Sustainability Project: A Shower Head Analysis for Walter Gage Residence

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APSC 261

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UBC Social Ecological Economic Development Studies (SEEDS) Student Report

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EXECUTIVE SUMMARY

In recent years, UBC has taken very seriously the concept of being sustainable, and this can be seen through many of the initiatives they have been part of. One area where UBC is attempting to be more sustainable is in their water use. In previous SEEDS projects, groups did triple bottom line analyses of competing low flow shower heads using economic, social and environmental indicators to make a suggestion to Student Housing and Hospitality Services (SHHS) about a more sustainable replacement shower head. While these groups did attempt to make suggestions to SHHS, it was concluded that more research would need to be done before a decision was made. Our SEEDS project was designed to make further suggestions to SHHS about implementing low flow shower heads at Walter Gage residence, and more broadly, for all of UBC.

Walter Gage residence had one criteria that other residences didn't have: The replacement shower head needed to have a wand in order for the cleaning and maintenance staff to more easily clean the showers. Knowing this, we researched different shower head brands and their reviews and came up with two shower heads which we would test. These two shower heads are called WaterPik Eco-flow 6-Setting Handheld, and Niagara Earth Massage Handheld, hereinafter respectively referred to as the "WaterPik" and "Niagara". To analyze the possibility of using these as the new replacement shower heads, we did a triple bottom line assessment using economic, social and environmental indicators.

Our economic analysis was done by comparing the cost of each shower head, along with the amount of money saved in water conservation over a ten year period. Our analysis showed that the Niagara and WaterPik would both be economically viable, but the Niagara more so. Our environmental analysis was done by calculating the water saved by switching to each shower head, and why conserving water has environmental implications in Vancouver when we have a nearly unlimited supply of fresh water. This analysis also showed the the Niagara and WaterPik would have positive environmental impacts, with the Niagara again having the more positive impact. Our final indicator was a social analysis, where we gave each student testing out these shower heads surveys asking questions to determine their satisfaction with the shower heads and other such questions . This analysis did not go as well as anticipated for a variety of reasons.

Each student involved in testing out the competing shower heads (6 male, 6 female) were given these surveys after each shower head had been tested for a week. When we collected all the surveys,

we only received 19 out of the possible 36 surveys back, and it could be seen that most had been filled out at the last minute because of the date at the top. With so few responses, it was very difficult to make conclusions about each respective shower head. From the small sample size, it seemed as if the Niagara shower head was the least popular, but without more information, we could not say so conclusively.

Based on our economic and environmental indicators, the Niagara shower head seemed like the most viable option, but the surveys did not give us enough information to make a confident recommendation to SHHS about implementing it as the new replacement shower head. Without knowing the very important social implication of how much the students enjoyed the shower, we can only suggest that more research be done to examine the social impact of a new replacement shower head.

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GLOSSARY

Wand - A shower head with an included attached cord so that it may become hand-held.

Life-Cycle Analysis - An analysis done by looking at the entire life-cycle of a product, including cost of product, warranty, and money saved during lifetime.

Triple Bottom Line Assessment - An analysis that goes beyond the conventional method of solely economic implications, also including environmental and social aspects.

LIST OF ABBREVIATIONS

UBC - University of British Columbia

SEEDS - Social Ecological Economic Development Studies

GPM - Gallons Per Minute

DPG - Dollars Per Gallon

BC - British Columbia

SHHS - Student Housing and Hospitality Services

TBL - Triple-Bottom-Line

1.0 INTRODUCTION

Water is fundamental to human existence. Here in Vancouver we are surrounded by ocean, rivers, lakes and rainfall so water seems so abundant that we often take it for granted. Yet this is a luxury that much of the world does not experience, as over a billion people worldwide lack access to clean drinking water (UN Water, 2013). UBC has acknowledged that our water consumption is increasing at an unsustainable rate, and has taken many initiatives to decrease water consumption around the campus. One area for potential improvement is the showers in the residences of UBC, as these account for 13% of all water used at UBC (UBC Sustainability, 2011).

Currently there are close to 10,000 residents in UBC housing who all have access to showers in their residences (Student Residence - Vancouver, 2014). Last year, in conjunction with SEEDS, APSC 261 students performed triple bottom line assessments of shower heads for use in residences. In these projects, the students compared different "low flow" shower heads against the current replacement shower head, and concluded that there were more sustainable alternatives to the current replacement shower heads and recommended more research be done on the subject before UBC residences changes the model of shower head used as a replacement.

Our project picks up where these previous SEEDS projects left off. We built upon the knowledge that they amassed as a point from which to start our investigation, and implement their recommendation to compare specific models to find the most sustainable shower head option. In addition to the social, environmental, and economic analysis of shower heads inherent to a TBL assessment, our stakeholder Ricky Biring, specified that the replacement shower head must have a wand extension. This is necessary because Walter Gage residence is converted into a hotel during the summer term, requiring maintenance staff to clean the showers very frequently. The shower heads that were originally installed in Walter Gage Residence have wand extensions which maintenance staff use to rinse the walls of the showers, however the current replacement model does not have a wand extension, making it very difficult for maintenance staff to clean the showers.

In this report, we compare two potential shower heads to the model currently used in Walter Gage residence. Our goal is to determine which model is most sustainable for use in UBC residences. The information for this project will be compiled from previous case studies, technical specifications, and survey results, combined in a triple bottom line (TBL) assessment.

2.0 SHOWER HEAD MODELS

The shower heads evaluated in this report include the current replacement head used by UBC SHHS the Delta Touch Clean, the Niagara Earth Hand-held, and the Waterpik Eco-flow 6-setting Handshower. Illustrations are included below, and each shower head's technical specifications can be found in Appendix E.

Figure 1: The Delta Touch Clean shower head is the current replacement used by UBC SHHS (AMRE Supply, 2014).

Figure 2: The Niagara Earth Hand-held (eBay, 2014).

Figure 3: The Waterpik Eco-flow 6-setting Handshower (The Home Depot, 2014).

3.0 TRIPLE-BOTTOM-LINE ASSESSMENT

3.1 Economic

A key limiting factor for our investigation was a limit of $35.00 per shower head. This constraint was set by the SHHS, and limited the type of solution our group could offer. We ruled out any plumbing work, as it would be far too expensive. A brief investigation revealed that shower timer systems, automated showers, and other electronic methods also exceeded our budget. Thus our group decided to research and compare different models of low-flow shower heads. We decided to compare an inexpensive shower head with 1.5 GPM flow rate, and a more expensive, but still low-flow shower head. After careful consideration, we picked the Niagara Earth Massage 1.5 GPM and the Waterpik Ecoflow 6-Setting Model.

The economic impact of a shower head is best represented in two categories: Fixed Costs and Variable Costs. Fixed Costs are costs which do not vary with amount of product produced or consumed. In this case, the fixed costs are the cost of each shower head unit and the cost of labour required to install the shower head. The lifespans of shower heads are long enough that we will consider the cost of each shower head a fixed cost. The shower heads which this survey considers all have installation times under 10 minutes. Since there is no significant difference in installation time, the cost of installation for all models is very similar and we can factor out the installation time from our economic assessment. Generally, over time fixed costs tend to be overshadowed by the variable costs.

Variable costs are costs which depend on the amount of product produced or consumed. For showers, the product consumed is water. The variable cost is the amount of water used multiplied by the price per unit of water which the city of Vancouver uses. Currently, the water rates for Vancouver is split into two rates depending on the time of year. From October 1st to May 31st, the price of water is $0.00319 per gallon, and between June 1st and September 31st the price is $0.00399 per gallon (City of Vancouver, 2014). If we assume that water usage from showers is constant all year, we can take a weighted average of these two rates to simplify this cost to $0.00346 per gallon. (⅔ * 0.00319 + ⅓ * 0.00399 = 0.00346). The price of each shower head is summarized in the following table:

Table 1: Shower head Prices

SHOWER HEAD	Flow rate	Price	Warranty
Niagara Earth	1.5	$16.86	10-year
Waterpik	2.0	$29.98	Limited Lifetime
Delta	2.0	$19.60	Limited Lifetime

In order to compare the different shower head models from an economic perspective, a number of assumptions must be made. Firstly, we will assume that the time it takes to shower is unrelated to flow rate and shower head model. By keeping shower time constant, our model considers solely flow rate in calculating the cost of the water used in a shower.

We can model the economic impacts of each shower head based on these assumptions. We define the economic impact of a shower head as the price of the shower head plus the flow rate multiplied by the price of water per gallon. Thus, we get the following data:

Table 2: Economic Model of Shower heads

Shower head	<shower head price> + <flow rate>*<price of water per gallon>
Niagara	16.86$ + 1.5 GPM*.00346 DPG
Waterpik	29.98$ + 2.0 GPM*.00346 DPG
Delta	19.60$ + 2.0 GPM*.00346 DPG

It is clear that the Niagara is the cheapest shower head. It has the lowest price per shower head, and consumes the least water. Based on our model, it costs 25% less than the current replacement model.

Annually, UBC consumes approximately $2.5 million, or 4 billion litres of water (UBC Sustainability, 2011). 13% of this total water is used in showers, which means the annual spending is $325000 for 520 Million litres. The current shower heads have a flow rate of 2.5 GPM, and reduction of .5 GPM and 1 GPM have significant impacts on water levels when looking at usage by all residents.

If the $325000 is distributed evenly between the 10,000 residents, each student consumes $32.5 of water per year. Over a 10 year span (the warranty on the Niagara), and considering that each shower head will last at least 10 years we get the following data:

Table 3: Savings for Shower heads

Shower head	Flow Rate	Yearly savings per student	10 year savings/student	Yearly Economic savings
Current Model	2.5	NA	NA	NA
Niagara	1.5	$13.50	$135	$130000
Waterpik	2.0	$6.50	$65	$65000
Delta	2.0	$6.50	$65	$65000

From this table, it is clear that the Niagara has a massive economic advantage, large enough that it can support replacement at the end of warranty and still have a net gain of $50 over 10 years. Economically, we conclude that the Niagara is superior to the other models.

At this point, it is important to remember this data is drawn from the previous assumption that shower time does not depend on flow rate. If we were to assume that shower time is inversely proportional to flow rate, then a better approximation is the following table:

Table 4: Yearly Savings with Time Dependence

Shower Head	Flow Rate	Yearly savings/student	10 year savings/student
Current Model	2.5	NA	NA
Niagara	1.5	$13.50 - 1.5*t*$.00349	$135 - 1.5*y*$.00349
Waterpik	2.0	$6.50 - 2.0*t*$.00349	$65 - 2.0*t*$.00349
Delta	2.0	$6.50 - 2.0*t*$.00349	$65 - 2.0*t*$.00349

In the future, further research could be performed to determine the actual correlation between flow rate and time spent per shower. This information would be useful in providing an even more meaningful economic recommendation.

3.2 Environmental

To measure the environmental impact of the shower heads, we analyzed the amount of water consumed in the different shower head models and the amount of energy used to heat up the water. However, since BC has a zero emission standard for greenhouse gases, there is a negligible environmental effect of consuming more or less energy (The BC Energy Plan, 2009). For this report, our environmental analysis will be based solely on the amount of water conserved by a shower head and the impact this has on the environment.

Here in Vancouver, we have the luxury of a nearly unlimited supply of water. This begs the question, "How does reduced water consumption impact the environment?" This is a question which previous SEEDS projects did not answer, and is important to understanding the environmental implications of water consumption. We can answer this question by looking at the process that water must go through before reaching a shower in residence. However, before getting started on how water reaches UBC, we will begin by discussing the amount of water saved by switching to our two competing replacement shower heads.

As calculated in the economic section of this report, 520 million liters of water at UBC are used each year in showers alone. Since the majority of shower heads currently being used in residences have a flow rate of 2.5 GPM, this number could be drastically reduced with low flow shower heads. The

Waterpik would reduce water consumption by 20% saving 104 million liters of water per year, and the Niagara would reduce water consumption by 40%, saving 208 million liters of water per year. This reduction in water consumption will have environmental implications throughout the entire water cycle.

Before reaching the consumers, water must go through rigorous cleaning and purifying processes. One of the processes that all water goes through in Vancouver is called ozonation, and there are environmental implications to this process. In ozonation, oxygen gas (O2) is transformed into ozone (O3), which is how Oxygen is found in our ozone layer. Ozone is extremely reactive and will latch onto and eliminate nearly all organic products (Oram, 2014). This causes the formation of various by-products such as formaldehyde and hydrogen peroxide. These by-products are known to be harmful to biological systems, but the extent of their toxicity has not yet been determined (World Health Organization, 2012). Since all water in Vancouver goes through this ozonation process, the only environmentally responsible course of action is to reduce water consumption in order to minimize the amount of ozonation that must be performed, thus reducing the amount of toxic by-products produced.

3.3 Social

The social implications to this project were extremely important to Student Housing and Hospitality Services, because their priority is maintaining the satisfaction of the residents. To measure the social impact of the shower heads we had 6 male and 6 female residents in Walter Gage Residence test each shower head, and then had them fill out a survey. This survey was developed in collaboration with the other SEEDS teams investigating low-flow shower heads. Residents filled out a survey about the shower heads already in their residence, then maintenance staff replaced their shower head each week with one of the models being compared in this report, and residents filled out the same survey about each of these models.

The two questions we are most concerned with are the time spent in the shower and user satisfaction with the shower head's performance. Based on the responses to our questions related to user satisfaction, we conclude that residents prefer the Waterpik model the most, the original model less, and the Niagara model the least. While this may seem like it is a valuable piece of information, there were many reasons that the survey did not present us with as clear of results as we had hoped.

The most significant flaw of our survey was that it was limited to very few people. There were only 12 people who tested out the showers and were given the surveys, and only 6 of them filled out the surveys and handing them back. On top of this, all the surveys that we received back were filled out the day they were handed back to us, which implies that the students did not fill them out with care, and while their experience with each shower head was fresh in their minds. We were afraid that this may happen as the survey was optional and students had no added incentive to complete it. Since we have such little data and it is potentially skewed, we cannot draw any conclusions about the social impact of the shower heads.

4.0 SURVEY RESULTS AND ANALYSIS

The surveys were completed on a voluntary basis. After the surveying process was complete, we acquired 18 useable surveys. The results were analyzed and presented graphically, using R statistical software. The data is separated into separate metrics: pressure, spread, and satisfaction. Descriptive statistical data was created by using data analysis tools available in LibreOffice suite.

4.1 Numerical Results

For our ratings of Pressure and Spread, 3 is the ideal result. Ratings of 1 and 5 correspond to too little or too much, respectively. A sample of the survey and completed physical surveys will be attached in the physical copy of this report. These results pertain to the total population, as the number of females that completed the survey were minimal (three useful surveys). There is no information on female preferences for the WaterPik. Description of the male-only results are available as well. Below are the statistical descriptions of the results:

4.1.1 Pressure

In terms of pressure, residents seemed to prefer the WaterPik more than the others. While the average and medians for pressure are relatively close, the Niagara had a larger variation in opinion for pressure than the others. Looking only at the male population, it is more likely that they think the current shower head is not high enough pressure, but there is minimal change with the Niagara.

Table 5: Water Pressure Results Analysis

	Mean	Median	Standard Deviation
Current shower head (Gage)	2.714	3	0.755928946
WaterPik Eco-flow 6-Setting Hand Held	3	3	0.7071067812
Niagara Earth Hand Held	3	3	1.4142135624

4.1.2 Spread

Male residents prefer the spread of the current shower head and Waterpik more than the Niagara. The current shower head results in more consistent results, and would likely minimize variance in satisfaction for male residents. There were no surveys completed by female residents for this shower head.

Table 6: Shower Spray Spread Results Analysis

	Mean	Median	Standard Deviation
Current shower head (Gage)	2.857	3	0.377964473
WaterPik Eco-flow 6-Setting Hand Held	3.2	3	0.8366600265
Niagara Earth Hand Held	3	2.5	1.2649110641

4.1.3 Satisfaction

The WaterPik seems to give more satisfaction, but there are some people who will dislike the shower head, as indicated by the larger standard deviation. The current shower head is the most consistent, giving the least standard deviation. The Niagara is considered by residents to be consistently worse than the others.

Table 7: Overall User Satisfaction Results Analysis

	Mean	Median	Standard Deviation
Current shower head (Gage)	3.286	3	0.5714285714
WaterPik Eco-flow 6-Setting Hand Held	4	4	1.2247448714
Niagara Earth Hand Held	2.667	2.5	0.8164965809

4.1.4 Shower times

As the surveys were completed all at once, the times provided by the residents are considered inaccurate, and cannot account for the difference in shower times that may result from use of different shower heads. Assuming the results are of the original shower head, residents typically use spend 11.6 minutes in the shower and shower 6.6 times per week. It is not possible to see the effect of the shower heads and satisfaction on the time spend in the shower.

4.1.5 Conservation

Most residents seem to agree that conservation is somewhat relevant in their lives, and there is some correlation between their opinion on conservation and the total time spent in the shower each week (obtained by multiplying the number of showers taken each week, but the amount of time spent in the shower each time). Extra factors, such as length of hair or physical activity, may also influence the result, and were not measured in this survey.

4.2 Written responses

Only one survey contained a written response. It was against the use of fixed shower heads. No other residents spoke out against the shower heads. Feedback from the plumber seems to indicate that the quality of the mounting mechanism for the Niagara is worse than that of the WaterPik. No comments were made in comparison to the current shower head.

5.0 CONCLUSIONS AND RECOMMENDATIONS

In this SEEDS project, we performed a triple bottom line assessment comparing low-flow shower heads to recommend the most sustainable option to Student Housing and Hospitality Services based on economic, social, and environmental indicators. More specifically, we were asked to make a recommendation for a shower head with a wand attachment for the replacement shower head used in Walter Gage Residence. Our recommendation applies not only to Walter Gage Residence but to all UBC residences.

Based on the price of water and the price and warranty of each shower head, we conducted a life-cycle analysis over a ten year period to determine the cost using each competing shower head. This analysis showed that if we swapped out all existing shower heads right now with the Niagara shower head, they would pay for themselves within the year in water conservation, and would save UBC over $100,000 a year. One assumption we made is that shower length remains constant even after switching shower heads. Our survey was inconclusive in assessing if a change in shower heads affected length of shower, and this would drastically affect the amount of savings if it was deemed that people took longer shower with the Niagara. Future SEEDS groups could investigate this correctness of this assumption and it's impacts on the TBL assessment.

In assessing the environmental impact of these competing shower heads, a similar result was found. The savings in water consumption from the Niagara would account for 208 million liters per year, which would have beneficial environmental impacts when looking at the entire water cycle. However, similarly to in our economic analysis, this savings would become obsolete if it was found that people take longer showers with the Niagara.

As our final indicator, we created a survey to assess the social impact of the shower heads. Implementing the survey deemed more difficult than we anticipated, and we only got a handful of surveys back. This amount of data was insufficient to draw concrete conclusions about the social impact of shower heads. This confirms our conclusion that the Niagara shower head is the best option available, but more research must be completed for a better understanding of shower length and shower enjoyment affect the TBL assessment.

Based on our evaluation of the social, economic, and environmental impacts of the shower heads investigated, we conclude that the Niagara shower head seems to be the most sustainable, but more research must be done before a suggestion to SHHS is made.

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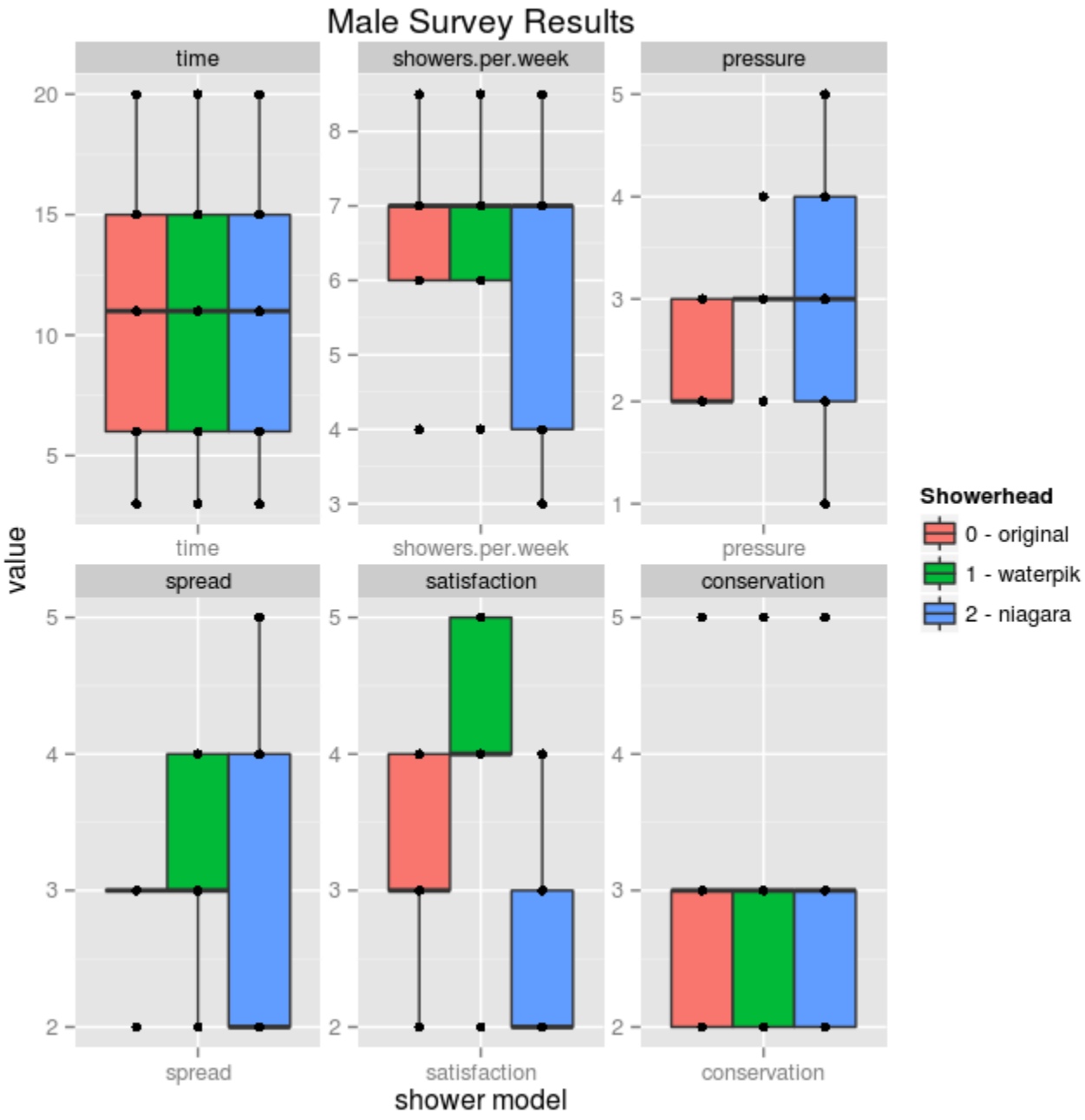
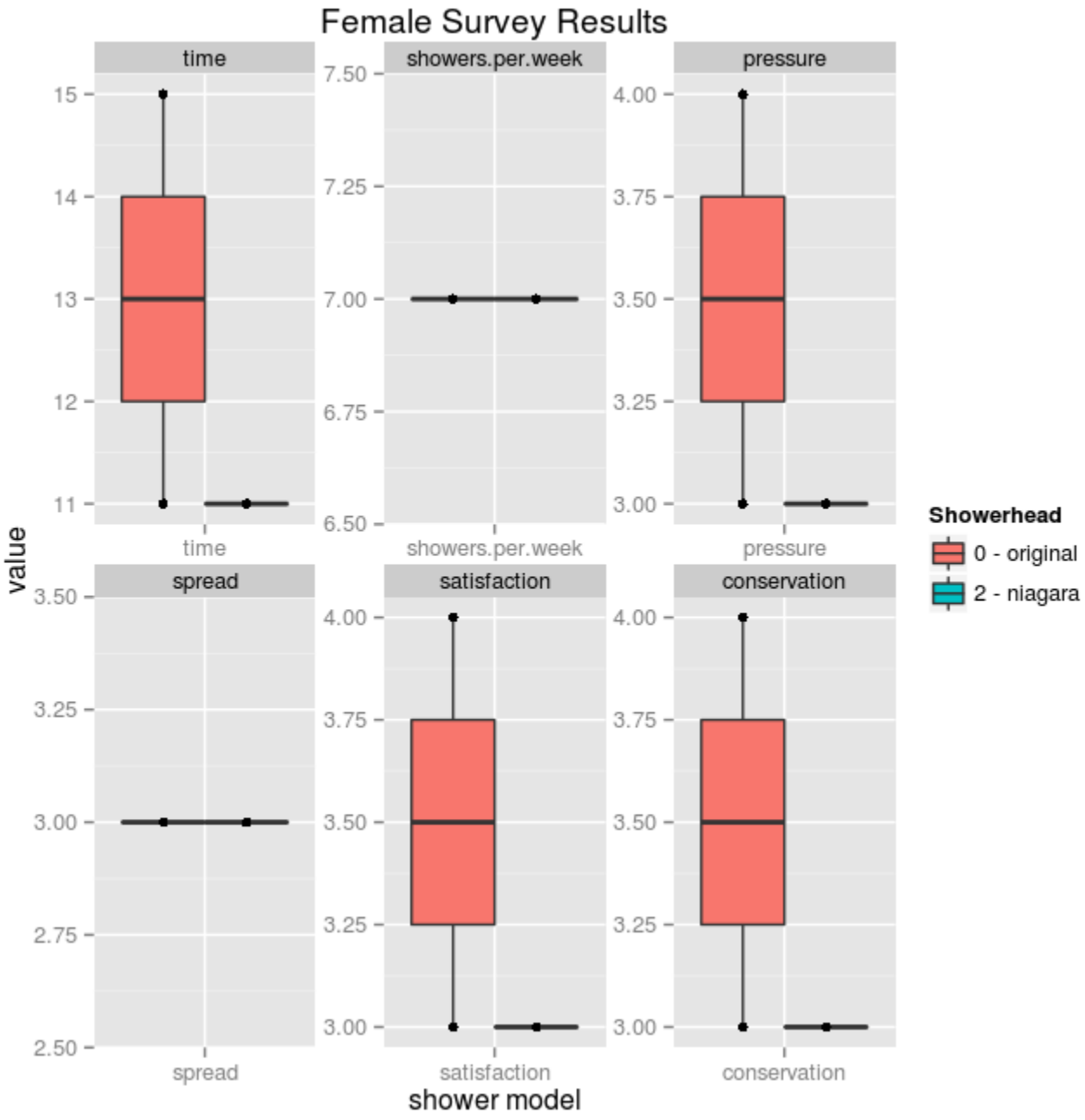
APPENDICES

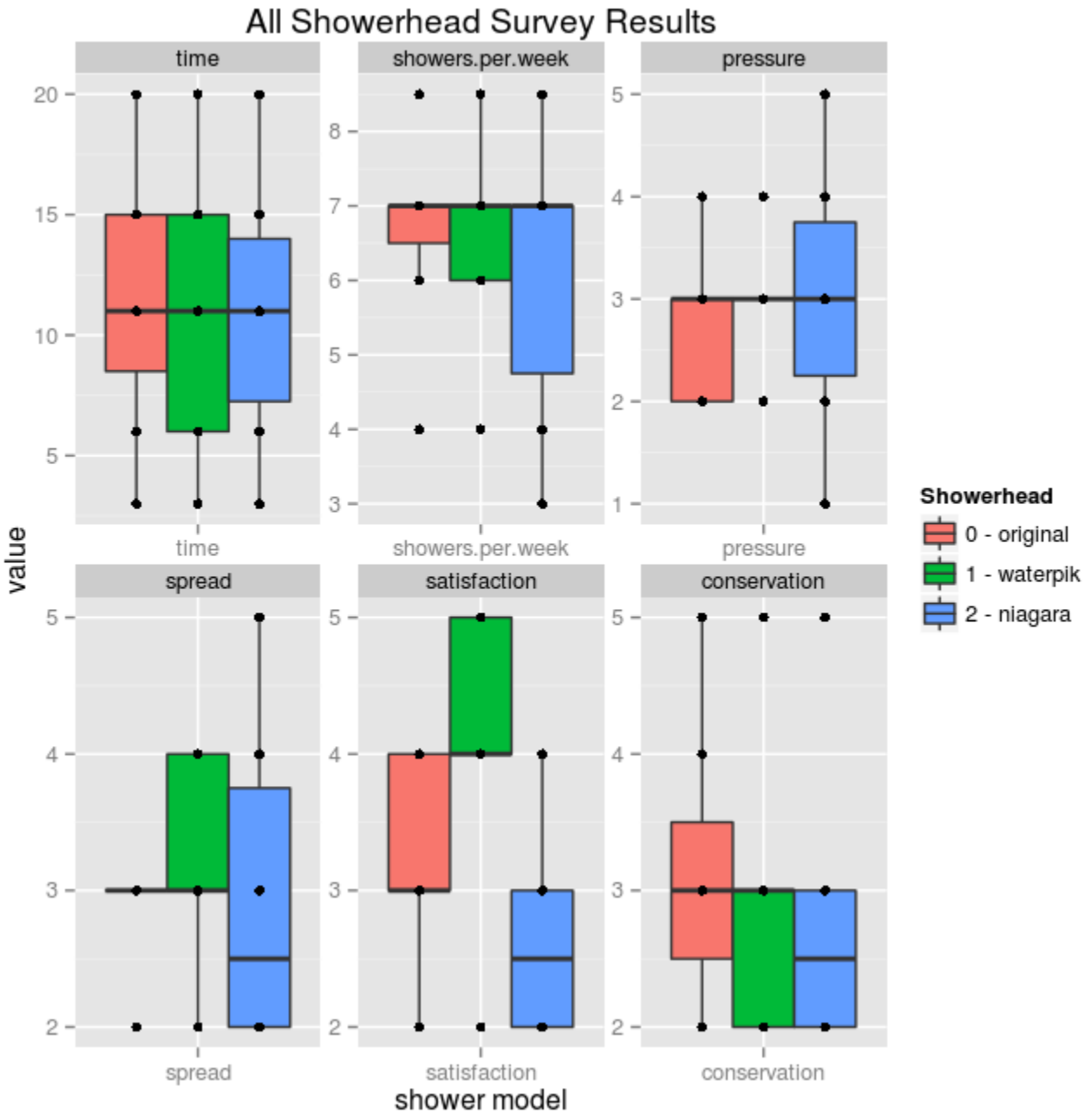
Appendix A: Male Survey Chart



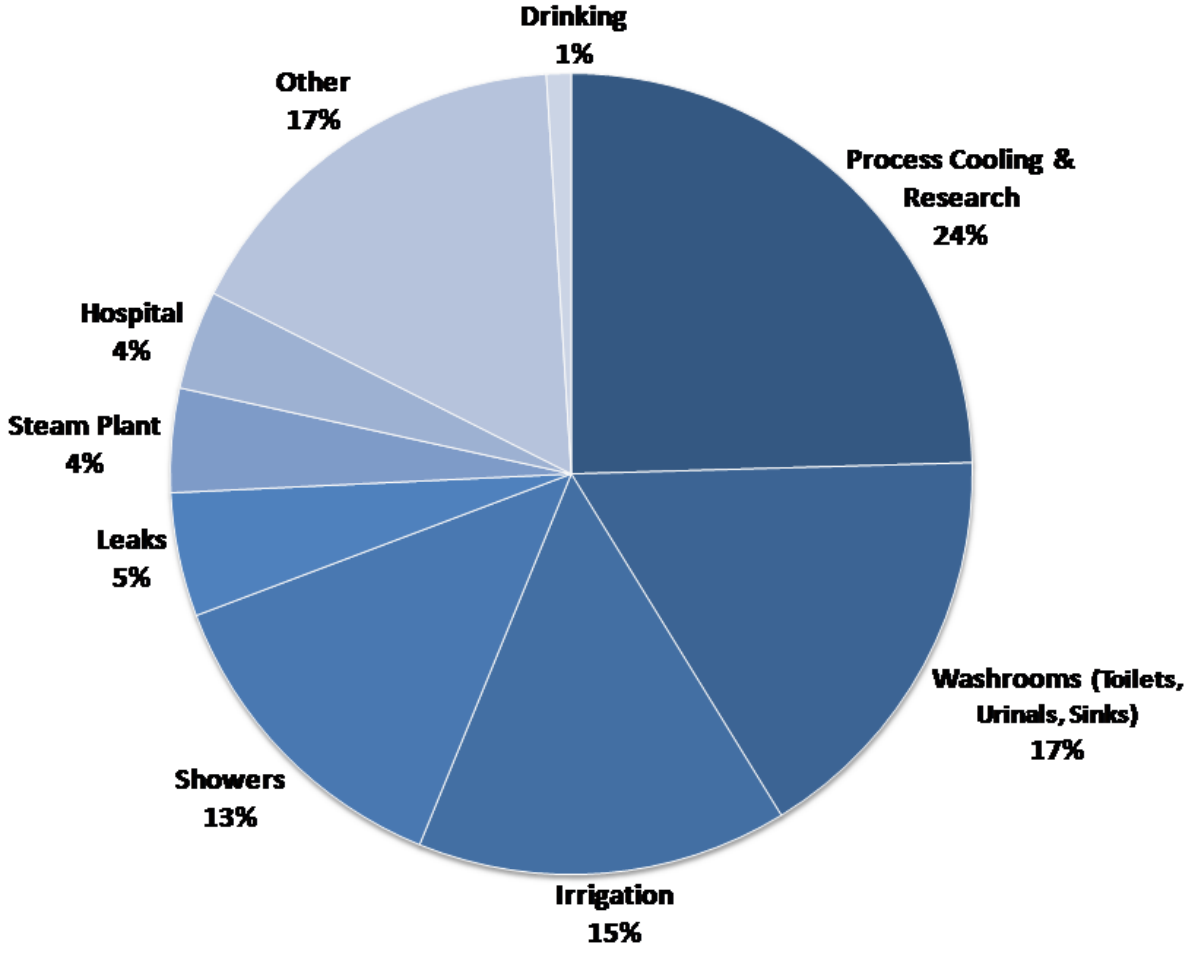
Appendix B: Female Survey Chart



Appendix C: All Survey Results



Appendix D: Water Distribution UBC



Appendix E: Shower head Specifications

	Niagara	Waterpik	Delta (Current Replacement Model)
Flow rate (gallons per minute)	1.5	2.0	2.0
Manufacturer Warranty	10 years	Lifetime	Lifetime
Has Wand Extension	Yes	Yes	No
Hose length (in.)	72	60	NA
Number of Spray Settings	3	6	1
Spray Pattern	Jet Spray, Shower, Combo	Full,Massage,Vigorous	Full Body Spray
Material	Plastic	Plastic	Stainless steel, plastic