Water Management at UBC Okanagan
Part 1: An Overview of Water Use

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A SEEDS Work Study and Directed Studies Project

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UBC - Okanagan, a Growing University with a Fresh Start

The University of British Columbia - Okanagan was 'born' in the year 2005, and the campus aspires to become a social and environmental leader much like its sister campus, The University of British Columbia - Vancouver. UBC-O is much different than UBC-V in many substantial ways though; these differences will bring both challenges and opportunity in its bright future. UBC-O is located in Kelowna, British Columbia, a semi-arid region in the Central Okanagan Valley. The semi-arid climate, along with the high consumption of water in the valley, puts stress of the hydrological systems of the Central Okanagan. To become a community leader, UBC-Okanagan needs to ensure that it reduces its irrigation and indoor water consumption to sustainable levels. If UBC-O can reduce unnecessary water consumption, it can prove to be a model to the residents of Kelowna and the Central Okanagan, as well as to other Canadian and international universities. Throughout this paper I am going to provide a description of the UBC-O water delivery system, the current water using infrastructure and equipment on campus, other aspects of campus which involve the consumption of water, the climate, geology, hydrology, and ecology of the Central Okanagan, and future opportunities and recommendations for sustainable water use at UBC-Okanagan.

Figure 1: Cascades student residences. Source: photograph by author**.**

Quick Facts About UBC-O

Student Population: 5,325

Faculty Population: 353

Staff Population: 389 full- and part-time

Faculties: 7

Campus Housing: 1,078 single-student spaces

Size of Campus: 260 acres (105 ha)

Buildings: 46,400 sq. m (0.5 million sq. ft.) in 2005, expanding to 139,000 sq. m. (1.5 million sq. ft.) by 2010"

(UBC-O 2008)

UBC- O Masterplan and UBC EcoTrek Initiatives

The UBC-O Masterplan has included sustainable water initiatives, and has acknowledged the retention ponds/wetlands in the future development of the campus. The flora of the Okanagan is drought resistant and requires little water to thrive; the UBC-O Masterplan says that "Most of the peripheral campus landscape will be designed with native plants suited to the Okanagan climate that, once established, will not be irrigated" (UBCO 2005:48). Also, "the existing wetland will be enhanced and will become part of the stormwater management system" (UBCO 2005:48). The future development of UBC-O will hopefully stick to these initiatives and will include more sustainable water initiatives in regards to vegetation and the retention pond/wetland habitats.

UBC Vancouver has become a sustainable champion in the international university community through the project 'EcoTrek'. The EcoTrek project has reduced water consumption substantially as well as energy use, paper products, etc. Through the energy performance contracting method, UBC-V has reduced its water use by thirty percent and therefore has saved $1.5 million dollars. This reduction was achieved by installing over 3,000 low consumption plumbing fixtures in over 250 buildings, and by repairing and replacing over five kilometres of condensate pipes to ensure that the steam used in each building returns to the central plant to be re-used (UBC 2006). The UBC Vancouver EcoTrek project is now complete and the campus is benefiting economically, socially, and environmentally from the changes.

Project Description

This project is a Social, Ecological, Economic Development Study (SEEDS) in which I worked together with UBC-O faculty member Dr. John Wagner, and UBC-O Facilities Manager Roger Bizzotto. As stated in the introduction, this research is focused on Sustainable Water Management at UBC-O. In Part 1 of the research, I carried out a basic water balance and overview study of how water is used at UBC-O, and developed an equipment inventory which includes bathroom water faucets, toilets, urinals, etc. The water delivery system, storm water system, and other regular uses of water on the campus are also discussed. To put the overall purpose of this study in a local perspective, I have provided a basic description of the climate, geology, hydrology, and ecology of the Kelowna/ UBC-O campus area. The current water saving initiatives which are being undertaken by UBC-O facilities and the water and monetary costs and savings for these are discussed. I conclude Part 1 of the study with recommendations regarding possible retrofitting initiatives and educational programs which can be options for future water conserving opportunities. This information will be provided to Dr. John Wagner and will contribute to his research, as well as to UBC-O facilities where the information can be used to help in future water conservation initiatives. Part 2 of the study, which deals with water features and the built environment at UBC Okanagan, is described in a second report.

Goals and Objectives

The objectives of this project are to gather the following information:

- How much water UBC-O uses on a monthly and annual basis?
- How much water is used for certain categories of use; e.g. student residences?
- How water is disposed of and in what volume once it is used?
- What types of water infrastructure and equipment currently exist and how water efficient is this infrastructure?
- What routine practices on campus are likely to have the largest impact on overall water consumption?
- What opportunities exist to conserve water by making changes to infrastructure or existing practices, and how can these conservation measures best be implemented?
- What costs are likely to be associated with these measures and what cost savings are likely to result?

The main goal of this project is to contribute to a sustainable future at UBCO. This includes ecological, financial, and social sustainability:

<u>Ecological:</u> Through recommendations regarding changes in water infrastructure, equipment and educational programs there is a possibility for the reduction of per capita water use. Also recommendations and information can be used to make improvements to

water disposal systems so that used water re-enters the hydrological cycle in the most ecologically sustainable way possible.

Financial: By reducing the per capita cost of water use and sewage disposal the university can save money and invest in ecologically friendly water equipment and infrastructure.

Social: Recommendations regarding student, faculty, and staff water conservation educational programs will be discussed for future implementation. This education will focus on sustainable water use practices, and it will enhance appreciation for our environment and freshwater.

Methods

Interviews: I have met with a number of individuals for semi-structured interviews ranging from twenty minutes to ninety minutes. The interviews enhanced my knowledge of the corresponding subjects and answered many questions which were essential to this project. The interviews, in chronological order of when they were done are listed below:

- UBC-O Anthropology Faculty Member, Dr. John Wagner (met with bi-weekly)
- The City of Kelowna's WaterSmart Program Coordinator, Neal Klassen
- UBC-O Facilities Manager, Roger Bizzotto (met with bi-weekly)
- GEID Manager of Engineering and Development, Darren Schlamp
- Aramark UBC-O Assistant Director, Natalie McHugh
- UBC-O Graduate Student, Skye Thomson
- Environment Canada Meteorologist, Ross Klock
- UBC-O Residence Life Manager, Emily Webb

Meter Readings: The water meters which were installed by OUC/UBC-O were read on a monthly basis. I was accompanied by a UBC-O maintenance or facilities staff member to each of the meters where we read each one manually. A total of eleven meters were read each month, but one meter was found to be inaccurate, so data for a total of ten meters has been used for this study. Nine of the ten meters are located in student residence buildings. A meter in the new Fipke Centre will be soon be assembled and available to collect water consumption data. The monthly data from the five GEID owned meters was kindly provided by GEID Development Clerk, Pat Schmidt (see appendices A and B on pages 39 and 44).

Equipment Inventory: I have gathered all of the water using equipment data for UBC-O washrooms, kitchens, and student residences. To gather the inventory information for the washrooms and kitchens, I counted each piece of equipment, and recorded its type and location. For each type of equipment I took a picture to create the picture inventory. To gather the inventory information for the student residences, I visited one of each type of room and recorded equipment type and location. The total numbers of each type of equipment could be calculated from the known number of rooms and numbers of equipment in each room (see appendix C, on page 45).

UBC-O Washroom Water Faucet Rating System: In addition to the inventory of the types of washroom faucets found on the UBC-O campus, I have tested each type of faucet for the minimum time which it can be turned on with a flow, the maximum time it can be on with a flow, five tests for ten seconds each to measure the amount of water which flows in that time, the average amount from each of the five tests, and the average litres per minute that each type of faucet flows. The tools which I used for these tests include one timer and one large measuring cup. To assess the sustainability of the faucets I have produced a ranking system which is based on the water consumption, and the style and function of the faucet in relation to efficiency (see appendix D, page 52).

UBC-O Central Courtyard Pond Measurements: I have calculated the average amount of water which is used to fill the UBC-O central courtyard pond each month. To gather this data I had the help of another person, and together we used a tape measure, and plastic coloured place markers. We first calculated the surface area of the pond, then the average depth of the pond, and finally the volume. See appendix E on pages 52-53 for the calculations and further methodological explanation.

Literature Research: I have drawn my information about the climate, geology, hydrology, and ecology of the study area from peer reviewed journal articles, relevant, reliable websites, and books. I have also gathered information about water conservation opportunities, sustainable management of water, and water using equipment and infrastructure from different bodies of literature. All of the references I have used are listed on pages 36-38.

Project Partners

The information and support from the following individuals has greatly improved, and overall contributed to the successful completion of this project. Neal Klassen, Darren Schlamp, Natalie McHugh, Ross Klock, Emily Webb, Skye Thomson, Pat Schmidt, Brenda Sawada, the staff at Cambridge Brass, Scott Reid, and Hiltrud Vogler. I would like to give a very special thank you to Dr. John Wagner, Roger Bizzotto, and all of the UBC-O maintenance and facilities staff.

Overview of Climate, Ecology, Geology, and Hydrology of Central Okanagan

Climate

Climate is the largest factor which affects the flora, fauna, soils, and hydrology of an area. The Okanagan basin is categorized as a semi-arid continental climate; the mean annual temperature is 6 degrees Celsius, with a summer mean of 15 degrees Celsius, and a winter mean of -3.5 degrees Celsius. The mean annual precipitation ranges between 250-300 mm in the valleys, and 400-600 mm in the plateau regions (Cohen and Kulkarni 2001:14). The basin receives little precipitation because it sits in the rain shadow of a chain of coastal mountains. The climate is not only effected by the regions geology though, as “a preliminary study suggests that climatic change is expected to add to these pressures by increasing temperatures between 2.5-5 degrees Celsius by 2080, which in turn could result in a six-week earlier spring freshet and significantly increased crop demand” (Shepherd 2006:33). The climate and more specifically climate change are essential aspects in this study because they affect the hydrology of a region through changes in the timing, amount, and form of precipitation, evaporation and transpiration rates, and soil moisture (Merritt 2006:80). For successful long term planning, UBC-O needs to take the current and future climate into consideration for all water management.

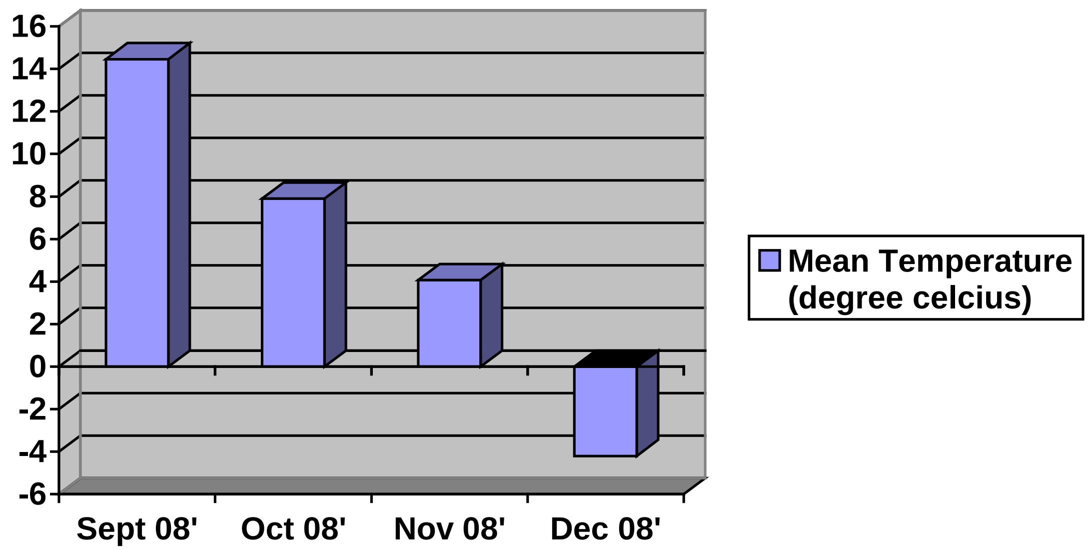


Figure 2: Mean temperatures during study months. Temperature readings taken at the MWSO Station on the UBC-O campus. Source of information: Environment Canada 2009.

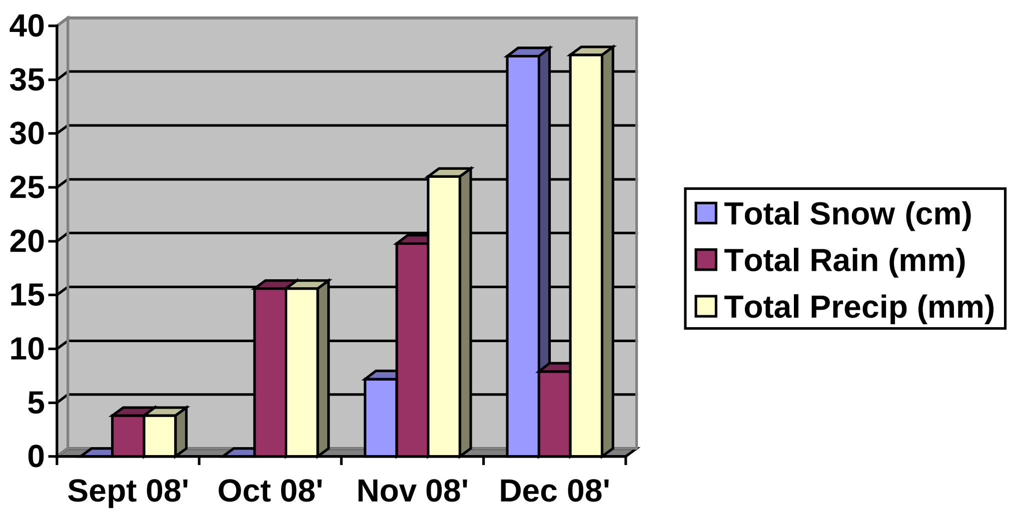


Figure 3: Mean precipitation during study months. Precipitation readings were taken at the MWSO Station on campus. Source: Environment Canada 2009.

Flora and Fauna

The flora of the Okanagan is drought resistant to suit the semi-arid climate.

Sub-alpine areas support lodgepole pine, Engelmann spruce and sub alpine fir. At lower elevations, mixed forests of lodgepole pine, trembling aspen, white spruce and Douglas fir cover the rolling landscape. Drier valley bottoms support drought adapted species such as Douglas fir and pine grass, or scattered ponderosa pine among bluebunch wheat grass and sagebrush. Varied grasslands, sagebrush, and antelope brush characterize the most arid areas south of Penticton (Cohen and Kulkarni 2001:14).

On campus, vegetation includes ponderosa pine, Douglas fir, bunchgrass, and balsam root among many other species. If we remove some of the ponderosa pine and Douglas fir areas on campus, it is possible that we will experience an increase in surface runoff in the spring, or another type of change in the campus hydrological system. According to Murray A. Roed (1995:129), up to 30% more water can occur in the form of snow in a opening which has been clear-cut compared to that of an undisturbed forest, and the snow in clear cut areas melts approximately two weeks earlier than in the natural forest". In addition to changes in the hydrological system, the removal of the native vegetation may alter or harm the surrounding vegetation because dryland flora is easily damaged and may be slow and difficult to rehabilitate (Barrow 2006:322).

Figure 4: Balsam root at UBC-O. Source: photograph by author

Figure 5: Bird species at UBC-O retention pond/wetland habitat. Source: photograph by author.

The fauna on campus is very diverse and is concentrated in the retention pond/wetland habitat area, and in the ponderosa pine/ Douglas fir forested areas. Fauna which I have personally observed include chipmunks, ducks, white tail deer, multiple species of birds including magpies and heron, ground hogs, wood ticks (which I observed far to close), and many other species of insects. From my observations the largest concentration of birds is in the retention pond/ wetland habitat area; the birds have made themselves at home on the pond, in the ponderosa pine, and in the grasslands.

Soils

The active soil layer on the UBC-O campus is estimated to be an average of two meters thick. Below these two meters of soil is the recharge zone where the ground begins to become saturated with water. The soils of the Okanagan are quite often "coarse textured, rapidly drained soils…although other soils prevail as well" (Roed 2004:65). The soils on campus are also quite varied depending on what organic materials are present, the angle of the slope on which it rests, past glacial deposits, etc. It has been recorded that during the excavations for the OUC (presently UBC-O) campus, clays which are subject to swelling were found. "Final design was based on removal of over three meters of the clay and replacement with compacted sands and gravel. This acts as a thick 'mat' foundation, and will insure that no settlement takes place even if there is minor swelling in the remaining clay soils at depth" (Roed 1995:110). The type of soils in an area has a large impact on how water will travel on the surface and through the ground, and therefore should be an important factor in assessing the way water is leaving our campus and how it is impacting the surrounding areas.

Figure 6: 12 inch (top) soil profile North West of the retention pond/wetland habitat. Photograph by author.

Geology

The 8200 km2 Okanagan valley is a long, narrow basin which has been shaped through the power of glaciers and freshwater. The valley extends from (North) Armstrong to (South) the United States border at Osoyoos Lake (Cohen et al. 2006:333-334).

The basin has been deeply carved 1,000 meters into the Thompson plateau (Roed 2004:66).

Figure 7: The Okanagan Basin, British Columbia. Source: Cohen et al. 2006:334.

The UBC-O campus' topography is very sloping and 'hilly'; "East of the core, the land slopes dramatically toward the highway; this change in elevation is intensified to the North of University Way where gravel and sand extraction has created an escarpment and an area remediation before it will be sited for development." "The topography in the northwest quadrant of campus is a south-facing hillside rising to a summit at the north boundary of campus where the water reservoir is being built" (UBCO 2005).

Hydrology

A key focus of this study is the movement of water through the UBC-O campus: where it is used; how much it is used; and why it is used in certain amounts. The natural movement of water also plays a part in this study, as it shapes the local perspectives about water in general. What is a watershed anyways? According to Murray Roed, a watershed is "the land area that accumulates all the runoff (surface and groundwater) above a specified point" (1995:125). The Okanagan valley is a part of the interior dry belt, it receives very little precipitation, and most of the runoff occurs from May to July. Most of the precipitation is snow and the annual average historical average is 554 mm (Roed 1995:123).

> Of the 554 mm of precipitation that falls in the basin, 419 mm is used by the forests and other vegetation for evapotranspiration including infiltration to groundwater, 122 mm flows into Okanagan lake of which 53 mm evaporates. This leaves only 13 mm (2%) of the surface water to be used for domestic or irrigation purposes (Road 1995: 125-27).

A more recent study at the Kelowna airport, which is ten kilometres from UBC-O has found than the airport receives about 366 mm of precipitation per year. In comparison to the central coastal areas of B.C. which receive over 3,000 mm of precipitation per year the North Kelowna area is very dry (Cohen 2001:18).

"Serious watershed management is now a government mandate in British Columbia as set out in the new Forest Practice Code" (Road 1995:135). This sort of serious action to manage water sustainably is very important in the Okanagan for the previous reasons I have discussed. In addition to these reasons, human population in the Okanagan, and in Kelowna in particular is increasing rapidly. This increase in population will result in an increase of overall water consumption, and therefore requires even more careful and strict management. Philippa Shepherd says that "In the face of rapid population growth, limited water supplies and significant annual variability in precipitation, stakeholders in the region (Okanagan) are already concerned about the availability of water, independent of future climate change impacts" (2006:32). A last, shocking fact from Murray Road; of the total water which falls into the Okanagan basin, only 15% is available for human use (1995:129).

Glenmore Ellison Improvement District

The University of British Columbia - Okanagan receives its water from the Glenmore Ellison Improvement District (GEID). As one of the five Kelowna water purveyors, it supplies water to many residences and farms in addition to the university campus. Even though UBC-O uses a substantial amount of water, it is not the largest customer to GEID; the City of Kelowna's 'Tutt Lands' which is an agricultural area nearby the university use the most water in the GEID. Water usage for irrigation makes up the majority of consumption in the area, and this is quite often the case throughout the Okanagan. GEID provides water to approximately 13,000 people, and it has a serviceable area of 9007.50 acres. The water which is supplied to the campus is taken from the McKinley reservoir, and is delivered to UBC-O via one large intake, and during the summer also via two on campus vector wells (see pages 22-24). The wells are only used in the summer months because of the increased need for water in the summer due to irrigation, as well as the wells will freeze in the colder winter months. "Glenmore Ellison Irrigation has the rights to store 6.9 million cubic meters of water in reservoirs (Postill Lake, Bulman Lake, South Lake) in the Kelowna Creek watershed" (Roed 1995:128). To meet fire flow requirements GEID provides a maximum of 225 litres/ second for a maximum time of three hours, however we use much less water on a regular basis. The time of the day with the maximum daily usage in the GEID on average is between six to eight am, but due to the large amount of data I was unable to find out the time of maximum daily usage for the UBCO campus. GEID has recently been awarded two grants from the Okanagan Basin Water Board for the Water Conservation and Quality Improvement grant program and for a Cattle Use Inventory and Off Channel Watering Study.

Description of UBC-O Water Balance Situation

Inputs

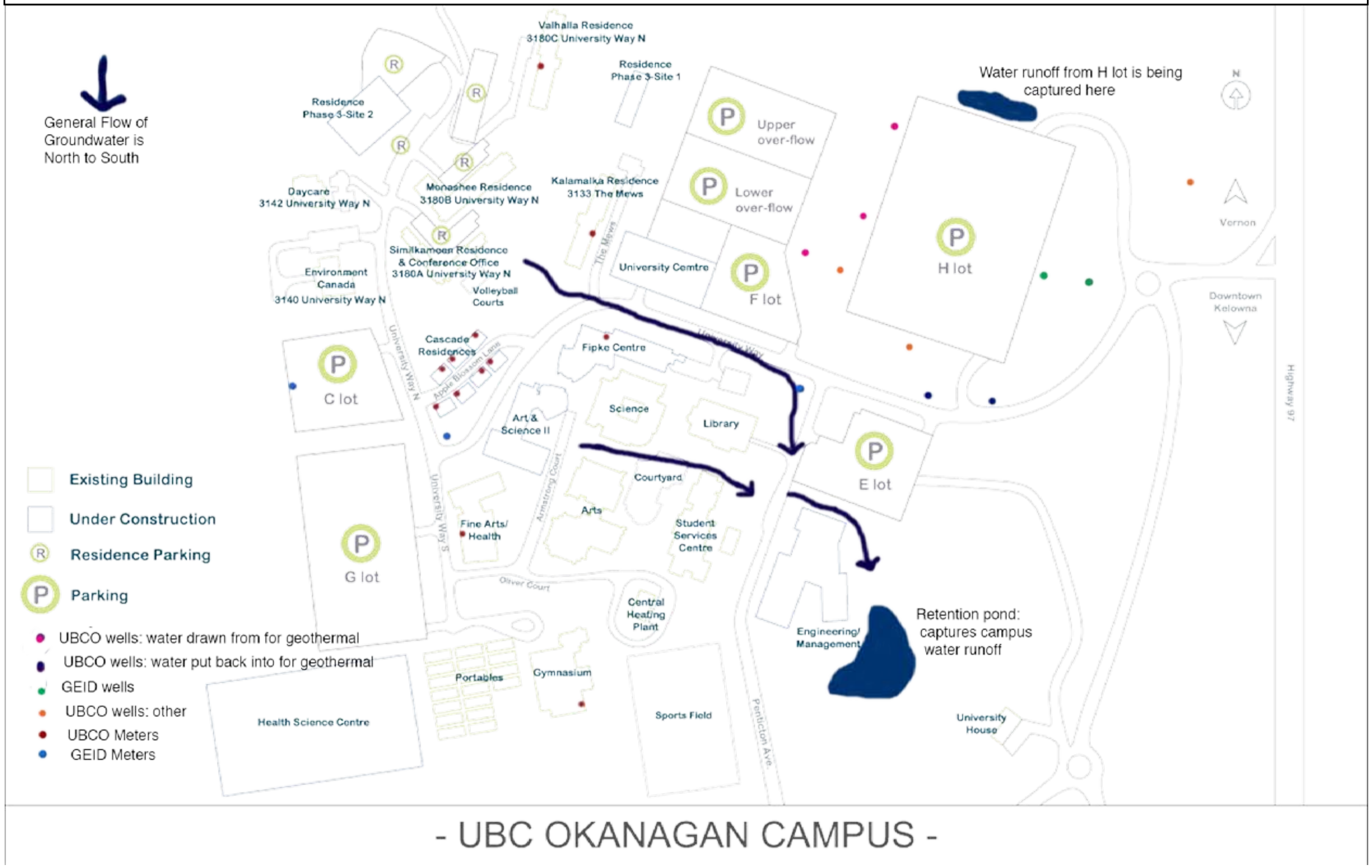
The water which is entered into our campus system includes potable water from Glenmore Ellison Improvement District, and precipitation.

As I have previously discussed in my methods, I have done monthly reading of the UBC-O campus water meters. These meters measure the amount of water the corresponding building uses. For the purpose of this study, I have read the meters on the dates October 1st, October 31st, December 1st, and January 2nd; these dates provide 31-32 days in between each reading so the data should be similar. The data has been changed from m3 into both UK gallons and litres, and each month's readings subtract the previous months readings to determine the amount of water used in between the dates of the two readings. See pages 39-43 for data tables.

All of the student residences except for two currently have water meters installed. Each month I read these meters, collected the data, and calculated the number of people per building; from this I have been able to estimate the average water consumption per person / per month by the students living in residences. Three of the buildings include clothing washing machines; Valhalla residences, Kalamalka residences, and Cascade residence building C.

To calculate how much water was used per person/ per month I divided the amount of people per building by the total consumption of the building. For Valhalla and Kalamalka, the laundry water use was included in this without any additional calculations. I then calculated the per person/ per month consumption for Cascade buildings A, B, D, E, F, and G; the average per person/ per month consumption for these six buildings has been used as the average per person/ per month consumption for residence and laundry Cascade building C. The total amount of consumption from building C subtracted by the calculated average total consumption left the amount of water being used for laundry for all of the Cascades. This total amount of laundry water

Figure 8: Map indicating locations of UBCO wells, GEID wells, UBCO meters, GEID meters, groundwater catchments, and flow of groundwater. Source of base map: UBC Okanagan AVP Operations 2008.



was then divided by the total number of people living in all of the Cascade buildings to provide a per person/per month average of water use for laundry facilities. This per person/per month average consumption for laundry facilities is then added to the per person/per month average consumption without laundry facilities. All of these averages for all residence buildings with meters, is then divided to provide a total average/per person/monthly consumption.

For the month of October, the total residences average/per person/monthly consumption (including an average of 1,404.15 litres water/per person/month for laundry in Cascades) was 5106.25 litres. For the month of November, the total residences average/per person/monthly consumption (including average of 130.73 litres water/per person/month for laundry in Cascades) was 4,230.25 litres. See pages 41-43 for data tables. The data for the month of December was very variable because students left for the holidays at different times during the month.

In addition to these readings, I have been receiving monthly readings for the total amount of water used by UBC-O from GEID staff. During the month of October, UBC-O used 11,145,000.00 litres of water; In November, UBC-O used 12,399,700.00 litres of water; In December UBC-O used 6,982,275.98 litres of water (see appendix A).

The monthly readings from GEID from the months of October to November will include extra consumption of water from construction. The construction companies spray water on the dry soils so the areas do not become dusty. The readings for December will also be significantly different because of the reduction in students attending classes on campus and living in residences. The meter readings are all accurate, but it is unclear about exactly how water is being used as there are so many variables which change.

Outputs

Water naturally leaves our campus system through groundwater flow, surface runoff, or evapotranspiration. The water which we flush down toilets, sinks, and drains is taken to the City of Kelowna as sewage. The meter which measures the amount of water leaving campus through water using equipment and infrastructure is read daily by UBC-O staff. The data has been added together into total monthly readings, and changed from m3 into both UK gallons and litres; each month's readings subtract the previous month's readings to determine the amount of water used in between the dates of the two readings. I have received these readings from them and have correlated these reading with those from GEID. During the month of October, UBC-O disposed of 22,116,380.00 litres of water; In November, UBC-O disposed of 21,732,470.00 litres of water; In December UBC-O disposed of 16,466,669.99 litres of water. This does not match up to the input readings, as it shows much more water being disposed of than used (see appendices A and B). After talking with facilities management, the lack of correlation between these readings is still unclear. The UBC-O output meter has been calibrated, so this problem needs to be looked into in more depth.

Description of UBC-O Water Delivery System

The water used for bathroom, kitchen, laboratory, cleaning, etc. on campus is provided from GEID. The infrastructure which pipes the water from McKinley reservoir to the campus has also been built by GEID. The infrastructure on campus which connects to GEID infrastructure was built by OUC (presently UBC-O).

UBC-O has been planned so there is a storm runoff drainage system. The system directs the overland flow which can be quite substantial during the spring snowmelt. The water follows this overland and groundwater course to one large retention pond/ wetland habitat, and also a newly forming small catchment area.

Figure 9: Surface water flow. The large angular rocks prevent the soil from becoming saturated and therefore the water from having high turbidity. Photographs by author.

Figure 10: Map indicating locations of GEID and UBCO water meters.

Source of base map: UBC Okanagan AVP Operations 2008.

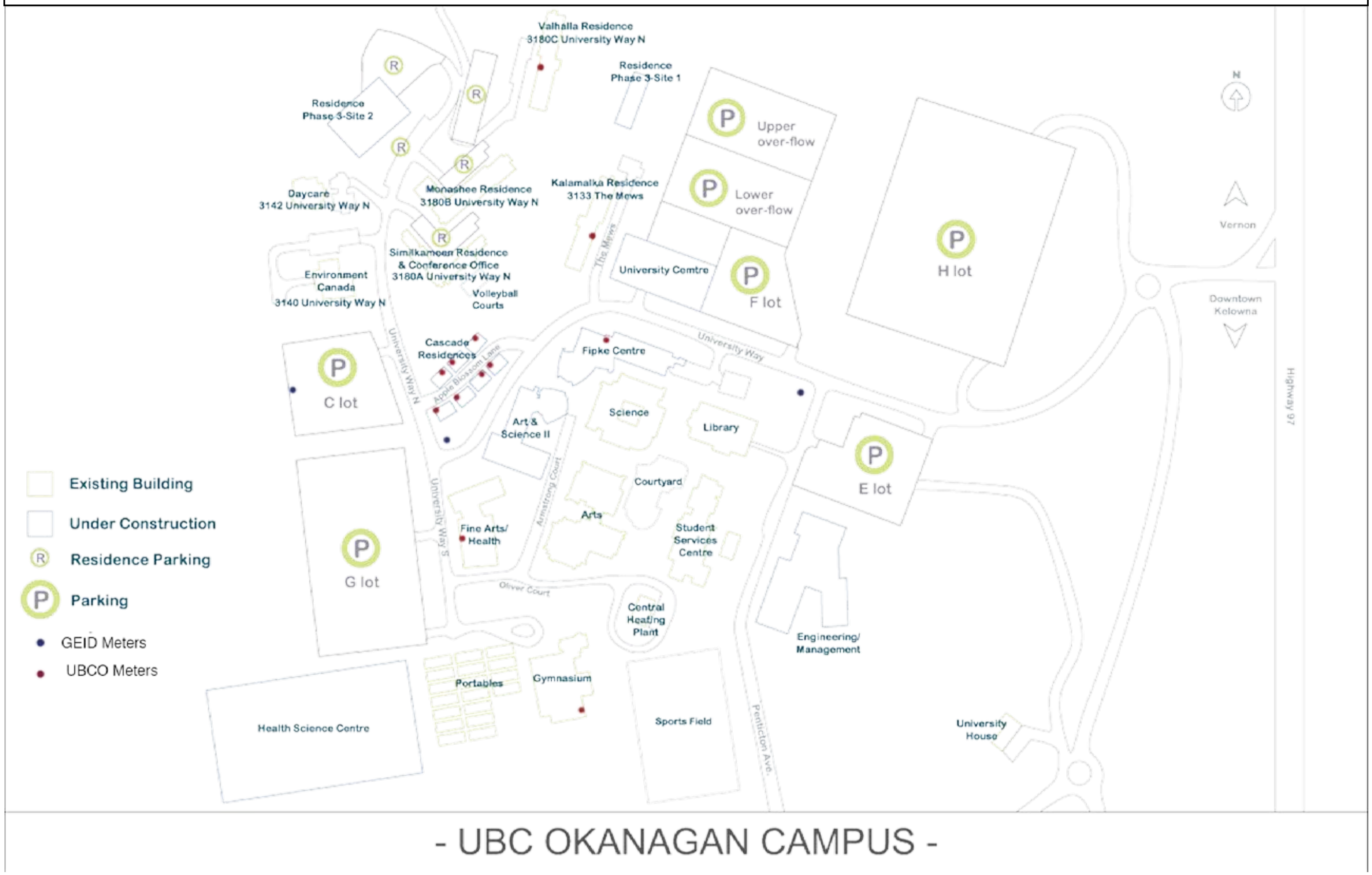
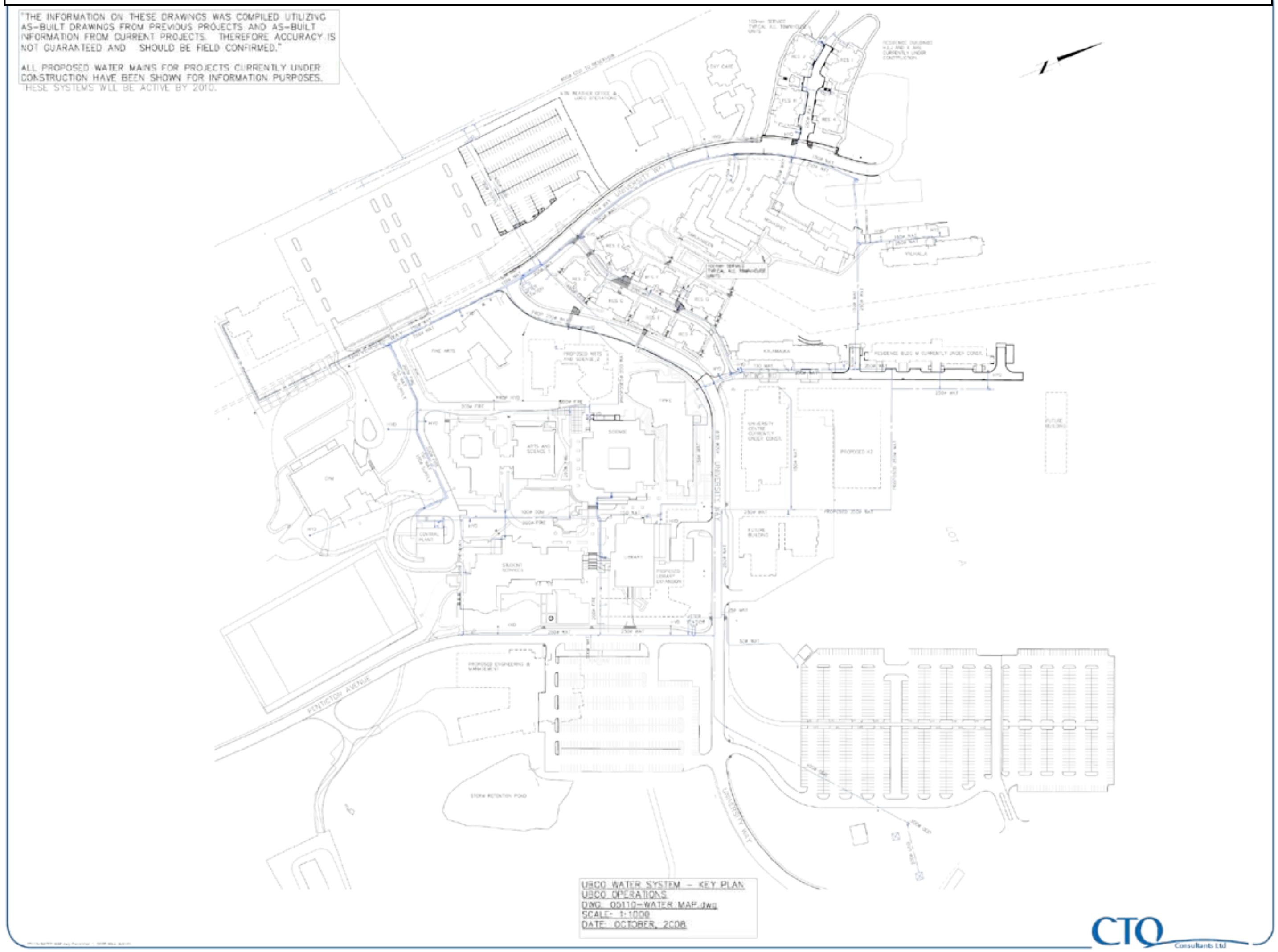


Figure 11: The UBC-O Water System Key Plan/Schematics. Source: Walroth 2008**.**



Surface Water Catchments

The surface water catchments on campus include one large retention pond/ wetland habitat in the southeast quadrant of the campus, and also a newly forming small catchment area in the northeast quadrant of campus (see Figure 12). The southeast surface water catchment has formed because of the natural flow of groundwater, the lower elevation, and the management of flow at UBC-O. The small northeast catchment has been formed from runoff over the newly built H parking lot; the parking lot slopes to the North, and the amount of water in the catchment area can vary from very little water to a substantial amount depending on the season.

Figure 12: Retention pond/wetland habitat in December and May. Photos by author.

Wells

The UBC-O campus has a total of ten wells. Three of those wells (wells ten, four, and five) are used to draw water from in order to heat the new hydrothermal heated building on campus, and two of the wells (wells six and seven) are used to put the water pulled from wells ten, four, and five back into the ground. Two of the wells on campus are owned by GEID (vector wells) and one of the two wells is used during the summer months. The well is used in the summer because of the increased need for irrigation water, and the wells are not used from August/ early September until the Spring because the costs to use the wells would triple in the winter, water is better quality in the winter, and flows drop in the winter. The last three wells on campus are owned by UBC-O, but are currently not being used.

Figure 13: Groundwater flow and surface water catchments. Source of base map: UBC Okanagan AVP Operations 2008.

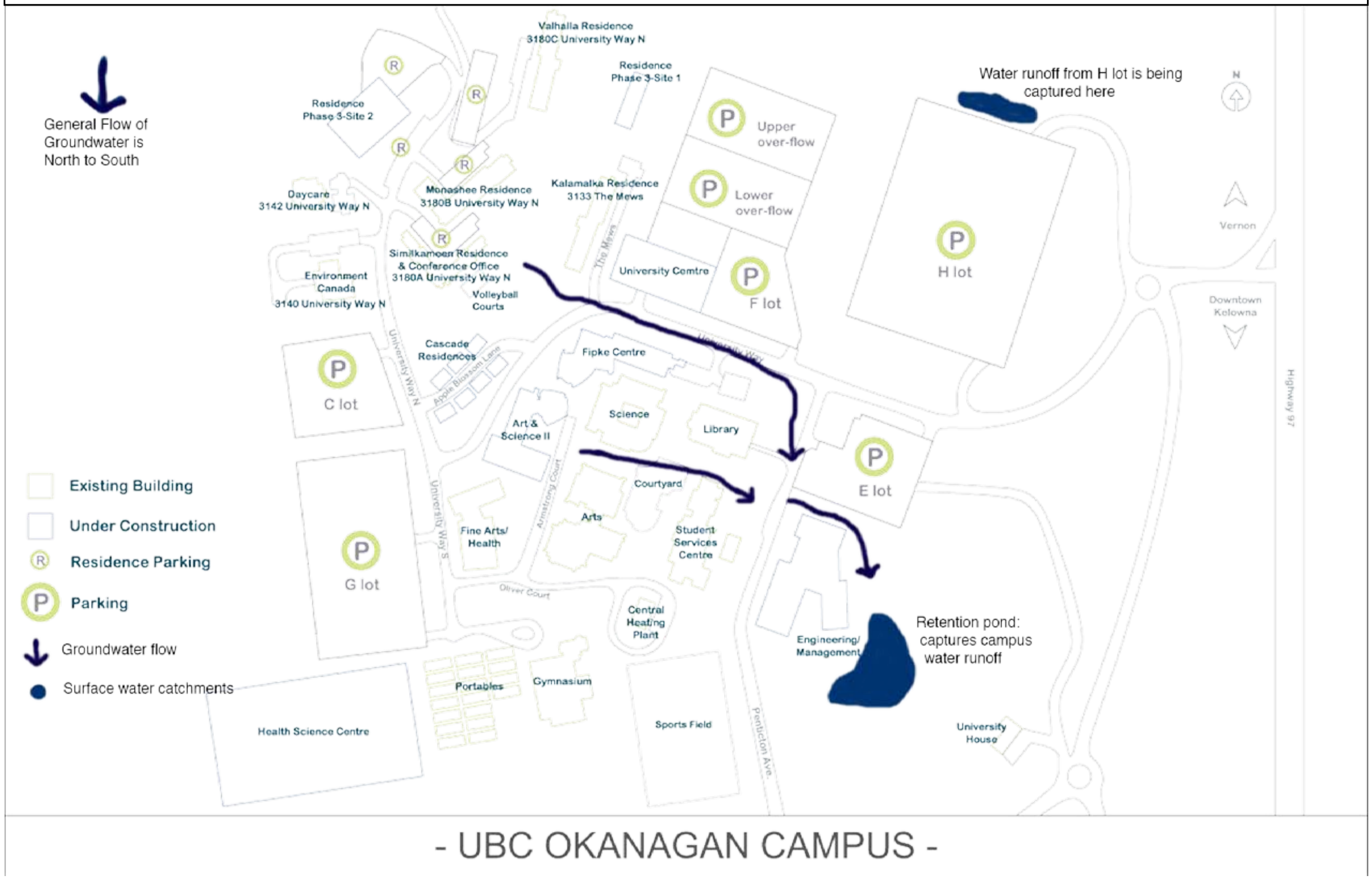
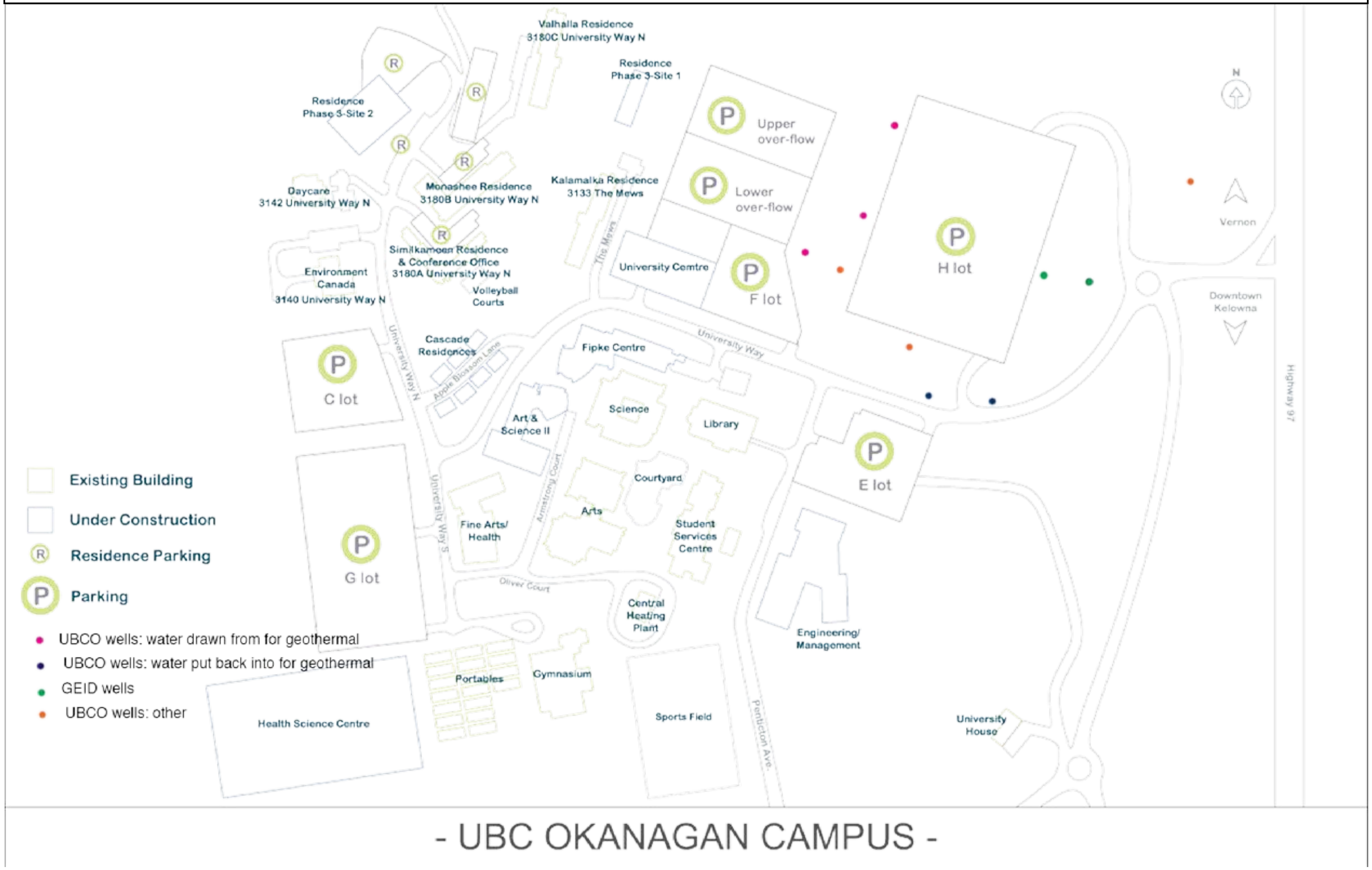


Figure 14: Locations of GEID and UBC-O wells. Source of base map: UBC Okanagan AVP Operations 2008.



UBC-O Water Using Equipment Inventory

Researching the type of water using equipment on campus is essential to ensuring the future water sustainability of UBC-O. According to the BC Green Building Code Background Research Water Efficiency by the Lighthouse Sustainable Building Centre (2007: 12):

> The Ministry of Environment is currently researching implementation of higher standards for water conservation of plumbing fixtures. Specifically, one of their planned actions is to convene a sub-committee of the Water Conservation Strategy Working Group. The sub-committee is to address proposed amendments to the water efficiency regulation, including:
>
> - Ultra low flush toilets (6 litre) and urinals in new developments; and
> - Similar standards for industrial, commercial and institutional buildings.

UBC-O's water using equipment in general does meet the higher standards described by the Lighthouse Sustainable Building Centre for water conservation for plumbing fixtures. Of the thirteen types of toilets I have encountered on campus, I was able to location information regarding water consumption for seven of them; the consumption of all of these was 6.0 litres/ flush. Of the three types of urinals I have encountered on campus, I found information regarding water consumption for two of them; this included one which uses 3.8 litres/ flush, and 0.0 litres/flush (3.78 litres used to clean/ month). There are seven types of shower heads found on campus, and I located information regarding water consumption for two of them; these two shower heads use 9.5 litres/ minute. The other types of equipment I have included in the inventory include bathtubs, washing machines, drinking fountains, dishwashers, automatic beverage machines, ice machines, kitchen faucets, and residential industrial faucets. The recently completed Fipke Centre is the on-campus model for efficient urinals, but I am unsure of the consumption of the type of toilets in the building (see appendix C, pages 45-51, for full details of water using equipment at UBC-O).

UBC-O Water Faucet Rating System

The washroom faucet rating system uses the data in the water using equipment inventory, as well as multiple tests to test the average consumption/ minute used by each faucet type. I could not use the consumption quoted by the companies because the on campus psi (pounds per square inch) is 70. The average consumption/ per minute ratings from companies is not confirmed to have been calculated at 70 psi. From the testing, I have confirmed that the Symmons Auto Press type faucet uses the least amount of water/ minute; an average of 1.69 litres/minute. The Delta Sensor #1 and Delta Sensor #2 follow close behind as they use an average of 2.4 litres/minute and 2.34 litres/ minute. Even though the Symmons Auto Press uses less water per minute on average, I believe the Delta Sensor #1 and Delta Sensor #2 are more sustainable. The Symmons Auto Press does not let the user control how long the faucet stays on; the range of time the faucet stays on is from nine seconds to thirty-five seconds. Both Delta Sensor faucets turn off when you remove you hands from under the water, and this ensures there is no wasted water. The faucets which need to be turned on manually were all found to be inefficient; this is in part due to the average amount of water/ minute released, as well as the possibility that the faucet may be left on or left dripping.

Central Courtyard Pond and Fountain

In the UBC-O central courtyard, a large pond with a fountain greets all students, faculty, and staff on campus. The water in the pond sits in concrete and flows out through three basalt rock fountains. The fountain does recycle the water, and the pond is drained, re-filled and cleaned once a month from April to October. From November to March the pond is drained and left unused due to the freezing temperatures. Each month an observed average of a couple of inches of water evaporates from the pond. I have calculated that the total surface area of the pond to be 2,387.509 square feet, and the average depth to be 1.082 feet. The volume of pond is therefore 2,583.28 cubic feet, and 73,150.343 litres of water is used to fill the pond each month. The pond and fountain has been apart of the campus central courtyard for many years now, but the basalt rocks are a new 2008 addition to the pond. The university spent between $9,000.00 and $10,000.00

on the basalt rocks. The pond and fountain is a large part of the campus aesthetics, culture, and overall environment.


Figure 15: The UBC-O central courtyard pond and fountain in summer (left) and winter (right). Photo on left courtesy of UBCO Student Recruitment and Advising Welcome Centre. Photograph on right by author.

On Campus Irrigation

UBC-O currently has one large sports field which does not need irrigation, and a number of mixed vegetation gardens and grassed areas which it irrigates. The sports field has just recently been excavated and turf has been placed overtop the field. The soils which the field have been built on are very sandy, and therefore very permeable to water. It was very costly to irrigate the field before the turf was placed because the water was going straight back into the ground without fully saturating the grass. The turf requires no irrigation, and the university will save a very large amount of water as well as money with the new and improved field. A second UBC-O turf sports field will be made in the near future. Currently the irrigation system being used is composed of separate Hunter parts, but a new Hunter system will be replacing it this year. The new system is a 'Hunter: IMMS 2.0 Central Control Irrigation System' which is a sustainable, technologically advanced system. The system includes a wireless rain sensor, dew point sensor, and freeze sensor which ensures that during rainy weather or when temperature drops to two degrees Celsius, the irrigation system will shut down. The system will also report if there are water line breaks, and will provide graphs on potential water use per system. The system, at a cost of $99,851.00 will conserve water in the area (irrigation) which uses the most amount of water, and therefore will save the university a large sum of money over time.

Food Services

Aramark Higher Education is the main company which provides food services to UBC - Okanagan. There also includes a privately owned sushi bar, and a UBC-O Students Union run pub and coffee shop. Aramark produces the majority of food and has the most food services water using equipment on campus. According to Aramark UBC-O Assistant Director, Natalie McHugh, all UBC-O Aramark staff have been instructed to run only full loads in the dishwashers, and to promptly send in work orders for leaky faucets. The floors and walls in the Aramark food service areas are washed daily, and the equipment is cleaned every three days or sooner if it is needed. The water using equipment found in all UBC-O food service areas is included in the equipment inventory found on pages 42-49. In the new up and coming student service centre, the 'Green Thread Café' will have all 'energy star' equipment, and the new student pub will have water efficient floor cleaning infrastructure installed.

Future Opportunities and Recommendations

Current UBCO Water Saving Initiatives

1.) The recent replacement of grass on the sports field for turf. This means there will be large savings in water consumption because the turf will not need to be watered, and water which enters the field will stay absorbed in the turf longer. The upcoming second sports field will also be covered with turf.

2.) Replacement of inefficient irrigation system for the new, computerized Hunter IMMS 2.0 Central Control Irrigation System. The system will be aware of precipitation, dew point, and temperature so it does not water the campus any more than it needs to. It will also report if there are water line breaks, and it will produce potential water use graphs for each system.

3.) Instalment of Energy Star water efficient food services equipment in the soon to be complete ‘Green Thread Café’.

4.) Instalment of water efficient floor cleaning infrastructure in the soon to be completed Student Service Centre pub.

5.) Future instalment of water re-circulating system for Dr. Scott Reid’s fish holding facility. This facility uses about 98% less water, which will save 4.2 million US gallons of water per year.

Monetary Costs of Basic Water Consumption and Disposal

One cubic meter of water from GEID costs $0.25 cents. One cubic meter of sewage water to the City of Kelowna costs $0.78 cents. As indicated in Table 1 below, reduction of water use through conservation measures could substantially reduce the sewerage costs paid by the university to the city of Kelowna. Significant savings could also result from the implementation of a more efficient water supply for the courtyard pool (for additional details regarding GEID consumption calculations, city of Kelowna sewerage charges, and the pool water use, see appendices E and F.

Table 1: Monetary costs of UBC-O water consumption.

Basic Water Use and Disposal	Cost
Average cost of GEID water consumption/ month: (Average calculated from GEID readings January 1, 2008 to December 31, 2008)	= $3,044.38/ month
Average cost of water discharge to City of Kelowna/month: (Average calculated from UBCO readings October 1, 2008 to January 1, 2009)	= $15, 682.03/ month
Total cost to fill the central courtyard pond/month: (Does not include evapotranspiration)	$75.33/ month ($18.28 to GEID and $57.05 to the City of Kelowna)

Table 2: Cost of Water Efficient Retrofitting.

	Total Monetary Costs	Total Monetary Gains	Total Water Consumption Savings
Replacing (1) field with turf:	$1.2 million (*includes some donor money)	Unknown exact amount, but substantial.	Unknown exact amount, but substantial.
Replacing old irrigation with Hunter Irrigation System:	$99,851.00 plus GST	Unknown exact amount, but substantial.	Unknown exact amount, but substantial.
Water recycling system for fish research:	$42,000.00 ($20,000 provided by UBC Vancouver)	$15,380.00/ year	4.2 million US gallons/ year
Replacing inefficient bathroom taps:	Variable. Dependant on type of tap used to replace, amount of taps replaced, etc.	Unknown exact amount, but substantial.	Unknown exact amount, but substantial.

Figure 16: The beauty of fresh water. Photograph by author.

Recommendations Regarding Changes and Implementation

1.) Installation of water efficient water using equipment. In the faucet ranking system, I have provided information regarding which faucets are efficient and which need to be replaced. For the most part, I do not suggest replacing all faucets which are not the most sustainable on the market, but I do suggest replacing the very inefficient faucets and when inefficient faucets do not work, to replace them with very efficient ones. A building which I believe does need immediate replacement of bathroom faucets is the campus daycare building. The faucets are stripped so it is very confusing in which way to turn them on and turn them off, and they have a large amount of unnecessary water pressure emitted from them which splash up onto to counter and persons using the faucet. Through observation, as well as from talking to daycare staff, the manual turn faucets are often left on by the children because of the confusing nature of them, and the children get splashed often. I suggest installing an automatic sensor faucet such as the Delta Sensor #1, or Delta Sensor #2 in the daycare building.

Figure 17: 0 litre/flush 'Kohler sensor' urinals found in the Fipke Centre. Photograph by author.

2.) Installation of water meters in all UBC-O buildings. Of the (currently completed) twenty buildings on campus, only ten of them have water meters which are installed and working properly. Nine of these meters are located in student residences. The other meter is located in the Fine Arts/ Health Building. Also the Fipke Centre has a meter, but it has not yet been electrically installed. The meter in the Gym was installed improperly, so the readings from it could not be used for this study. Water meters are useful because facilities can keep track of the records to discover where water is being consumed, and therefore where conservation needs to be implemented, as well as they can be integrated into incentive programs. According to Jonathan Chonoweth, water meters in residential areas encourage impartiality and transparency, they clearly establish who the big users are, and therefore provide an incentive for people to fix leaky taps, etc (2005:172). This sort of proactive approach can be integrated into the campus lifestyle as well.

3.) Gather additional information regarding the pond in the central courtyard. As stated in the UBC-O Master Plan, a principal is to “Orchestrate an aesthetic and welcoming entry experience onto the campus from all entry points” (UBC-O 2005:7). The pool in the central courtyard is a symbol of our campus culture and in Part 2 of this study I have conducted research to assess the symbolic and aesthetic significance of this campus feature. I have conducted a cross-cultural study of water symbolism and the relation of water, as symbol, to landscape aesthetics, campus culture and sustainable water management practices. This included a questionnaire which assessed the attitudes of the UBC-O campus community towards the central courtyard pool and the retention pond/ wetland located at the southeast corner of the campus. I have also reviewed two other university campuses in order to assess the extent to which those initiatives are shaped by aesthetic sensibilities and inclusion of water features. I believe this study is a key indicator of how the UBC-O campus culture feels about the pond in the central courtyard, and further recommendations surrounding this can be found in part two of this study: “UBC Okanagan Water Features: Aesthetic Perceptions and Symbolic Associations”.

4.) Ensure future development of the UBC-O landscape includes the planting of only indigenous and drought resistant vegetation, and also a minimal removal of natural vegetation. If we remove some of the ponderosa pine and Douglas fir areas on campus, it is possible that we will experience an increase in surface runoff in the spring, or another type of change in the campus hydrological system. Also by planting or by not removing native plant species, UBC-O will need to irrigate less often. The species which are native to the area are drought resistant and need very little water. Not only will this save water, but also by doing so we will “design landscape ‘thresholds’ in order to make the experience of campus expressive of the Okanagan landscape and to initiate the sense of place of UBC Okanagan” (UBC-O 2005:7).

5.) Integrate decision making between facilities, staff, faculty, and students. By including all types of individuals affected by water equipment retrofitting or replacement, water use and disposal, and water aesthetics on campus into the decision making process, will ensure that a well accepted, and most likely sustainable choice can be made. If two minds are better than one, then more must be even better! John C. Dernbach believes "To operationalize sustainable development, we need to recognize that one principal - integrated decisionmaking- holds the other principals together. Integrated decisionmaking would ensure that environmental considerations and goals are integrated or incorporated into the decisionmaking processes for development, and are not treated separately or independently" (2003:14).

C.J. Barrow has a similar outlook on public integration into environmental management. He believes that the public may be able to provide additional advice that management may have missed, as well as their opposition to management will be reduced and they will be able to identify much more with management's final decisions (2006: 155). Both myself, and Dr. John Wagner suggest that UBC-Okanagan create a social and environmental stewardship committee composed of students, faculty, and staff. This committee could be chaired by Leanne Bilodeau, someone else in the 'Workplace Health and Sustainability' office, or it call fall under the mandate of the Okanagan Sustainability Institute (OSI). I believe that through creating this committee we can provide a space for the campus community to collaborate together and improve aspects of the campus that may not have been visible from only one or two perspectives.

Recommendations Regarding Educational Programs

1.) Students, faculty, and staff need to be aware of the sensitive semi-arid environment in which we live, and how reducing water consumption can ensure a healthy future for the Central Okanagan. Through an on-campus water conservation education program, UBC-O can reduce its water consumption through discretionary water use changes. Actions as simple as ensuring taps are completely shut off, reporting leaky plumbing, washing dishes without the water running constantly, and showering for a shorter period of time will make a big difference when the 6,067 students, faculty, and staff begin to change their habits. The City of Kelowna has reduced their consumption of water by 20%

through their Watersmart program. They are now working towards an additional 15% reduction goal which would mean a consumption of 34 litres/per capita/per person a day. World Water Day is a great UBC-O success each year and an annual water education tool for everyone on campus. If a year round water conservation initiative was implemented, it would benefit UBC-O and individuals even more.

Water Conservation Education Ideas:

a.) World Water Day (already an annual initiative)
b.) Access to informational materials
c.) Signage in washrooms, residences, labs, and studios to remind campus community to conserve water
d.) An online or on campus ‘pledge to be water smart’
e.) A water smart challenge contest
f.) A rain barrel painting contest

Possible Future Projects

1.) The air conditioning system in the science building is a water cooled system. This means that a constant trickle of water runs through the system to cool the building. When I asked an air conditioning trades person about this type of system, I was told it is more efficient in cooling the building, but it does use quite a bit of water. The water is not recycled, but rather it goes straight down the drain. A great project could be to investigate this system further and determine the amount of water it uses on a daily, monthly, and annual basis.

2.) A continued monthly reading of the water meters on campus. A regular collection of readings can determine whether the per/capita consumption of water on campus is increasing or decreasing.

3.) A more in depth look at the type of water using equipment on campus and the possible alternatives.

4.) A comprehensive review of and inventory of types of flora found currently on campus, and the types of proposed flora for the campus. Areas to focus on in this review include whether or not the species is indigenous or not, and drought resistant or not. Through my basic observation of the types of grasses and plants currently on campus, it seems as though they are the generic choices that have been made popular from our British colonial past, and are not water conservative.

5.) An environmental impact assessment (EIA) and Social Impact Assessment (SIA) of the retention pond/ wetland area on campus. As this is a partially 'man-made pond' and development around it has been ongoing this would not be a conventional EIA. However, the recent rapid development of the parking lot, connector road to the highway, and engineering building around the wetland is most likely impacting the species living in and using the area for migration more now than ever. As a major component of this assessment, the water in the pond can be tested for harmful chemicals picked up during runoff from the construction areas and parking lot. Also, the way the pond affects the local hydrologic system and vegetation should be considered.

Conclusions

The University of British Columbia - Okanagan is a growing and vibrant campus. The water conservation challenges that come with an increasing population brings exciting, new opportunities to become sustainable in a creative way. Through retrofitting and replacement of inefficient equipment, installation of very efficient equipment, campus community water conservation education, and integrated decision making, UBC-O will be able to decrease its per capita water consumption. The basic water balance and overview of how water is used at UBC-O, the water using equipment inventory, the information about the water delivery system, the storm water system, and the basic description of the climate, geology, hydrology, and ecology of the Kelowna/ UBC-O campus area can hopefully be used by UBC-O facilities, Dr. John Wagner, and other individuals interested in local water for their research and management.

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Appendices

Appendix A. Input Meter Readings

UBCO Water Meter Readings			
	Oct-01		
	m3 (ongoing total)	gallons (m3 X 220[UK gallons])	litres (UK gallons X 4.54609)
Gymnasium	n/a	n/a	n/a
Fine Arts and Health Building	947.6 m 3	208472	947732.474
Fipke Building	n/a	n/a	n/a
University Way and University Way N	n/a	n/a	n/a
University Way and Penticton Road	n/a	n/a	n/a
Valhalla Residences	14977.93 m 3	3295144.6	14980023.91
Kalamalka Residences	13278.47 m 3	2921263.4	13280326.33
Cascade Residences- A	1280.265 m 3	281658.3	1280443.981
Cascade Residences- B	189.332 m 3	41653.04	189358.468
Cascade Residences- C	2278.101 m 3	501182.22	2278419.478
Cascade Residences- D	202.510 m 3	44552.2	202510
Cascade Residences- E	154.135 m 3	33909.7	154156.548
Cascade Residences- F	2371.998 m 3	521839.56	2372329.605
Cascade Residences- G	1178.936 m 3	259365.92	1179100.815
	October		
TOTAL UBCO USE (Data from GEID meters):	m3 (per month)	UK gallons (per month)	litres (per month)
Done monthly. E.g. Oct 1- 31 use is 11,145.0 m3	11,145.0 m 3	2,451,557.27	11,145,000.00

Appendix A (cont'd)

UBCO Water Meter Readings	Oct-31				
	m3 ongoing total)	**UK gallons (m3 X 220)**	**litres (UK gallons X 4.54609)**	**UK gallons used. Oct 1 - Oct 31**	**Litres used. Oct 1 - Oct 31**
	n/a	n/a	n/a	n/a	n/a
Gymnasium	963.1	211882	963234.641	3,410	15,502
Fine Arts and Health Building	n/a	n/a	n/a	n/a	n/a
Fipke Building	n/a	n/a	n/a	n/a	n/a
University Way and University Way N	n/a	n/a		n/a	n/a
University Way and Penticton Road	15553.62	3421796.4	15555794.4	126,651.40	575,766.09
Valhalla Residences	13912.95	3060849	13914895.03	139,585.60	634,569.03
Kalamalka Residences	1420.413	312490.86	1420611.573	30,832.60	140,167.59
Cascade Residences- A	348.314	76629.08	348362.694	34,976.04	159004..226
Cascade Residences- B	2822.403	620928.66	2822797.571	119,746.48	544,378.09
Cascade Residences- C	362.376	79722.72	362426.66	35,170.52	159,916.66
Cascade Residences- D	289.951	63789.22	289991.535	29,879.52	135,834.99
Cascade Residences- E	2652.460	583541.2	2652830.813	61,701.64	280,500.53
Cascade Residences- F	1323.884	291254.48	1324069.078	31,888.58	144,968.26
Cascade Residences- G					
		November			
		m3/ month	UK gallons/month	Litres/month	
TOTAL UBCO USE (Data from GEID meters):		12,399.7 m3	2,727,552.69	12,399,700.00	
Done monthly. E.g. Oct 1-31 use is 11,145.0 m3					

Appendix A (cont'd)

UBCO Water Meter Readings	Dec-01				
	m3 (ongoing total)	**UK gallons (m3 X 220)**	**litres (UK gallons X 4.54609)**	**Dec 1-Oct 31 = UK gallons used**	**Dec 1-Oct 31 = litres used**
	n/a	n/a	n/a	n/a	n/a
Gymnasium	984.7 m 3	216634	984837.661	4,752	21,603
Fine Arts and Health Building	n/a	n/a	n/a	n/a	n/a
Fipke Building	n/a	n/a	n/a	n/a	n/a
University Way and University Way N	n/a	n/a	n/a	n/a	n/a
University Way and Penticton Road	16162.47	3555743.4	16164729..513	133,947	608,935
Valhalla Residences	14520.39	3194485.8	14522420	133,636.80	607,524.95
Kalamalka Residences	1571.76	345787.2	1571979.73	33,296.34	151,368.16
Cascade Residences- A	592.715	130397.3	592797.861	53,768.22	244,435.17
Cascade Residences- B	3016.123	663547.06	3016544.65	42,618.40	193,747.08
Cascade Residences- C	535.998	117919.56	536072.932	38,196.84	173,646.27
Cascade Residences- D	438.506	96471.32	438567.303	32,682.10	148,575.77
Cascade Residences- E	2829.094	622400.68	2829489.51	38,859.48	176,658.69
Cascade Residences- F	1476.629	324858.38	1476835.43	33,603.90	152,766.35
Cascade Residences- G					
		December			
		m3/month)	UK gallons/month)	Litres/month)	
TOTAL UBCO USE (Data from GEID meters):		6981.3 m 3	1,535,886.00	6,982,275.98	
Done monthly. E.g. Oct 1-31 use is 11,145.0 m3					

Appendix A (cont'd)

UBCO Water Meter Readings	Jan-02				
	m3	**UK gallons (m3 X 220)**	**litres (UK gallons X 4.54609)**	**Jan 2- Dec 1 = UK gallons used**	**Jan 2 - Dec 1 = litres used**
	n/a	n/a	n/a	n/a	n/a
Gymnasium	990.727 m 3	217959.94	990865.5036	1,325.94	6,027.83
Fine Arts and Health Building	n/a	n/a	n/a	n/a	n/a
Fipke Building	n/a	n/a	n/a	n/a	n/a
University Way and University Way N	n/a	n/a	n/a	n/a	n/a
University Way and Penticton Road	16459.33 m 3	3621052.6	16461631.01	65,309.20	296,901.50
Valhalla Residences	14818.33 m 3	3260032.6	14820401.6	65,564.80	297981.6
Kalamalka Residences	1649.781 m 3	362951.82	1650011.639	17,164.62	78,031.91
Cascade Residences- A	880.156 m 3	193634.32	862851.957	63,237.02	270,054.10
Cascade Residences- B	3116.966 m 3	685732.52	3117401.751	22,185.46	100,857.10
Cascade Residences- C	617.077 m 3	135756.94	617163.267	17,837.38	81,090.34
Cascade Residences- D	514.037 m 3	113088.14	514044.5807	16,616.82	75,477.28
Cascade Residences- E	2920.871 m 3	642591.62	2921279.338	20,190.94	92,789.83
Cascade Residences- F	1539.310 m 3	338648.2	1539525.196	13,789.82	62,689.77
Cascade Residences- G					
TOTAL UBCO USE (Data from GEID meters):					
Done monthly. E.g. Oct 1-31 use is 11,145.0 m3					

Appendix A (cont'd)

UBCO Residence Water Use			
	# of people	Oct 31 - Oct 1= litres used	Average consumption
			31 days
Valhalla Residences	175 (includes washing machines)	575,766.09	3,290.09 litres/person/month (includes laundry)
Kalamalka Residences	175 (includes washing machines)	634,569.03	3,626.10 litres/person/month (includes laundry)
Cascade Residences A	40	140,167.59	4,908.33 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
Cascade Residences B	40	159,004	5,379.25 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
Cascade Residences C	38 (includes washing machines)	544,378.09	(14,325.45) (BUT includes laundry)
Cascade Residences D	40	159,916.66	5,402.06 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
Cascade Residences E	40	135,834.99	4,800.02 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
Cascade Residences F	40 (included one personal dishwasher)	280,500.53	8416.66 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
Cascade Residences G	40	144,968.26	5,028.235 litres/person/month (includes average of 1,404.15 litres water/per person/month for laundry)
		Total residences average/per person/monthly consumption (including average of 1,404.15 litres water/per person/month for laundry in Cascades) for October = 5106.25 litres (All average consumptions combined [except Cascade C] / 8)	
		If Cascades C was using the average amount of consumption (total amount of water/ number of buildings), then 390,354.97 litres is left. This leftover water is most likey used for laundry. If we divide the total # all of the cascades residents with the leftover water amount (390, 354.97/278) we can say each resident uses an average of 1,404.15 litres of water used for laundry/person/month.	

Appendix A (cont'd)

UBCO Residence Water Use			
	# of people	Oct 31- Dec 1 = litres used	Average consumption
			31 days
Valhalla Residences	175 (includes washing machines)	608,935	3,479.62 litres/person/month (includes laundry)
Kalamalka Residences	175 (includes washing machines)	607,524.95	3,471.57 litres/person/month (includes laundry)
Cascade Residences- A	40	151,368.16	3,914.93 litres/person/month (includes average of 130.73 litres water/per person/month for laundry)
Cascade Residences- B	40	244,435.17	6,241.6 litres/person/month (includes average of 130.73 litres water/per person/month for laundry)
Cascade Residences- C	38 (includes washing machines)	193,747.08	(5,098.60) (BUT includes laundry)
Cascade Residences- D	40	173,646.27	4,471.88 litres/person/month(includes average of 130.73 litres water/per person/month for laundry)
Cascade Residences- E	40	148,575.77	3,845.12 litres/person/month (includes average of 130.73 litres water/per person/month for laundry)
Cascade Residences- F	40 (included one personal dishwasher)	176,658.69	4,547.19 litres/person/month (includes average of 130.73 litres water/per person/month for laundry)
Cascade Residences- G	40	152,766.35	3,949.88 litres/person/month (includes average of 130.73 litres water/per person/month for laundry)
		Total residences average/per person/monthly consumption (including average of 130.73 litres water/per person/month for laundry in Cascades) for November = 4,230.25 litres (All average consumptions combined [except Cascade C] / 8)	
		If Cascades C was using the average amount of consumption (total amount of water/ number of buildings), then 36,344.62 is left. This leftover water is most likely used for laundry. If we divide the total # all of the cascades residents with the leftover water amount (36,344.62/278) we can say each resident uses an average of 130.73 litres of water used for laundry/person/month.	

Appendix A (cont'd)

UBCO Residence Water Use			
	# of people	Dec 1 - Jan 2nd = litres used	Average consumption
			32 days
Valhalla Residences	175 (includes washing machines)	296,901.50	* variable because students left for the holidays
Kalamalka Residences	175 (includes washing machines)	297981.6	* variable because students left for the holidays
Cascade Residences- A	40	78,031.91	* variable because students left for the holidays
Cascade Residences- B	40	270,054.10	* variable because students left for the holidays
Cascade Residences- C	38 (includes washing machines)	100,857.10	* variable because students left for the holidays
Cascade Residences- D	40	81,090.34	* variable because students left for the holidays
Cascade Residences- E	40	75,477.28	* variable because students left for the holidays
Cascade Residences- F	40 (included one personal dishwasher)	92,789.83	* variable because students left for the holidays
Cascade Residences- G	40	62,689.77	* variable because students left for the holidays

Appendix B. Output Meter Readings

UBCO Output Meter Readings

	Oct 1 - 31			Nov 1 - 30			Dec 1- Jan 1		
	m3 per month	UK gallons per month	Liters per month	m3 per month	UK gallons per month	Liters per month	m3 per month	UK gallons per month	Liters per month
Total use:	22,116.38	4,864,923.48	22,116,380.00	21,732.47	4,780,475.09	21,732,470.00	16,466.67	3,622,161.02	16,466,669.99

Appendix C.

UBCO Water Using Equipment Inventory

Toilets													
	Crane Presto manual	Crane manual Covered	American Standard manual mini covered	Toto #1 sensor	Toto #2 sensor	Delta manual	Kohler manual	Zurn Aqua-flush manual	American Standard	Cam-bridge Brass manual	Eljer Manual old	Eljer Manual new	Mona-shee ?
consumption			6.0 l/flush	6.0 litres/ flush	6.0 litres/ flush		6.0 litres/ flush	6.0 litres/ flush	6.0 litre/flush			6.0 litres/ flush	
Library				11						10			
Library Food Services													
Student Service Centre					6				1	16			
SSC Food Services													
Arts	17			13									
Arts Foods Services													
Sciences	18			14									
Fine Arts and Health				15	2								
Gym										19			
Fipke						22							
Daycare		1	5										
Environment Canada							2	8					
Similkameen											46		
Simi Café'													
Monashee		1							28		3		110
Valhalla											92		
Kalamalka											92		
Cascades All												139	

Appendix C (cont'd)

Urinals			
	Toto sensor	Kohler sensor/auto	Cambridge Brass manual
consumption	3.8 litres/ flush	0 litres. 1 gallon month/for cleaning	
Library	9		
Library Food Services			
Student Service Centre	4		
SSC Food Services			
Arts	12		
Arts Foods Services			
Sciences	14		
Fine Arts and Health	6		
Gym	2		4
Fipke		6	
Daycare			
Environment Canada			3
Similkameen			
Simi Café'			
Monashee			
Valhalla			
Kalamalka			
Cascades All			

Appendix C (cont'd)

Showers								**Bath-tubs**
	Symmons Safety mix	Newsent	Symmons Hydrapipe	Moen	Similkameen (?)	Monashee (?)	Valhalla and Kalamalka (?)	Mivet
consumption		9.51 litres/ minute max		9.5 litres/m inute				
Library								
Library Food Services								
Student Service Centre								
SSC Food Services								
Arts								
Arts Foods Services								
Sciences	2							
Fine Arts and Health								
Gym			23					
Fipke								
Daycare		2						
Environment Canada								
Similkameen					44			6
Simi Café'								
Monashee						116		
Valhalla							90	
Kalamalka							90	
Cascades All				140				

Appendix C (cont'd)

Drinking Fountains						
	Sunroc	Hansley Taylor	Haws Berkeley, California	Other (stick out)	Elkay	Other (in wall)
consumption					36.33 litres/ hour	
Library						1
Library Food Services						
Student Service Centre						2
SSC Food Services						
Arts	4	2				
Arts Foods Services						
Sciences	4	3				
Fine Arts and Health		1			2	
Gym			2	1		
Fipke						
Daycare						
Environment Canada						
Similkameen						
Simi Café'						
Monashee						
Valhalla						
Kalamalka						
Cascades All						

Appendix C (cont'd)

Bathroom Faucets												
	Symmons auto press	Symmons Manual	American Standard sensor	? Manual turn	Moen #1 manual	Moen #2 manual	Moen #3 manual	Delta #1 sensor	Delta #2 sensor	Delta Manual	Walter manual	Moen # 4
consumption												
Library	12		10	2								
Library Food Services												
Student Service Centre	11			2								
SSC Food Services												
Arts	13			15								
Arts Foods Services												
Sciences	16			7								
Fine Arts and Health					5			9				
Gym				14								
Fipke									23			
Daycare											8	
Environment Canada						6						
Similkameen							40					
Simi Café'												
Monashee							114			28		
Valhalla		92										
Kalamalka		92										
Cascades All												141

Appendix C (cont'd)

Dishwashers				**Beverage makers (auto)**	**Ice machines**	**Washing Machines**
	Hobart small	Hobart large	Residence	Varying styles	Varying styles	Maytag
consumption						
Library						
Library Food Services						
Student Service Centre						
SSC Food Services		1		7	1	
Arts						
Arts Foods Services				1	1	
Sciences					2	
Fine Arts and Health						
Gym						
Fipke						
Daycare	1					
Environment Canada						
Similkameen						
Simi Café'						
Monashee						
Valhalla			2			9
Kalamalka			2			9
Cascades All			1 (building F)			8 (building C)

Appendix C (cont'd)

Kitchen Faucets									
	Doubles (1 tap)	Doubles (2 taps or 1 tap and 1 sprayer)	Small Sinks	Eurostream	Waltec	Delta	Monashee	Moen	Val and Kal
consumption									
Library									
Library Food Services	1		2						
Student Service Centre									
SSC Food Services	3	1	7						
Arts									
Arts Foods Services		1	1						
Sciences									
Fine Arts and Health			1						
Gym									
Fipke									
Daycare			3	1					
Environment Canada			1						
Similkameen	5								
Simi Café'					2				
Monashee						28	89		
Valhalla									8
Kalamalka									8
Cascades All								71	

Appendix D. Water Consumption Ranking (based on litres/flush, or litres/minute).

1: Very efficient. Is currently one of the most efficient available.
2: Efficient. I recommend replacing with 1A when needed.
3: Inefficient. I recommend replacing with 1A when needed.
4: Very inefficient. I recommend replacing with a 1A as soon as possible.

Style and Function in Relation to Efficiency Ranking (based on personal observation).

A: Very efficient.
B: Inefficient. I recommend replacing with 1A when needed.
C: Very inefficient. I recommend replacing with 1A as soon as possible.

Faucets Data										
	Ranking	Minimum time on	Maximum time on (with hand under)	Test One	Test Two	Test Three	Test Four	Test Five	Average test time	Average litres/minute
				(10 sec)	(10 sec)	(10 sec)	(10 sec)	(10 sec)	(10 seconds)	
Symmons Auto Press	2B	9 seconds	35 seconds	290 ml	275 ml	290 ml	280 ml	275 ml	282 ml	1.692
American Standard Auto Sensor	4A	2 seconds	10 seconds	720 ml	810 ml	800 ml	750 ml	780 ml	772 ml	4.632
Moen #1	3B	1 second	infinate	700 ml	1700 ml (on max)	1650 ml	750 ml	300 ml	variable	variable
Moen #2 manual	3C	1 second	infinate	1600 ml	1400 ml	1800 ml max	700 ml	1500 ml	variable	variable
Moen #3	3B	1 second	infinate	550 ml	1600 ml	300 ml	700 ml	800 ml	variable	variable
Manual (X version)	3B	1 second	infinate	425 ml	375 ml	750 ml	475 ml	1,000 ml (on max)	variable	variable
Manual (O version)	4C	1 second	infinate	950 ml	750 ml	400 ml	2850 ml (on max)	600 ml	variable	variable
Manual (with aerator)	3B	1 second	infinate	500 ml	600 ml	385 ml	440 ml (on max)	260 ml	variable	variable
Delta sensor #1	2A	3 seconds	30 seconds	250 ml	250 ml	500 ml	500 ml	500 ml	400 ml	2.4
Delta sensor #2	2A	5 seconds	45 seconds	350 ml	360 ml	350 ml	450 ml	440 ml	390 ml	2.34
Walter manual	4B	1 second	infinate	650 ml	1800 ml (on max)	1700ml	1100 ml	360 ml	variable	variable

Appendix E. UBC-O Central Courtyard Pond Measurements

Table 1	
Line	Length (ft)
#1	3.11
#2	68.2
#3	77.2
#4	37.5
#5	34.1

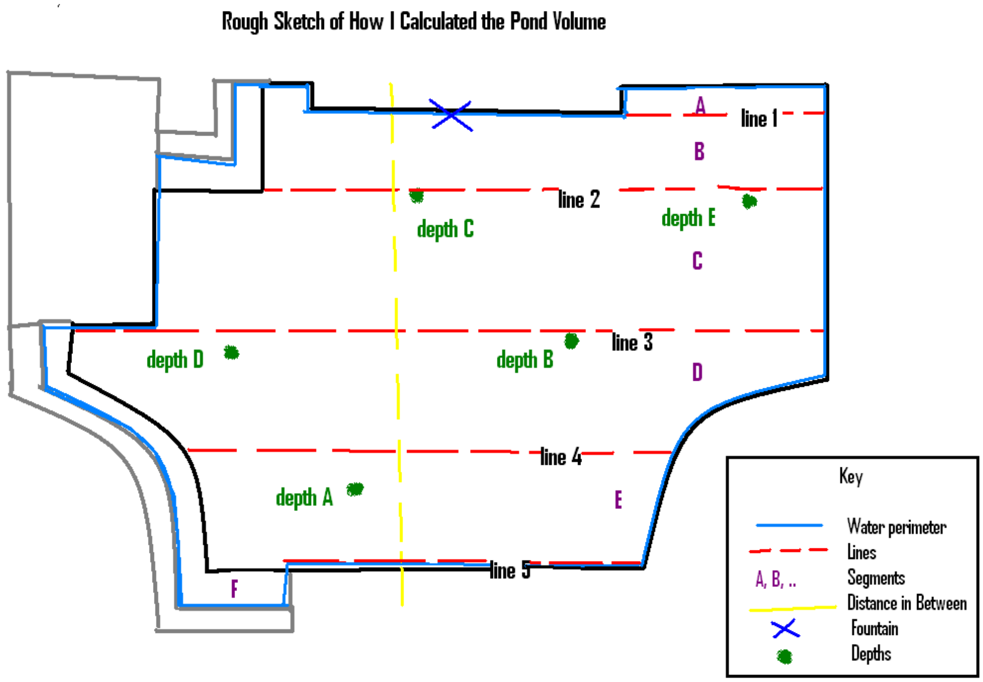
Table 2	
Segment	Distance (ft)
A	2
B	15.4
C	11
D	11.5
E	9
F	2

Table 3				
Segment	Side 1 (ft)	Side 2 (ft)	Distance (ft)	Area (square ft)
A	3.11	3.11	2	6.22
B	3.11	68.2	15.4	549.164
C	68.2	77.2	11	799.7
D	77.2	37.5	11.5	659.525
E	37.5	34.1	9	322.2
F	34.1	16.6	2	50.7
Total Surface Area				*2,387.509*

Table 4	
Sections	Depths (ft)
A	1.3
B	1.3
C	1.2
D	1.5
E	.11
Total	*5.41*
Average	*1.082 feet*

Table 5
Volume = area x average depth
2,387.509 x 1.082 = 2583.284738 Volume of pond = 2,583.28 cubic feet Or 73,150.343 litres

Appendix E (cont'd)



Appendix F. Monetary Costs Calculations

Table 6:

Total cost to fill the central courtyard pond/ month:

73,150.343 litres = 73.1503 M3

GEID costs $0.25 cents (per M3) x 73.1503 = $18.28

City of Kelowna costs $0.78 cents (per M3) x 73.1503 = $57.05

$18.28 to GEID and $57.05 to the City of Kelowna

= Total $75.33/ month

*Does not include evapotranspiration

Average cost of GEID water consumption/ month: (Average calculated from GEID readings January 1, 2008 to December 31, 2008). Total = 146,130.6 / 12= 12,177.55 m 3. Average monthly cost (.25 x 12,177.55 m3) = $3,044.38

Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sep 08	Oct 08	Nov 08	Dec 08	Total
M3	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3
9493.6	5623.3	9646.2	11235.3	9982.4	10240.0	20346.0	22368.9	16668.9	11145.0	12399.7	6981.3	146130.6

Average cost of water discharge to City of Kelowna/month: (Average calculated from UBCO readings October 1, 2008 to January 1, 2009). Total = 60,315.52/3 =20,105.173 m3. Average monthly cost (.78 x 20,105.173 m3) = $ 15,628.03

Oct 08	Nov 08	Dec 08	Total
M3	M3	M3	M3
22,116.38	21,732.47	16,466.67	60,315.52