Analysis of water usage for Robson and Tec de Monterrey, Vanier Residences, UBC

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PLAN 597 – Assignment #1

This report is detailing the analysis of monthly water consumption data for two of the Place Vanier residence buildings on UBC Campus, Robson House and Tec de Monterrey House (Figure 1). Robson was built in 1959, and is the oldest of the 12 Place Vanier residence buildings. Tec de Monterrey was built in 2003 and is the newest of the Place Vanier buildings. I emailed the housing department, but was unable to get exact data on the number of residents in each building. Therefore, I went to the buildings themselves to determine the occupancy data. According to residents of Tec de Monterrey, all the bedrooms in the residence are 1 person rooms. There were 41 rooms on the first floor, and 43 rooms for the 2nd through 6th floors, leading to a calculated occupancy of 256 students. In Robson, a floor plan of each floor was available. I was able to count the number of students currently in each room, reaching a count of 102. The assumption of full residences for the entirety of the study is reasonable given that there are currently more students looking to stay in residence than there are residence rooms. This is unlikely to be a new issue. Exceptions to a full residence would include drop outs and students evicted from residence; however, theoretically, the dropout/eviction rates should be similar for each residence.

The most recent 50 monthly data points for both residences were used for the report. Although data wasn't collected in June for either residence, it was collected in July and so the mid-May to mid-July data was divided in half. This method was also applied if a collected data point was obviously misrecorded (i.e. a data point was too high or too low to be possible). The main downside of this method is that it would lower the variance for these two months as the consumption is evenly split between the two months; therefore, the variance calculated in this assignment is likely lower than the actual variance. Since the number of days in a month changes on a monthly basis, weekly data would have been preferred. Unfortunately this data was not available, and so monthly data was used instead. By using monthly data, longer-term trends were able to be captured, while providing more information on the monthly variation than data collected on a quarterly basis, without getting bogged down in hourly or daily variation that can occur (which, while interesting study questions, are not the focus of this report).

The monthly minimum, maximum, mean and median values for both total consumption and consumption per person in Robson and Tec de Monterrey can be found in Table 1. While the mean water consumption for Tec de Monterrey was higher than Robson, it's per person consumption is lower. The histograms of the total monthly water consumption and the monthly water consumption per person for Robson display more of a skewed distribution, while the histograms for Tec de Monterrey display a more normal distribution (Figures 2 and 3). To the best of my knowledge, neither residence has undergone any renovations to improve water consumption rates. Both residences experience similar seasonal patterns, with higher consumption in the winter, and lower consumption in the summer (Figure 4). This is likely due to the potential vacancy rates experiences by the residences during the summer months, when most of the undergraduate students have moved out of residence for the summer.

An F-test was performed on the data to determine if the variances are statistically different between Robson and Tec de Monterrey. They were found to be statistically different, and so a two-tailed t-test assuming unequal variance was executed. The mean monthly water use per resident for Robson and Tec de Monterrey were found to be statistically different (t-test = 2.57, p-value < 0.05), with the mean water use per resident higher in Robson. Since the mean water consumption per person in Robson is higher than that of Tec de Monterrey, it is likely that the technology being used in more recent buildings is more efficient than technology used in older buildings. If dollar values were calculated for these water savings, the value of the water saved from upgrading some of the technology in Robson could be calculated, and the amount of time it would take for these upgrades to pay for themselves could be determined.

When visually examining the data in Figure 4, it appears that the peak water use in the winter months may have been declining for Robson for the past 4 years. However, longer-term data would be required to determine if this is a statistically significant change. This change could be due to changing water consumption patterns at the personal level, but could also be related to climate (i.e. in warmer winters people may not shower as often, etc.), or changes in the technology of the building (for example, the 3 washing machines in Robson appear to be fairly new). Future research could look at the water consumption data for Robson in its entirety, to determine the effect of habit changes among its residents over the last 50 years and determine if the visual trend of decreasing winter water consumption is a long-term trend. It would also be interesting to see if this trend could be correlated to either a change in the public perception of water consumption, and/or changes in climate. Finally, it would be beneficial to know if this difference between older and newer residence buildings occurs throughout campus, as it would strengthen the argument that the difference is due to technological advances in more recent buildings, and would provide further support for the need of retrofits to older buildings.
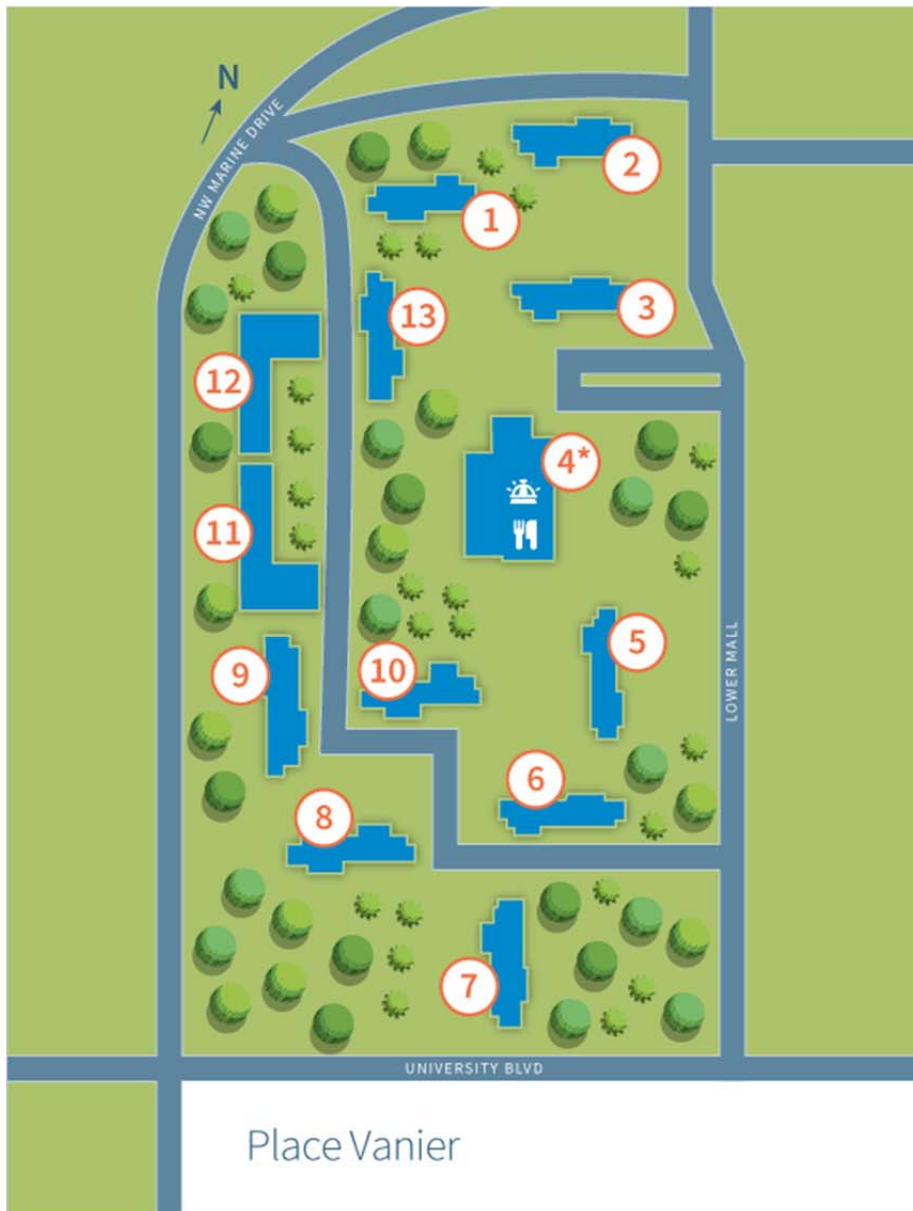
PLACE VANIER MAP

1. Ross House
2. MacKenzie House
3. Hamber House
4. Commonblock,
   Front Desk and Dining Room
5. Okanagan House
6. Kootenay House
7. Sherwood Lett House
8. Tweedsmuir House
9. Cariboo House
10. Robson House
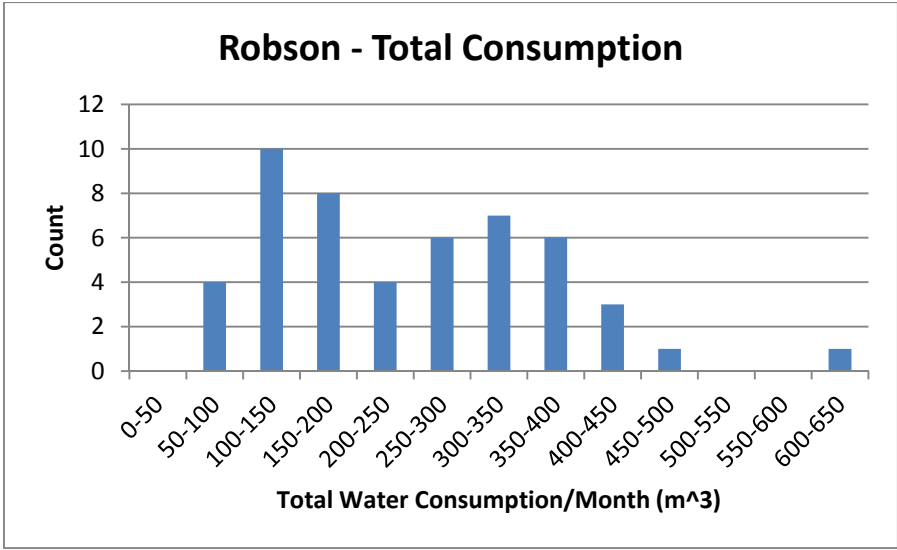11. Tec de Monterrey House
12. Korea-UBC House
13. Mawdsley House

Figure 1: A Map of the Place Vanier residence buildings. The buildings examined in this report include 10) Robson House and 11) Tec de Monterrey House.

Table 1: Summary statistics for two of the Vanier Place residences, Robson House and Tec de Monterrey House.

	Residence	
	Robson	**Tec de Monterrey**
Built (yr)	1959	2003
# of Residents	102	256

Water Consumption (Total)		
Minimum (m^3)	77.5	119.18
Maximum (m^3)	623.1	834.18
Mean (m^3)	250.268	495.5576
Median (m^3)	237.7	490.77
Standard Deviation (m^3)	122.3116377	196.3532247

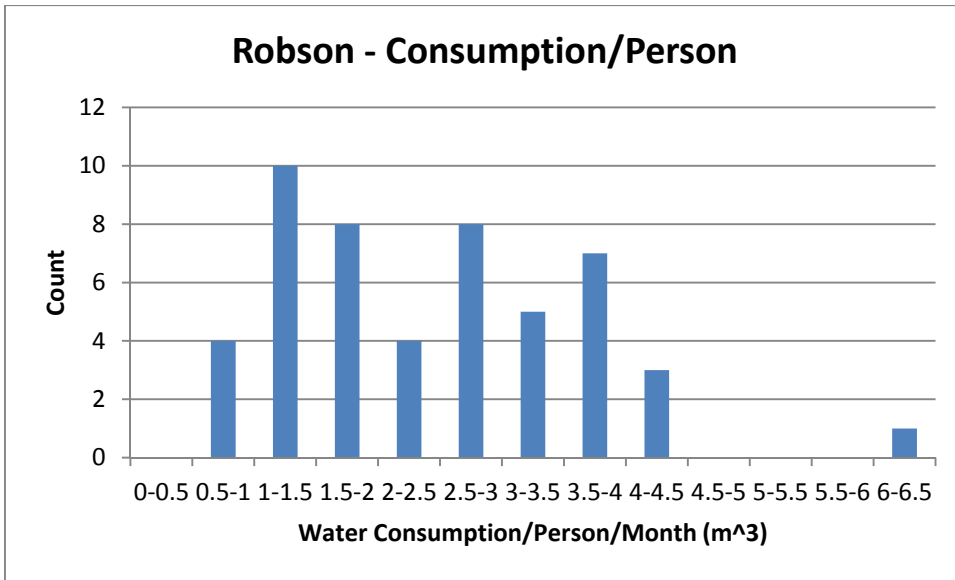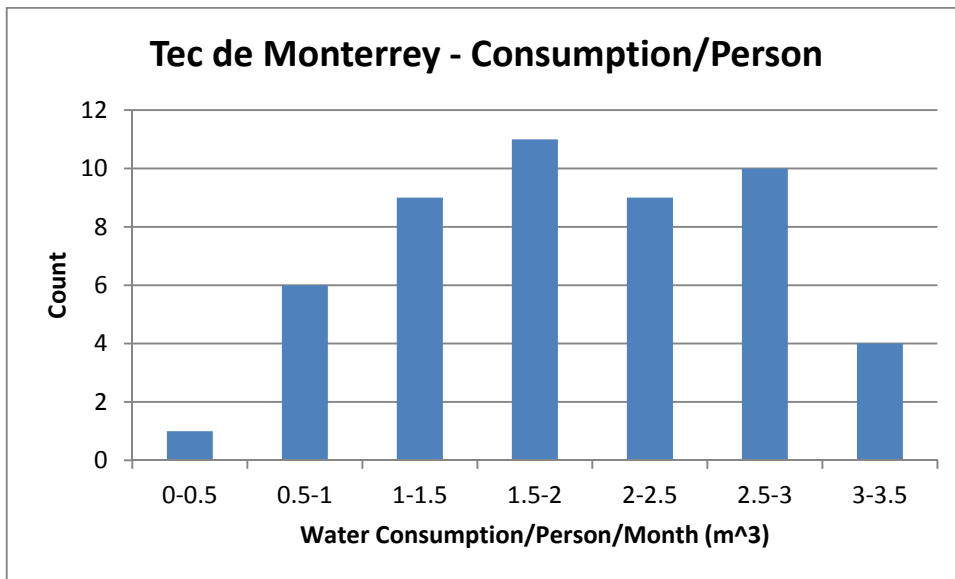| **Water Consumption (per Student)**		
Minimum (m^3)	0.759803922	0.465546875
Maximum (m^3)	6.108823529	3.258515625
Mean (m^3)	2.453607843	1.935771875
Median (m^3)	2.330392157	1.917070313
Standard Deviation (m^3)	1.199133703	0.767004784

a)
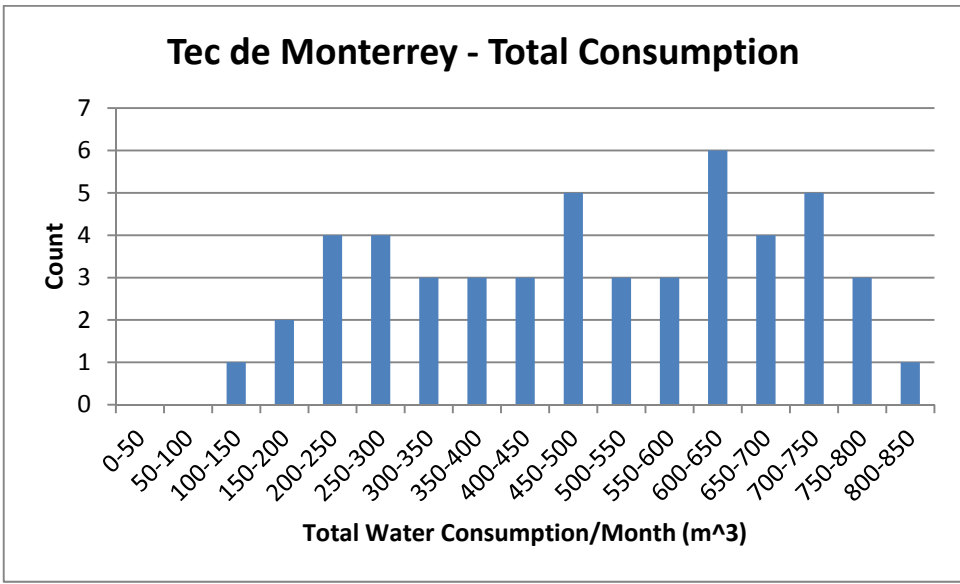
b)

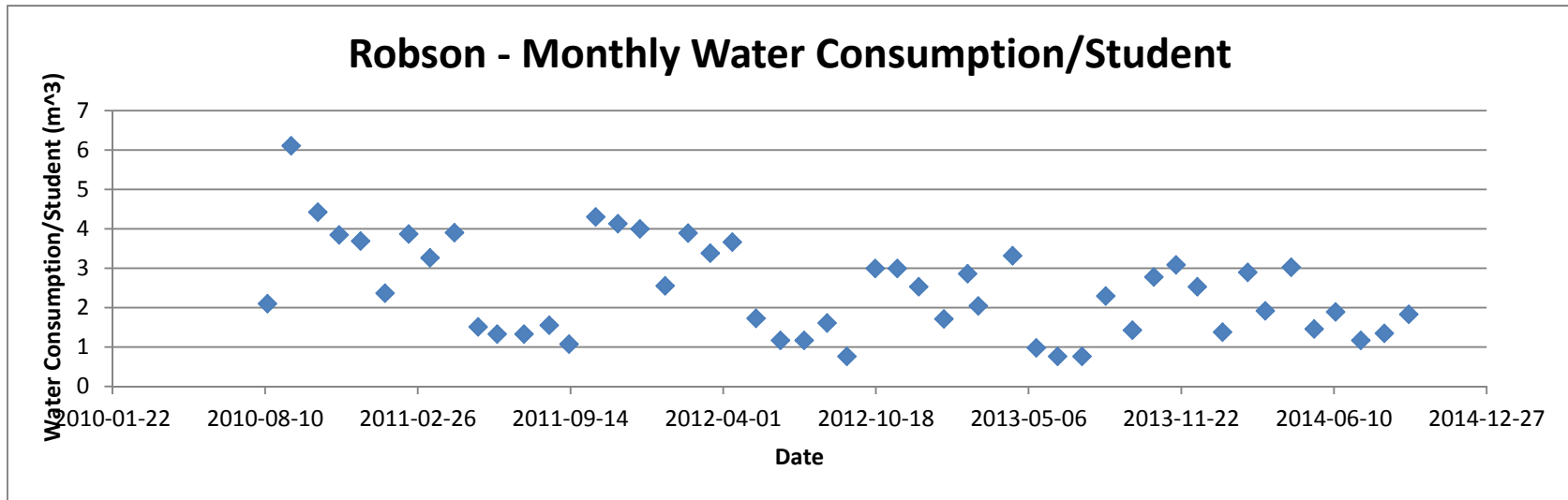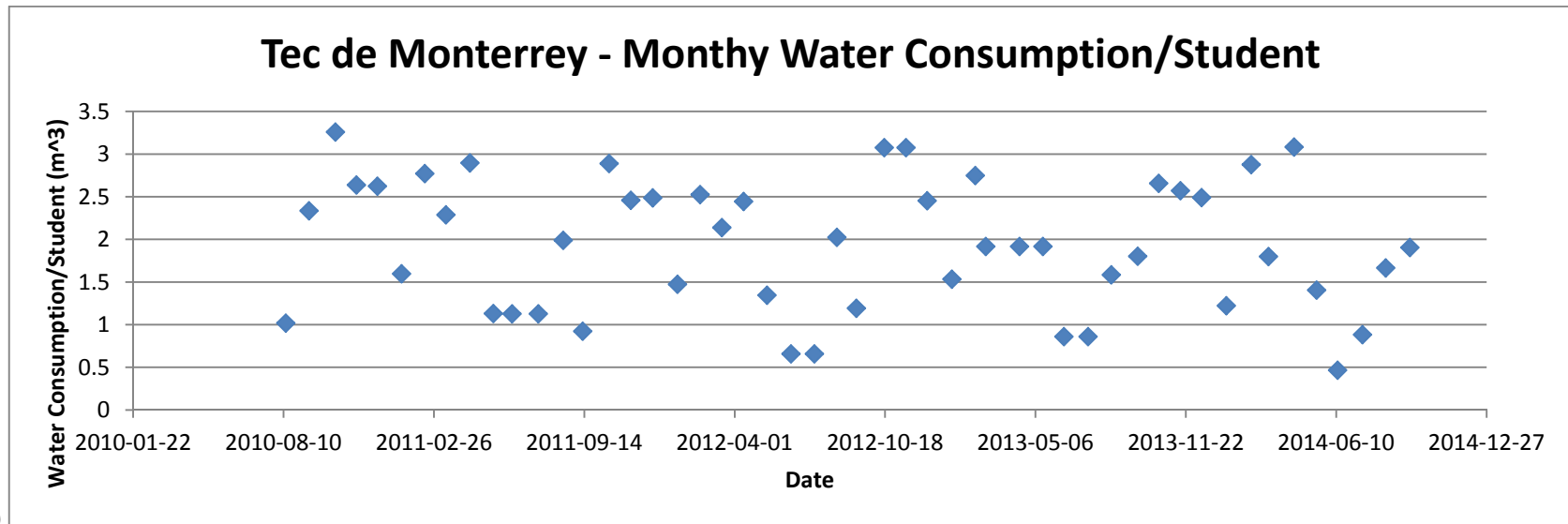**Figure 2**: Histograms of a) Robson House and b) Tec de Monterry House total monthly water consumption data.

a)

b)

Figure 3: Histograms of the monthly water consumption per person for a) Robson House and b) Tec de Monterrey House.

Figure 4: Monthly water consumption/student for a) Robson and b) Tec de Monterrey over time. Dates are year-month-day.