UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Benefits of Installing Additional Rain Sensors within the UBC Irrigation System

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A Business Case Analysis

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Table of Contents

List of Tables

List of Figures

Executive Summary

Analysis of the irrigation data available indicates that rain sensors save 84% of the water used and are therefore economically viable on a plot of lawn of 260 sq. m and a bed of 520 sq. m based on a 10 year return period. The manufacturer specifies a water savings of 15% which would make rain sensors economically viable on a plot of lawn of 1460 sq. m and a bed of 2920 sq. m based on a 10 year return period. There is insufficient data to have confidence in the results from the data analysis so more research is required. If the results of the data analysis are confirmed then this report recommends rain sensors to be installed on all plots larger than the critical area. Plots smaller than the critical area can be transmogrified into rock gardens to further help achieve UBC's goal of reducing their irrigation water consumption by 75% by 2020.

Introduction

Objective

The main objective of this report was to determine whether or not it would be economically feasible to install additional rain sensors within the UBC irrigation system to reduce the amount of potable water used for irrigation purposes. Specifically, to determine the minimum area of irrigated land that would economically benefit from the installation of a rain sensor.

Scope of Report

This report took into consideration five plots currently on the UBC irrigation grid, three of which are equipped with a rain sensor and two are on a timer. A map of UBC irrigation plots can be seen in Appendix B. Water usage patterns from 2006 to 2012 were used to project water usage for the next decade on a cubic meter water per meter squared basis for lawns and beds. Predicted potable water price inflation information was obtained from the *UBC Irrigation Action Plan*.

Description of current UBC irrigation water use

Irrigation currently makes up approximately 15% of UBC's total water usage. Potable water currently costs UBC $0.78/cubic meter. Table 2 presents estimated water prices for the next two years as well as past trends in price increase. UBC currently spends around $500,000 annually on grounds irrigation, this cost encompasses irrigation system maintenance and the cost of potable water used for irrigation. UBC has set a goal of reducing the irrigation water usage by 75% by 2020. This aim is outlined, in detail, in the current *UBC irrigation action plan*. Figure 1 represents irrigation's place in UBC's overall water consumption (Stantec ,2012).

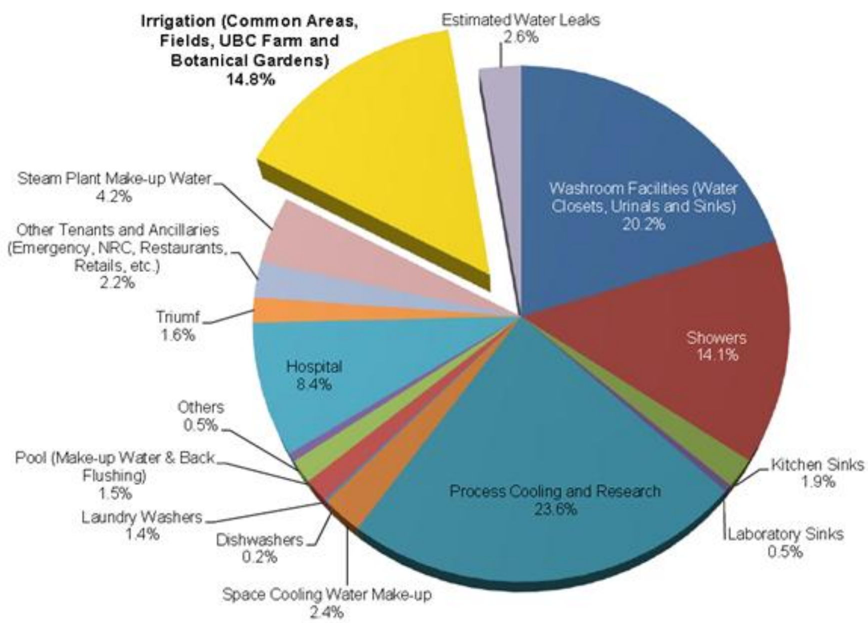

Figure 1: Current UBC water use pattern

Rain Sensor Background

The UBC irrigation system is made up of approximately 140 zones. Each zone operates independently of the others. The UBC irrigation system is responsible for watering 453,000 m^3 of lawns and beds. Presently, rain sensors monitor only 167,000 m^3 of this total, approximately 36.9%. The irrigation products supplier, *Rain Bird*, provides the rain sensors currently being used by UBC. Each rain sensor and its corresponding modular timer can be purchased for approximately $118. The use of a contractor is required for installation. Instillation costs are estimated to be around $400 per unit. The typical life span of a rain sensor is between 15 and 25 years. This report uses a conservative lifespan of 10 years to account for vandalism and other unexpected damages. Figure 2 shows the bucket style rain sensors currently being used in UBC's rain sensored areas.

Figure 2: Water sensor currently in use at UBC

Data Analysis

Water usage data was collected for five parcels of irrigated land: Triumph house, Rashpal Dhillion track, Wolfson field, the baseball field, and an area near the Angus building. The data obtained for the Angus building parcel was collected by reading the meter on 13/02/2013 and, when analysed, this data produced a result that was a clear outlier. The data from the Angus building parcel was not used for further calculation or interpretation. The Triumph house and Wolfson field parcels' irrigation systems are controlled by a timer while the Rashpal Dhillion track and baseball field parcels' irrigation system is controlled by a rain sensor.

Since lawns are watered approximately twice as much as beds, it was necessary to calculate the volume of water used per square meter per year for both lawn and bed areas (see Table 3). Because the calculation was based on proportionality between water required for lawns and beds, the water savings, in percent, is the same for both.

Water Usage

On average, the water amounts used for lawns were 0.18 m^3/m^2 yr and 0.03 m^3/m^2 yr for timed and rain sensored plots respectively. Beds used 0.09m^3/m^2 yr and 0.015 m^3/m^2 yr for timed and rain sensored plots respectively. The data points used for these calculations agreed well with each other and were all within 1.5 standard deviations of the mean (see Appendix A). According to this data, rain sensors reduce water usage by 84%. According to literature produced by the manufacturer, rain sensors reduce water usage by 15%. Due to the large discrepancy between these values, further calculations were completed for both values (see Tables 4-7).

Due to the quality and quantity of data obtained from UBC, some outlying data points had to be eliminated without qualitative explanation of why they were unusual. Plot areas and lawn to bed ratios are not recorded so estimations were made from ARCGIS and employee knowledge. The estimations used seem to be sufficient based on the agreement between the resulting values.

Economical Analysis

A pricing scheme for water used at UBC was obtained from the *UBC Irrigation Action Plan* (see Table 2). The prices for future years were calculated based on a $0.07/m^3 increase per year. Based on the capital cost to purchase and install a rain sensor and the savings on water usage, a minimum area of lawn and bed was calculated for rain sensor installation to be economically feasible, based on a return period of 10 years (see Table 1).

Table 1: Critical Areas calculated for rain sensor installation with a 10 year return period

	84% saved		**15% saved**	
	Lawn	Bed	Lawn	Bed
Area (m^2)	260	520	1460	2920

The formuli can be seen in Appendix C; the full calculation can be seen in Tables 4-7.

Conclusion and Recommendations

The results in this report were based on limited data and so it is recommended to obtain more robust data before installing rain sensors. The irrigation water use data currently held by UBC are neither well organized nor complete. Plot areas and lawn to bed ratios should be measured. Meter readings should be conducted regularly (although annually is sufficient for the purpose of this report). These data should be compiled into one database. The calculations seen in Appendix C can be applied to all plots to determine water usage for beds and lawns.

If the results of this report are confirmed for the 84% savings then rain sensors should be installed on all plots larger than the areas indicated in Table 1. For areas consisting of lawn and bed, the following formula should be satisfied for rain sensors to be economical.

$$1 \leq \frac{Area\ of\ lawn}{260} + \frac{Area\ of\ bed}{520}$$

For plots that do not satisfy the above equation, other water saving measures can be taken. Fully or partially replacing an irrigated plot with an attractive rock garden, such as the one found on the Southwest corner of Westbrook Mall and Thunder Bird Boulevard (see figure 3), can reduce or eliminate irrigation needs depending on the degree of coverage of the rocks.

Figure 3: Rock garden at Westbrook Mall and Thunderbird; no irrigation required

In addition to the economical benefits, the installation of rain sensors throughout the UBC irrigation system would have several environmental benefits that would significantly contribute to UBC's sustainability goals. The reduced water usage would decrease UBC's environmental impact by lowering the university's energy demands. The energy associated with pumping water to feed UBC's water supply would be reduced. Additionally, because UBC's irrigation system is fed from the main potable water supply to the university, the environmental impacts of water treatment would decrease. Some of these water treatment impacts would include a lowered need for chlorine and UV light to treat the water at the Capilano water treatment plant, where UBC gets its supply of potable water from.

If a rain sensor and timer can be applied to multiple plots it would compound the savings. This would enable the critical area to be applied to the cumulative area of multiple plots under the control of the same timer and rain sensor.

Appendix A: Data

Table 2: Current and projected water prices as shown in the UBC Irrigation Action Plan (Stantec, 2012)

Year	Water price ($/m3)
2011	0.64
2012	0.71
2013	0.78
2014	0.85
2015	0.92
2016	0.99
2017	1.06
2018	1.13
2019	1.2
2020	1.27
2021	1.34
2022	1.41
2023	1.48
2024	1.55

Table 3: Calculated water usage values for lawns and beds and timed and rain sensored plots

	Water used for lawns (m^3/m^2 yr)	Water used for beds (m^3/m^2 yr)	
Rashpal Dhillon Track	0.0267	0.0133	Rain Sensored
	0.0261	0.0131	
	0.0361	0.0180	
Baseball Field	0.0244	0.0122	
Average	0.0283	0.0142	
Standard Deviation	0.0053	0.0026	
Wolfson Field	0.1716	0.0858	Timed
	0.2052	0.1026	
Triumph House	0.1603	0.0802	
	0.1801	0.0901	
Average	0.1793	0.0896	
Standard Deviation	0.0190	0.0095	

Table 4: Projected economic analysis for a plot of lawn with 84% savings

Lawns with 84% savings						
		Critical Area (m^2)		260		
		timer		rain sensor		
year	water price ($/$m^3$)	water usage (m^3/yr)	total cost ($)	water usage (m^3/yr)	total cost ($)	net savings ($)
2014	0.85	46.62	39.62	7.36	6.26	33.36
2015	0.92	46.62	82.51	7.36	13.03	69.48
2016	0.99	46.62	128.66	7.36	20.32	108.33
2017	1.06	46.62	178.07	7.36	28.13	149.94
2018	1.13	46.62	230.75	7.36	36.45	194.30
2019	1.2	46.62	286.68	7.36	45.29	241.40
2020	1.27	46.62	345.89	7.36	54.64	291.25
2021	1.34	46.62	408.35	7.36	64.50	343.85
2022	1.41	46.62	474.08	7.36	74.89	399.19
2023	1.48	46.62	543.07	7.36	85.79	457.28
2024	1.55	46.62	615.32	7.36	97.20	518.12

Table 5: Projected economic analysis for a bed with 84% savings

Beds with 84% savings						
		Critical Area (m^2)		520		
		timer		rain sensor		
year	water usage (m^3/yr)	water usage (m^3/yr)	total cost ($)	water usage (m^3/yr)	total cost ($)	net savings ($)
2014	0.85	46.62	39.62	7.36	6.26	33.36
2015	0.92	46.62	82.51	7.36	13.03	69.48
2016	0.99	46.62	128.66	7.36	20.32	108.33
2017	1.06	46.62	178.07	7.36	28.13	149.94
2018	1.13	46.62	230.75	7.36	36.45	194.30
2019	1.2	46.62	286.68	7.36	45.29	241.40
2020	1.27	46.62	345.89	7.36	54.64	291.25
2021	1.34	46.62	408.35	7.36	64.50	343.85
2022	1.41	46.62	474.08	7.36	74.89	399.19
2023	1.48	46.62	543.07	7.36	85.79	457.28
2024	1.55	46.62	615.32	7.36	97.20	518.12

Table 6: Projected economic analysis for a plot of lawn with 15% savings

Lawns with 15% savings						
		Critical Area (m^2)		1460		
		timer		rain sensor		
year	water usage (m^3/yr)	water usage (m^3/yr)	total cost ($)	water usage (m^3/yr)	total cost ($)	net savings ($)
2014	0.85	261.76	222.50	222.50	189.12	33.37
2015	0.92	261.76	463.32	222.50	393.82	69.50
2016	0.99	261.76	722.47	222.50	614.10	108.37
2017	1.06	261.76	999.93	222.50	849.94	149.99
2018	1.13	261.76	1295.73	222.50	1101.37	194.36
2019	1.2	261.76	1609.84	222.50	1368.37	241.48
2020	1.27	261.76	1942.28	222.50	1650.94	291.34
2021	1.34	261.76	2293.04	222.50	1949.09	343.96
2022	1.41	261.76	2662.13	222.50	2262.81	399.32
2023	1.48	261.76	3049.54	222.50	2592.11	457.43
2024	1.55	261.76	3455.27	222.50	2936.98	518.29

Table 7: Projected economic analysis of a bed with 15% savings

Beds with 15% savings						
		Critical Area (m^2)		2920		
		timer		rain sensor		
year	water usage (m^3/yr)	water usage (m^3/yr)	total cost ($)	water usage (m^3/yr)	total cost ($)	net savings ($)
2014	0.85	261.76	222.50	222.50	189.12	33.37
2015	0.92	261.76	463.32	222.50	393.82	69.50
2016	0.99	261.76	722.47	222.50	614.10	108.37
2017	1.06	261.76	999.93	222.50	849.94	149.99
2018	1.13	261.76	1295.73	222.50	1101.37	194.36
2019	1.2	261.76	1609.84	222.50	1368.37	241.48
2020	1.27	261.76	1942.28	222.50	1650.94	291.34
2021	1.34	261.76	2293.04	222.50	1949.09	343.96
2022	1.41	261.76	2662.13	222.50	2262.81	399.32
2023	1.48	261.76	3049.54	222.50	2592.11	457.43
2024	1.55	261.76	3455.27	222.50	2936.98	518.29

Appendix B: Map

Due to the size and format of the map (Figure 4), it has been electronically appended as a separate file.

Appendix C: Sample Calculations

Water usage per square meter of bed per year

Assumption: Lawns are watered twice as much as beds

$$U_{bed} = \frac{U_{total}}{\frac{2 * A_{lawn}}{A_{total}} + \frac{A_{bed}}{A_{total}}}$$

U_{bed} – Water usage per square meter of bed per year (m^3/ m^2 yr)

U_{total} – Total water usage for a plot (m^3/ m^2 yr)

A_{lawn} – Area of plot that is lawn (m^2)

A_{bed} – Area of plot that is bed (m^2)

A_{total} – Total area of plot (m^2)

Water usage per square meter of lawn per year

$$U_{lawn} = 2 * U_{bed}$$

U_{lawn} – Water usage per square meter of lawn per year (m^3/ m^2 yr)

U_{bed} – Water usage per square meter of bed per year (m^3/ m^2 yr)

Net savings (for lawn and bed)

$$E = S * A' * \sum_{1}^{n} (P_i * U'_i) - CC$$

E – Net savings over n years ($)

S – Water savings from using rain sensors (0.83 or 0.15)

P_i – Price per cubic meter of water ($\$/m^3$)

U'_i – Water used by a timed plot (m^3/m^2 yr)

A' – Size of plot (m^2)

CC – Capital cost ($518)

With n=10 years and E=$0, the critical area can be obtained. This is the minimum area that a rain sensor should be installed on to be economically feasible.

Appendix D: References

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