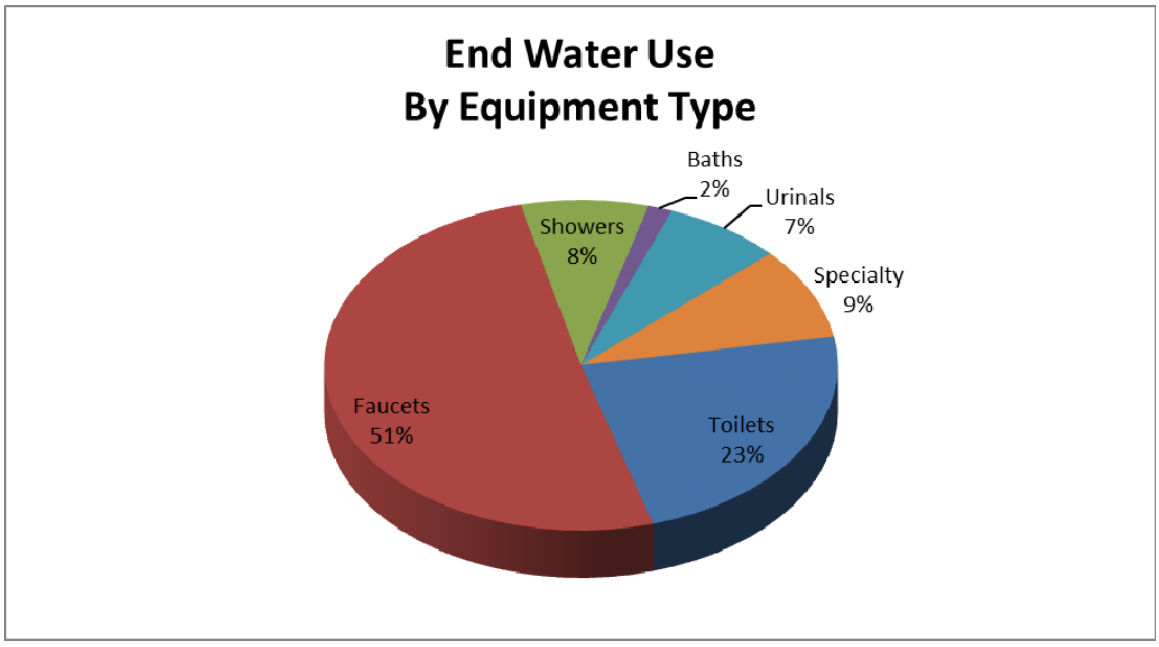
Results from these investigations and interviews are compiled into a water balance worksheet. The water balance provides an "accounting" of water consumption within the property; reviewing the theoretical water use with actual water use derived from historical billing information. Generally, theoretical water use should be within 10% of actual water use. Significant differences between theoretical and actual water use may indicate leaks or other unaccounted for water use within the distribution system. Lastly, the information determined within the water balance worksheet is used to calculate simple payback periods for the recommended water conservation recommendations.

Specific to the Phase 1 fixture inventory, the major water consumers are discussed further in regards to the fixture employed as well major water consuming operations (e.g. kitchen operations). Phase 2 water use investigations are presented in section 5.2

5.1 Phase 1 Fixture Inventory

Over the course of 10 days, CRD auditors conducted a fixture inventory of the UVIC main campus. The auditors identified and documented all fixtures within each building, noting the type of fixture, volume of water or flow rate used by the fixture and in some cases, the manufacturer and model number for identification purposes. The fixture inventory is found in Appendix D and a summary of findings for each main type of water fixture is discussed below.

Fixture Inventory							
Location	Toilets (Includes urinals)		Faucets		Showers		Once Through Cooling
	≤ 6 lpf	>6 lpf	≤3.8 lpm	> 3.8 lpm	≤5.8 lpm	>5.8 lpm	
University Services (includes ASB,COM,CSR, CRA,EOW,GSC, HEA, CHA, HLP, MCL, SUB, SEC,SAA, UVC, UCL, UH2, UH3, UH4, Facilities Huts A-Y & Saunders)	312	78	56	365	1	19	15
Residential	145	207	43	460	73	210	n/a
Academic Buildings	804	163	179	1226	9	137	n/a
TOTAL	**1261**	**448**	**278**	**2051**	**83**	**366**	**15**



5.1.1 Toilets

In total, 1709 toilets were identified during the fixture inventory. 1261 toilets were considered water efficient models (6 litres per flush (lpf) or less) while another 448 were considered water inefficient (> 6lpf). Facilities maintenance staff has been proactive in replacing or retrofitting the inefficient toilets to efficient models. The list of retrofitted buildings is found in appendix E.

Replacement of existing 13.25 & 20.0 lpf toilets with 6 lpf toilets will reduce water use from toilet flushing by 29%. Water efficient models range from 3.0 – 6.0 lpf and toilet replacement programs should ensure that any new toilets meet Maximum Performance Testing requirements[2] for optimal performance.

5.1.2 Faucet Aerators

Faucet aerator type as well as flow rate varied widely throughout the campus. In total, 2891 were identified: 585 water efficient aerators (5.8 lpm or less and 2306 (greater than 5.8 lpm) were found. Specific to laboratories, the specialized nozzle type allowing tubing connections consume 11.4 lpm.

Should aerators be replaced with water efficient models (1.9 lpm), an aerator replacement program can potentially save approximately 77% of water that is currently consumed through faucet use.

5.1.3 Showers

Showerheads are typically considered water efficient at flow rates of 9.5 lpm or less. However, technological improvements to showerheads have made 5.8 lpm models operate as well as 9.5

[2] http://www.cuwcc.org/WorkArea/showcontent.aspx?id=15786 (Veritec Consulting, Inc. and Koeller Co.)

lpm models and therefore should be considered for a showerhead replacement program. In total, 281 showerheads at UVIC consumed water at a rate greater than 5.8 lpm and 83 showerheads were water efficient.

For UVIC, showerhead replacements to water efficient models can potentially reduce water consumption through showerheads by 32%. Since showers consume large volumes of hot water, energy savings can be realized when shower heads are replaced with water efficient models.

5.1.4 Once Through Cooling

Once through cooling equipment is defined as any type of equipment that consumes potable water for cooling purposes. These types of units are common in walk-in freezers, walk-in coolers, ice machines. As well, the equipment is commonly used in computer server rooms when adequate ventilation for cooling purposes is not available.

UVIC currently employs 13 OTC units throughout the campus. The OTC equipment locations, cooling capacity and estimated water savings for each unit is noted below:

University of Victoria Once Through Cooling Equipment							
Famis EQ	**Building**	**Room**	**OTC Description**	**Manufacturer**	**Model**	**Cooling Capacity (BTU/hr)**	**Potential Water Savings (m^3)**
COMMONS							
EQU006894	COM	134	ICE MAKER	ICE-O-MATIC	C-40H-W-P-8	2,960	666
UNIVERSITY CLUB							
EQU006734	UCL	110	ICE MAKER (UCL)	HOSHIZAKI	KM500-MWE	6,663	1,499
EQU006749	GSC	116	ICE MAKER (GSC)	ICE-O-MATIC	ICEU220HAI	4,288	965
2nd Ice Machine						n/a	
STUDENT UNION BUILDING							
EQU006797	SUB	A101G	ICE MAKER (SUB)	MANITOWAC	QD0453W	8,000	1,800
EQU006798	SUB	A137	WALK IN COOLER (SUB)	COLDSTREAM	WIDC	9,265	2,085
EQU006799	SUB	A155	WALK IN FREEZER (SUB)	COLDSTREAM	WIDF	30,900	6,953
EQU006800	SUB	A153	WALK IN COOLER (SUB)	COLDSTREAM	WIDC	9,265	2,085
EQU006802	SUB	A145	WALK IN FREEZER (SUB)	COLDSTREAM	WIDF	31,600	7,110
EQU006803	SUB	A143	WALK IN COOLER (SUB)	COLDSTREAM	WIDC	21,800	4,905
EQU006822	SUB	A125	COOLER/BROILER (SUB	QUEST	OB32	8,000	1,800
CSR - FINNERTY EXPRESS							
EQU006851	CSR	42	ICE MAKER	MANITOWAC		3,400	765
UNIVERSITY CENTRE							
Ice Machine						2,990	673
STADIUM EAST							
			TELUS SERVER ROOM			n/a	
TOTALS					**POTENTIAL WATER SAVINGS (m^3)**		**31,305**
					POTENTIAL COST SAVINGS ($)		**69,185**

Notes & Observations:

- Potential water savings from Once through Cooling replacement work is estimated at 31,305m^3 per year, with potential annual cost savings of approximately $70,000 per year.

- Typically, simple payback periods for replacement of this type of equipment are less than 2 years. Further, the CRD provides a financial incentive (rebate) to assist business owners in removing OTC equipment.

5.1.5 Priority Fixture Upgrades by Building

Based on the fixture inventories conducted within each building, fixture replacement programs can be prioritized by buildings with a high percentage of inefficient water consuming fixtures. Toilet volumes greater than 6 lpf, faucet aerators consuming water at a rate greater than 3.8 lpm and showerheads greater than 5.8 lpm were identified. The results are noted below:

Fixture Inventory - Priority Replacements
Residential Buildings

Priority	Building	Urinals	Toilets over 6 lpf	Potential Savings ltrs per day	Faucets over 3.8 lpm	Potential Savings ltrs per day	Showers over 5.8 lpm	Potential Savings ltrs per day	Total Potential Savings per day
1	Haig-Brown Hall	12	18	4,100	26	1,193	10	1,961	7,254
2	Poole House	0	24	4,100	28	940	16	1,646	6,686
3	Wilson Hall	12	18	4,100	19	818	8	1,709	6,627
4	Emily Carr	0	13	3,362	24	1,526	8	1,458	6,346
5	David Thompson	1	16	3,485	26	897	14	1,098	5,480

Fixture Inventory - Priority Replacements
University Services Recommendations

Priority	Building	Urinals	Toilets over 6 lpf	Faucets over 3.8 lpm	Showers over 5.8 lpm	Once Through Cooling
1	Student Union Building - SUB	15	n/a	56	n/a	7
2	University Centre - UVC	20	8	55	2	1
3	Cadboro Commons - COM	6	13	49	1	1
4	University Club - UCL	3	9	18	n/a	3
5	Lou-Poy Child Care Centre - HLP	n/a	17	22	1	n/a

Fixture Inventory - Priority Replacements
Academic Building Recommendations

Priority	Building	Urinals	Toilets over 6 lpf	Faucets over 3.8 lpm	Showers over 5.8 lpm	Once Through Cooling
1	McKinnon - MCK	13	25	39	71	n/a
2	Ian Stewart Complex - ISC	14	18	59	31	n/a
3	Stadium - STA	23	48	30	13	1
4	Business and Economics - BEC	9	22	16	n/a	n/a
5	Strong - DSB	4	16	10	n/a	n/a

Notes and Observations:

- Residential buildings equipped with high proportion of inefficient fixtures include the Haig-Brown Hall, Poole House, Wilson Hall, Emily Carr and David Thompson Buildings. Based on typical residential toilet, faucet and showerhead use frequencies, water reduction estimates can be calculated. On average, each building can save approximately 6500 litres per day if water efficient fixtures were installed.

- Within University Services buildings, the highest priority for fixture replacements is the Student Union Building due to the number of students utilizing this building. Fixture replacements within the University Centre and Cadboro Commons buildings will also provide significant water savings.

- McKinnon and the Ian Stewart Complex will provide significant water savings due to the high proportion of 13.25 lpf toilets.

5.2 Phase 2 – Outdoor Aquatic Facility Water Use Analysis

Phase 2 of the UVIC water audit reviewed specific water uses within the Outdoor Aquatic Facility (OAF). The OAF consists of laboratories, aquatic animal holding facilities as well as a water treatment building. The OAF is the largest water consumer within UVIC, with approximately 18% of all water consumed within the main campus.

OAF uses three different water systems to complete its' day to day operations. These systems are:

Freshwater Flow Through System (FWFT): This system provides water to the pathology labs and supplies "make-up" water to the Freshwater Recirculation System. The FWFT filters potable water through 3 sand filters and 2 activated carbon filters. Chlorine is removed from the city water using sodium thiosulphate and the water temperature can be controlled for use within the pathology labs. Water that is used within the pathology labs is not used within the recirculation system.

Freshwater Recirculation System (FWR): Like the FWFT, the FWR uses granular media filtration to remove particulate from the water. The FWR also uses a bio-reactor fluidized sand bed to remove biological waste prior to disinfection with ozone and UV. Water within the FWR is also temperature controlled.

OAF Seawater Recirculation System (OAF-SWR): Seawater brought to site by truck is stored within the seawater reservoir. The seawater is pumped from the reservoir, treated with sand filtration and disinfected with UV prior to use within the facility.

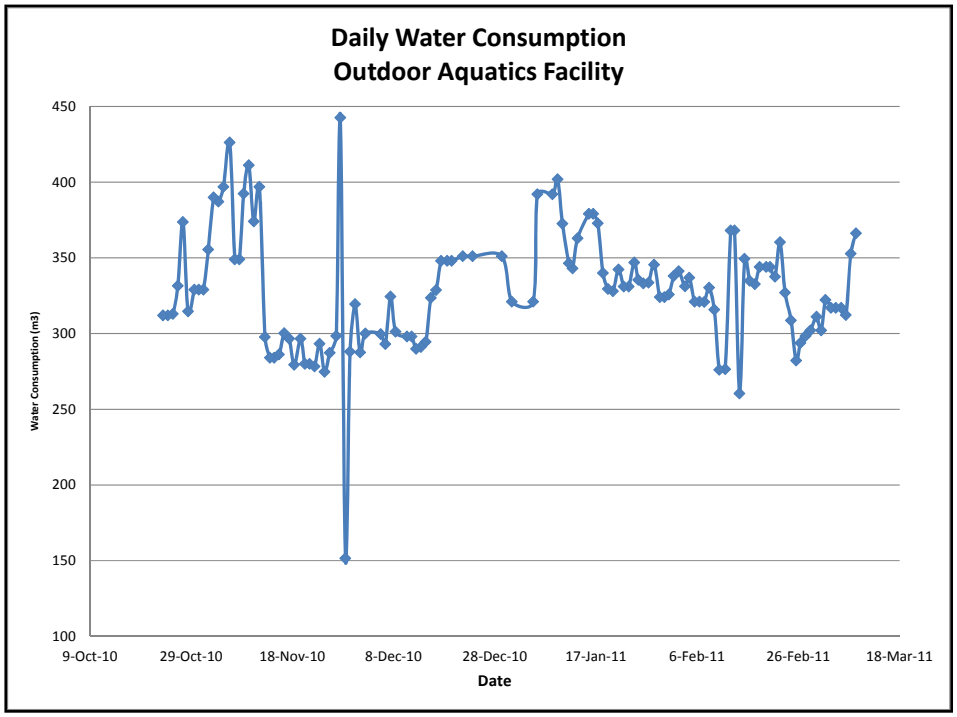
5.2.1 Phase 2 Description

This project phase included development of a fixture inventory of the facility and staff interviews to determine water use patterns and daily water use estimates. Typically, the staff was requested to describe the normal water uses, identify any special uses and provide the number of employees that would use the device. Water use analyses including sand filter

operation and optimization, OAF Pathology Lab operations and water re-use opportunities. Results from the staff interviews and specific water use analyses were used to develop the Water Balance worksheet, which is noted within section 5.3.

5.2.2 OAF Daily Water Consumption

On average, OAF consumes 330 m^3 of water per day, with the majority of consumption for three pathogen labs.



5.2.3 OAF Sand Filter Operation

OAF employs three sand filters to remove any particulate from the potable water source. While granular media filtration is a very effective filtration process, malfunctioning sand filter units or incorrect operations can lead to significant quantities of water loss. Typical issues with sand filter operations include excessive filter service rates, excessive backwash frequencies, as well as inadequate backwash rates. Any one of these issues can lead to filter media fouling and compromised water quality.

For each OAF sand filter, the filtration process, filter service rate, backwash rate, backwash duration and filter to waste were reviewed and findings are noted below.

Filter ID	Filter Service Rate (Usgpm/ft^2)	Backwash Rate (USgpm)	Backwash Rate (USgpm/ft^2)	Filter to Waste Rate (USgpm/ft^2)	Backwash Duration (min)	Optimal Filter Service Rate (USgpm/ft^2)	Optimal Backwash Rate (USgpm/ft^2)
1	4.7	53.7	10.9	9.5	5	3-5	12-15
2	3.9	58.1	11.8	7.9			
3	4.3	55.0	11.2	9.4			

Notes & Observations:

- Each filter is operating within an optimal filter service rate. These rates promote long filter runs, thereby reducing frequency of backwash and water waste.

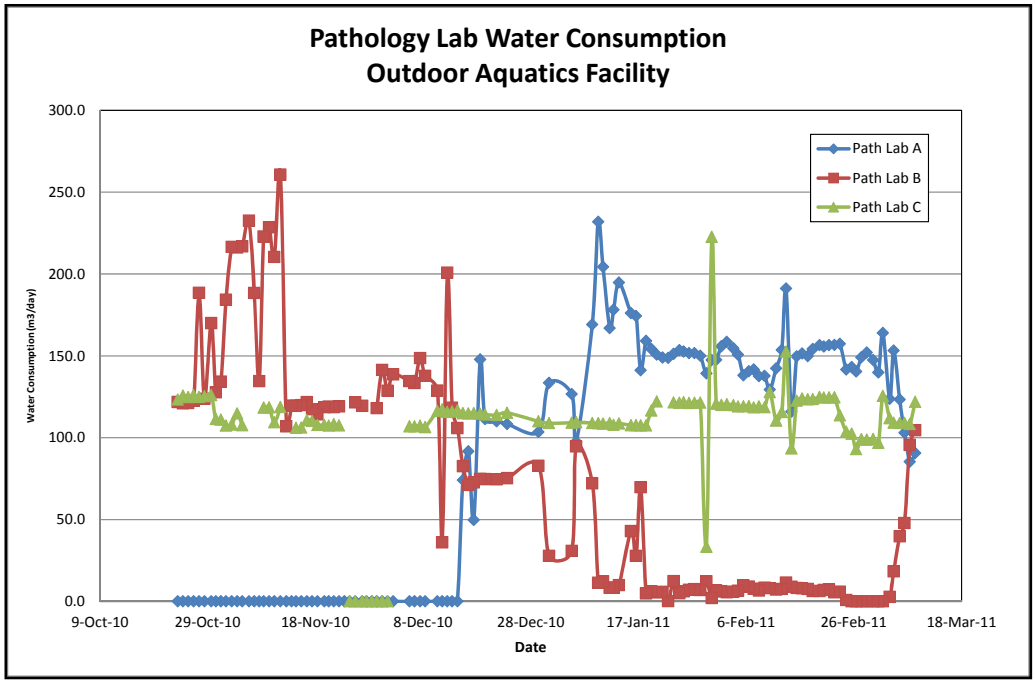
- Backwash rates measured during the audit were slightly below the optimal backwash rate. To achieve optimal particulate removal, backwash rates should be sufficient to fluidize the media to approximately 30% of the filter media depth.

- Each filter to waste cycle observed was greater than the optimal filter service rate. Filter to waste rates should mimic the filter service rate to promote filtration performance.

- Filter backwash frequency is maintained on a time basis. Each filter is backwashed every three days. Alternatively, backwash operations can be completed when a pressure of 10 psi is noted between the sand filter inlet and outlet pressures. Backwash frequency based on pressure promotes longer filter runs, thereby reducing the backwash frequency and required backwash water requirements.

5.2.4 OAF Pathology Labs

Water consumption within the pathogen labs is approximately 96% of all water used within OAF. Due to possible contamination and procedures used in research, water used within the pathogen labs cannot be re-used or recirculated. OAF water is passed to the wastewater treatment tank where it is disinfected prior to being discharged to the sanitary sewer or re-used in residential and selected academic buildings for toilet flushing purposes. Pathogen lab water consumption data from October, 2010 to March, 2011 is noted below.



Notes and Observations:

- On average, Pathogen Lab A consumes approximately 141 m^3/day, Pathogen Lab B consumes 73 m^3/day and Pathogen C utilizes 113 m3/day. In total, 327 m^3/day is required to operate the Pathogen Labs.

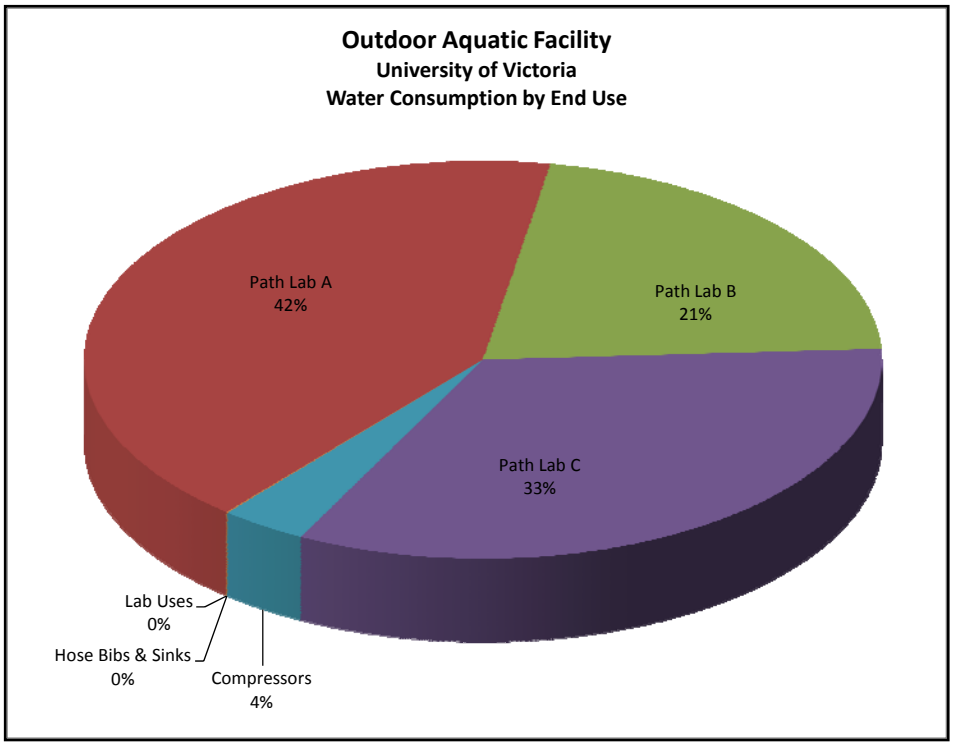
5.2.5 Once Through Cooling – Compressors

Within the OAF, two compressor units utilize potable water for cooling purposes. Potable water flow rates to each compressor were noted from March 9 to March 24, 2011. During this time frame, Compressor #1 operated at a flow rate of 14 lpm and Compressor #2 operated at 12 lpm. In total, 175,900 litres were consumed over the 15 day period, resulting in an average daily flow rate of 11,750 litres/day.

Operations personnel indicated that compressor operation and therefore water volumes determined during the audit were considered typical for the winter period. Due to the relatively cool weather in March, it is expected that compressor water consumption will significantly increase during the summer months. Simple paybacks for OTC compressor replacement are noted in Section 6.

5.3 OAF Water Balance & End Use

Based on the fixture inventory and water use analysis described above, a water balance was developed and verified against actual billed water use. The Water Balance can be found in Appendix B and reference sources for estimates and assumptions are included in Appendix F. Based on data collected during the audit, the annual water consumption by end use is shown below.



Notes and Observations:

- Two major water consumers were identified within the OAF: Pathogen Labs and OTC equipment. 96% of all water consumed within the facility is used by the Pathogen Labs, 4% is consumed through OTC equipment. All remaining water uses are negligible in comparison to Pathogen Lab use.

- Billing record & water consumption analysis confirm Pathogen Laboratory water consumption. A mass balance of water within OAF indicates that of the 330m^3/day coming into the facility, 327m^3/day was consumed within the Pathogen Labs.

5.3.1 Water Re-use Opportunities

Currently, UVIC re-uses a portion of the grey water produced from the OAF for toilet flushing purposes. Water taken from the grey water holding tank is disinfected with chlorine and ozone prior to use within the ECS and First Nations Building, 60 Residence and 126 Residence. Based on water consumption monitoring between October 23, 2011 and November 15, 2011, the water re-use system used a total of 4,514m^3 of grey water, or 196m^3/day.

Based on OAF's average daily consumption of 330m^3/day, further water re-use opportunities of approximately 134 m^3/day are available to UVIC. These opportunities include toilet flushing, sub-surface irrigation practices, fountain use (pending applicable approvals) or for cooling purposes. Please note that utilization of this additional grey water can provide significant cost savings to UVIC. Based on current water charges to UVIC for this water volume, an annual cost savings of approximately $110,000 (water and sewer charges as well as sewer use bylaw discharge fees) could be realized (see Section 6).

5.4 Phase 3 - Irrigation Practices

The third phase of the UVIC water audit reviews current irrigation practices employed by UVIC facilities staff. The work within this phase includes a site visit and discussion with facilities maintenance staff to assess the current practices and provide recommendations. Based on the site meeting, the following comments are provided:

- Facilities Maintenance personnel utilize a computer control system for irrigation practices. This type of control includes Evapotranspiration rates for plantings, soil types and weather patterns within the Greater Victoria area. This type of control system is considered one of the most efficient types of irrigation control when implemented correctly.

- FM staff indicated that outdoor water practices have been restricted to certain areas within the campus grounds. As part of UVIC's sustainability strategy, many areas are now maintained with consideration to the natural environment. Grass areas outside of the more common areas grow naturally; they are not cut, fertilized or irrigated.

- FM staff indicates that long range planning for playing fields includes artificial turf installations. Staff indicates that while artificial turf has higher initial capital costs to purchase and install, long term savings are realized through reduced maintenance costs.

6 Estimated Annual Water & Cost Savings

As noted above, significant water and cost savings are available to UVIC. Estimated annual water savings and associated costs for each project phase are noted below:

Phase	Water Efficiency Practice	Estimated Annual Savings (m^3)	Estimated Cost Savings ($)
1	Residential Fixture Upgrades	9,778	$ 21,609
2	OTC Cooling Equipment	31,305	$ 69,185
	Water Re-use Opportunities	48,945	$ 108,168
	Totals	80,250	$ 198,963

Notes and Observations:

- Estimated annual water savings from residential fixture upgrades assumes that each residential building identified within Section 5.1.5 are completed. Further savings could be available to upgrades within other residential buildings.

- OTC equipment replacements and water re-use opportunities can save approximately $177,350 annually (89% of identified savings).

- Based on 2009 consumption data, estimated annual savings make up 12% of all water use within UVIC.

7 Recommendations

Water conservation programs implementing a multi-disciplinary approach can provide long term water savings to the facility. This approach includes:

- mechanical or equipment improvements such as toilet, OTC and aerator replacements
- operational improvements or process modifications to reduce water consumption, and;
- education programs for employees and customers.

7.1 Mechanical Improvements

Specific to UVIC and within the framework above, the following mechanical modifications are recommended:

- Replace all Once Through Cooling Equipment (OTC) with air cooled equipment. Potential water savings from this replacement project are estimated at 31,305 m^3/year.

- Install instrumentation or mechanical switch within the OAF recirculation tank to control the volume of “top-up” water consumed on a daily basis.

- Replace all toilets greater than 6.0 lpf with water efficient models. Water efficient models range from 3.0 – 6.0 lpf and should meet Maximum Performance Testing requirements[3] for optimal performance. Replacement of existing 13.25 & 20.0 lpf toilets with 6 lpf toilets will reduce water use from toilet flushing by 29%.

- Replace all faucet aerators with a flow rate greater than 5.8 lpm with 1.9 aerators. In cases where the faucet is primarily used for purposes such as filling containers, pots or buckets, faucet aerators may not be required since water savings will be limited and fill time will be extended. Aerator replacement program can potentially save approximately 77% of water that is consumed through faucets.

- Replace all showerheads with a flow rate greater than 5.8 lpm with water efficient models (5.8 lpm). Showerhead replacement programs will also save energy since hot water consumption is reduced. Showerhead replacements to water efficient models can potentially reduce water consumption through showerheads by 32%.

- Replace each pre-rinse spray valve with water efficient models (6.0 lpm). These valves will save both water as well as energy due to the reduced hot water consumption. The CRD provides the pre-rinse spray valves to audit customers at no cost to the customer.

7.2 Operational Improvements

The following operational modifications should be considered:

UVIC Water Distribution System Operation

- Design and implement a water metering program that provides water consumption data for each building. The metering program should include water meter installation for each building as well as a Utility Management software package that integrates electronic meter reading. Meter readings should be evaluated on a regular basis to identify distribution system leaks that may develop over time. Furthermore, the metering program may provide revenue opportunities to UVIC as tenants could be billed for water consumption.

- Require UVIC staff responsible for water distribution system operations to hold at minimum, a Water Distribution System Operator Level I certification provided by the Environmental Operator Certification Program (EOCP).

- Develop and implement Best Management Practices (BMP) program for water distribution system operation. These practices should include Distribution System Audit, Leak Detection, Water Main Break Procedures, Water Main Flushing program as well as a Hydrant Use Policy.

- Require personnel operating the irrigation system hold at minimum, a Certified Irrigation Technician Level I certification provided by the Irrigation Association of British Columbia (IIABC) as well as any design modifications be reviewed by an accredited IIABC Irrigation Designer.

[3] http://www.cuwcc.org/WorkArea/showcontent.aspx?id=15786 (Veritec Consulting, Inc. and Koeller Co.)

The following operation modifications are considered:

- Develop equipment replacement protocols that ensure any water consuming equipment requiring replacement is replaced with similar equipment that is water and energy efficient.

- Ensure O&M practices provide an inspection and reporting system for leaks and/or malfunctioning equipment and ensure these items are repaired or replaced in a timely manner.

- Adjust all automated faucet and toilet sensors to ensure the equipment is properly functioning.

7.3 Education

- Provide water conservation education to all employees.

- Provide signage in all washrooms and water consuming areas as a reminder for staff to consider water conservation in their daily activities.

Appendix A

Water Audit Process Options

UNIVERSITY OF VICTORIA WATER AUDIT
Work Plan Options
August 3, 2010

	OPTION #1	OPTION #2	OPTION #3
Brief Description	**Base line survey for all buildings**	**Test Sites** • Full audits completed at typical site • Recommendations carried forward to other buildings of similar type	**Water audit completed for each building** • As per Work Plan #2 • Completed in each UVIC owned building • May require additional staff/volunteers • Partnership with Engineering Students
Desktop Review	**Staff Interviews** • Maintenance staff responsible for individual buildings • Professors, support staff as required **Literature Review** • Equipment specification pages • Water history, if available • Mechanical drawings of distribution system, plumbing systems	**Staff Interviews** • Maintenance staff responsible for individual buildings • Professors, support staff as required **Literature Review** • Equipment specification pages • Water history, if available • Mechanical drawings of distribution system, plumbing systems	
On-site Works	**On Site Works** • Fixture Inventory • Record model no.'s for major equipment	**On Site Works** • Fixture Inventory • Record model no.'s for major equipment • Measure flow from each fixture • Install flow meters as required on major equipment • Toilet flush counters on tank type toilets	

Reporting	**Report**
	• Introduction
	• Historical Review
	• Audit Process
	• Fixture Inventory
	• Recommendations
	  ○ Mechanical
	  ○ Operation
	  ○ Education
		Report
		• Introduction
		• Historical Review
		• Audit Process
		• Fixture Inventory
		• Water balance to develop theoretical water consumption
		• Water use analysis for specific equipment employed
		• Simple pay back periods for water efficiency improvements
		• Recommendations
		  ○ Mechanical
		  ○ Operation
		  ○ Education	

Time Frame	6 Weeks from audit commencing	1 Month per building	12-18 Months

Appendix B

Appendix C

Appendix D
Fixture Inventory Worksheets

Appendix E
List of 6.0 lpf Retrofitted Buildings

"HAVE BEEN DONE LIST"

FACILITIES MANAGEMENT
Material

For Work Order No. _____

(6 LTR.)

Quantity:	Only One Item Per Line:	Unit Price:	Amount:
	CLEARIHUE		
	ALL ~~[illegible]~~		
	Med Science.		
	CORNETTE NON RESIDENTIAL 2002		
	Continuing Studies		
	FRASER NON RESIDENTIAL 2002-3		
	ASB.		
	Phoenix.		
	Campus Services (Patterson Ly.)		
	Visual Arts.		
	EOW		
	ELW		
	Sanders front office.		
	Sedgewicks A wing.		
	C wing.		
	Fine Arts.		
	Health Services.		
	UH1		
	Cunningham		
	Sub.		
	HSD		
	Elliot.		
	ECS.		
	Petch.		

s:\fmgt\stnds\doc rev 8/30/96

↓ ↓ ↓

"SEE ATTACHED SHEET"

Bob Wright.
Library
FPH.
TEF
SSM.
294
South Tower.
126 bed
60 bed.

Appendix F

Appendix F – Typical Estimates, Assumptions and References for Water Audits

References for ICI Water Audits

08-Feb-08

Short Name	Reference
SWEB	Commexus Inc. and CH2M Hill Canada Ltd. *Saving Water - It's Everybody's Business*. Revised 2005.
Vickers	Vickers, Amy. *Handbook or Water Use and Conservation.* WaterPlow Press, Amherst, MA, 2001. ISBN 1-931579-07-5
EC	*Manual for Conducting Water Audits and Developing Water Efficiency Programs at Federal Facilities.* Environment Canada. Revised 1997. ISBN 0-662-20334-8
AWWARF	Dziegielewsli et.al. *Commercial and Institutional End Uses of Water*. Denver: American Water Works Association Research Foundation. 2000. ISBN 1-58321-035-0
Metcalf & Eddy	Tchobanoglous et.al. *Wastewater Engineering – Treatment and Reuse / Metcalf and Eddy, Inc.* Fourth Edition. McGraw-Hill. 2003. ISBN-13: 978-0-07-041878-3 ISBN-10: 0-07-041878-0
Veritec	Gauley, Bill. "City of Calgary Pre-Rinse Spray Valve Pilot Study - Final Report". Veritec Consulting Inc. Mississauga, ON. 2005.
Tso	Tso, Bing and Koeller, John. "Pre-Rinse Spray Valve Programs: How are they Really Doing?" SBW Consulting/Koeller & Co. 2005.
FSTC	"Low-Flow Prerinse Spray Valve Test Summary - Bricor B095NS". Pacific Gas and Electric Company, Food Service Technology Center. 2007.

Ice Machines	Scotsman - http://www.scotsman-ice.com/nafemcategory.asp?category=0142 - accessed January 25, 2008
	Hoshizaki - http://www.hoshizakiamerica.com/prod.asp - accessed January 25, 2008
	Manitowoc - http://www.manitowocice.com/products/products.asp - accessed January 25, 2008
	Ice-O-Matic - http://www.iceomatic.com/nafemcategory.asp - accessed January 25, 2008
	Sizing 1 - http://www.buyerzone.com/restaurant-equipment/ice-machines/qh-ice-machines.html - accessed April 15, 2008
	Sizing 2 - http://www.icemachine.com/selguide.html - accessed April 15, 2008
AWWARF-Res	W. Mayer and W. B. DeOreo et.al. *Residential End Uses of Water*. Denver: American Water Works Association Research Foundation. 1999. ISBN 1-58321-016-4
OEE	The Office of Energy Efficiency. http://oee.nrcan.gc.ca/english/index.cfm
CUWCC	California Urban Water Conservation Council - Commercial Dishwasher listing with water use 06-04-03
	California Urban Water Conservation Council - Commercial Steamer Study: http://www.cuwcc.org/Comm_Food_Service/Steamer_Field_Study_Final_Report_June-2005.pdf
Dishwashers	Knight Model: 112HL - http://www.knightequip.com/pdf/b_Ultrawash%20HiLo.pdf - accessed January 23, 2008
	Hobart - http://www.hobartcorp.com/products/warewashing - accessed January 23, 2008
Glass Washers	Moyer Diebel - Rotary Style Glass washer: http://www.moyerdiebel.com/specs/76.pdf
CRD	"Washroom Water Use Analysis – CRD Water Services Building – 479 Island Hwy, Victoria, BC". Capital Regional District. August 2007
Farmwest	Evapotranspiration rate for Victoria, BC. http://www.farmwest.com - accessed January 28, 2008

Rice Cookers	Rice Cooker World - http://www.ricecookerworld.com/index-electricricecookers.html - accessed February 14, 2008
Cooling Towers	Cycles of concentration graph - http://www.agiwater.com/articles.html - accessed February 15, 2008
Condensing Units	Refrigerative Supply Price List - http://www.rsl.ca/index.asp - accessed February 18, 2008
Dental Equipment	Cavitron - http://prevent.dentsply.com/handpc_maint/DFU/80617_CavSPS_.pdf - accessed April 18, 2008

Typical Estimates and Assumptions for ICI Water Audits

February 8, 2008

Item	Detail	Assumed Parameter			Unit	Reference(s)	Notes
		Low	Typical (default)	High			
Toilet	unmarked	15	**20**	26	lpf	SWEB, Vickers, EC	Vickers reports 15-17 lpf for toilets made later than 1980, and 19-26 lpf for toilets made before 1980. SWEB reports that pre-1985 toilets use 20 or more lpf, 19 lpf for valve-type and 15-25 lpf for tank-type toilets. EC reports 19-25 lpf for valve type toilets.
	marked 13.25 lpf		**13.25**		lpf		
	marked 6 lpf		**6**		lpf		
	marked HET		**4.8**		lpf		
	Use per employee	5	**10**	15	uses/FTE/week		Based on CRD audit experience and monitoring at 479 Island Hwy, approx 3 washroom uses per 8-hr shift. Women use toilets 3 times, men use toilets once and urinals twice where urinals are available. Low parameter assumes an all-male workforce where urinals are available, typical assumes equal proportions of women and men where urinals are available, and high assumes no available urinals or an all-female workforce.
	Use per resident - long-term care	6	**8**	10	uses/resident/day		Based on well established overall averages of 5 uses per day at home and 3 at work, it is assumed that a person typically uses a washroom 8 times per day.

	Customer use (full service restaurant)	0.2	**0.33**	0.5	uses/customer, or uses/meal served		Rough estimates based on CRD audit experience. Low parameter assumes only male customers where urinals are available, typical assumes equal proportions of women and men where urinals are available, and high assumes no available urinals or only female customers.
	(fast food)	0.1	**0.2**	0.3	uses/customer		
	(pub)	0.15	**0.25**	0.4	uses/customer		
	(retail)	0.05	**0.1**	0.15	uses/customer		
Urinal	unmarked	6	**8**	19	lpf	SWEB, Vickers, EC	SWEB suggests 6 lpf for "older" models. Vickers gives a range of 6-17 lpf for fixtures installed between 1980 and 1994, and 19 lpf for fixtures installed before 1980. EC reports "Standard" (presumably pre-1993) urinals use 7-9 lpf.
	marked 3.8 lpf		**3.8**		lpf		
	marked 1 lpf		**1**		lpf		
	marked 0.5 lpf		**0.5**		lpf		
	waterless		**0**		lpf		
	Use per employee	2.5	**5**	10	uses/FTE/week		Based on CRD audit experience and monitoring at 479 Island Hwy, approx 3 washroom uses per 8-hr shift. Men use toilets once and urinals twice where urinals are available. Low estimate assumes only 25% of employees are male, typical assumes equal proportions of men and women, and high assumes an all-male workforce.
	Customer use (full service restaurant)	0.08	**0.17**	0.33	uses/customer, or uses/meal served		Rough estimates based on CRD audit experience. Low parameter assumes only 25% of customers are male, typical assumes equal proportions of women and men, and high assumes only male customers.
	(fast food)	0.05	**0.1**	0.2	uses/customer		
	(pub)	0.06	**0.13**	0.25	uses/customer		

	(retail)	0.03	**0.05**	0.1	uses/customer		
Lavatory Faucet	no aerator	10	**15**	26	lpm	SWEB, Vickers	SWEB suggests 2-16 lpm; "conventional" is 13.5 lpm. Vickers gives a range of 10.5-11.5 lpm for 1980-94 fixtures, and 11-26 lpm for pre-1980 fixtures.
	unmarked aerator	10	**13.5**	16	lpm		
	2.2 gpm aerator		**8.3**		lpm		
	1 gpm aerator		**3.8**		lpm		
	0.5 gpm aerator		**2**		lpm		
	Use per employee	2.5	**3**	5	minutes/FTE/week	SWEB, Vickers	Based on CRD monitoring at 479 Island Hwy, approx 3 washroom uses per 8-hr shift and equivalent of 0.2 minute of faucet use per washroom visit (avg. 1.5 litres per visit using faucets with 8.3 lpm aerators). Other sources (Vickers, SWEB) report longer durations per use.
	Use per resident - long-term care				min/resident/day		
	Customer use (full service restaurant)	0.08	**0.1**	0.15	min/customer, or min/meal served		See notes above re/ washroom visits. Assume 0.2 minute per washroom use. Rough estimates.
	(fast food)	0.05	**0.06**	0.1	min/customer		
	(pub)	0.06	**0.08**	0.12	min/customer		
	(retail)	0.02	**0.03**	0.05	min/customer		
Kitchen/Utility Faucet	no aerator	10	**15**	26	lpm	SWEB, Vickers	SWEB suggests 9-18 lpm. Vickers gives a range of 10.5-11.5 lpm for 1980-94 fixtures, and 11-26 lpm for pre-1980 fixtures.
	unmarked aerator	9	**13.5**	18	lpm		
	2.5 gpm aerator		**9.5**		lpm		

Pre-rinse valve	unmarked	7	**11**	19		Vickers, Tso, Veritec	Vickers reports 7-10 lpm (marked or unmarked). Tso reports 8-19 lpm, average 11. Veritec reports 11-19 lpm, average 14 (Calgary) and 11 (Waterloo). Tso is the most comprehensive reference.
	2.6 gpm		**9**			Tso	Tso reports 9 lpm.
	2.2 gpm		**6.4**			Tso	Tso reports 6.4 lpm.
	1.6 gpm	4	**5**	6		Tso	Tso reports 4-5 lpm, average 4.5. Veritec reports 4-6 lpm, average 5.6 (Calgary) and 4.6 (Waterloo).
	0.94 gpm		**3.6**			FSTC	Bench test result at 60 psi, 120 degrees F of Bricor B095NS valve.
	Duration of Use	10	**20**	30	sec/rack		Aaron McCartie 1 year experience as a dishwasher
Household Dishwashers	Old Model	17	**38**	53	l/load	Vickers, AWWARF-Res	Vickers reports 17-53 l/load. AWWARF-Res reports average of 38 l/load
	Energy Star	7.8	**20.4**	33	l/load	OEE	Average of all energy star approved dishwashers.
Showers	Unmarked	9.5	**12.25**	15	lpm	Vickers	Vickers reports that the flow rates are based on 80 psi water pressure
	Unmarked	4.7	**8.3**	12	lpm	AWWARF-Res	Average flow rate of 2.2 gpm. Std. deviation of 0.95 gpm
	Duration of Use		**5.3**			Vickers	Based on 11.6 gallons per capita with a flow rate of 2.2 gpm
	Duration of Use	3.7	**8.2**	12.7		AWWARF-Res	Average duration of 8.2 mins. Std. deviation of 4.5 mins.
Household Washing Machine	Old Model	102	**160**	212	l/load	Vickers, AWWARF-Res	Vickers reports 102-212 l/load. AWWARF-Res reports a mean of 155 l/load
	Front load or Energy Star	22.5	**93.5**	170	l/load	OEE	Average of all current energy star approved washing machines
Irrigation	Intensity		**1**		inch/week	Farmwest	Victoria int'l airport average evapotranspiration rate from May 1st - Sept 30th
Hose Bib	3/4 inch - 19 mm	10	**15**	20	lpm	SWEB, Metcalf & Eddy	

Steamers	Boiler Based		**2.55**		lpm	CUWCC	Average of 9 in study. 4 Restaurants, 4 Cafeterias, 1 Banquet
			438		mins/day	CUWCC	Average of 9 in Study.
	Boilerless		**0.126**		lpm	CUWCC	Average of 3 in Study.
			282		mins/day	CUWCC	Average of 3 in Study.
Once-through cooling	Condenser		**1.75**		lpm per hp		Measured at Esquimalt High, July 2006, school not in session.
			14.04		lpm per hp	CRD Water Audit	
			11.16		lpm per Ton	CRD Water Audit	
		6.9	**8.3**	10.4	lpm per Ton	CRD Water Audit	
			5.7		lpm per Ton	Refregerative Supply	They are a Copeland Wholesaler. Nominal Estimate. Phone conversation February 11, 2008
		0.0005	**0.0007**	0.0009	lpm per BTU/hr	Tecumseh Product Info	
		6	**8.4**	10.8	lpm per Ton	Tecumseh Product Info	
		4.5	**7.0**	9.5	lpm per Ton	Accutemp	Terry from Accutemp. This is his estimate for water use from OTC condensers.
	Walk-in Duty Cycle		**66.0**		%		
	Freezer Duty Cycle		**75.0**		%		
	Server Room Duty Cycle		**75.0**		%	Accutemp	Terry from Accutemp. His estimate for duty cycle of server room A/C units.
	Soft-serve Duty Cycle		**7.0**		%	Saanich Centre Audit	This was reported from the owner of a fast food service. Machine runs for 1 min. every 15 mins.
Rice Cookers	Capacity		**6.9**		litres per batch	Rice Cookers	Average of 7 commercial models on website
Commercial Dishwashers	Unmarked Hobart Undercounter		**5.7**		litres per rack	CUWCC	Average of all Hobart undercounter machines

Cooling Towers		9.2	**43**	94.9	l/m^2	Cooling Tower Benchmarking	Based on CRD audit experience. Four audits performed in 2007 and 2008. W:/DM/ICI/AUDITS/TECHNICAL RESOURCES/Cooling Towers
Ice Machines	Fast Food	0.5	**0.75**	1	lbs/customer	Ice Machines - Sizing 1 & 2	Based on 2 websites found on sizing ice machines. Take customer per day information from peak demand and use it to size the machine. Also visit Manitowoc's sizing calculator: http://www.manitowocice.com/products/sizingguide.asp
	Restaurant	1.5	**1.75**	2	lbs/customer		
	Bar/Nightclub		**3**		lbs/customer		
Dental Equipment	Cavitron	0.0075	**0.031**	0.055	l/min	Dental Equipment	This is basically zero and can be ignored.