WATER EFFICIENCY DEVICES AND
CONSERVATION PRACTICES

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Acknowledgements

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Finally, I wish to express my gratitude to my family members and friends who supported me during the course of my graduate study.
Abstract

Southern California has a special and unique Mediterranean climate that is rare and only shared with a few countries around the world. In the last few years, the Southern California region has experienced unpredictable periods of both wet and dry weather, and it is likely that it will continue to experience these types of disruptions as a consequence of climate changes in the future (West Basin Municipal Water District [WB MWD]). Water supply agencies in the region have pressed for strong regulations in order to promote water conservation. The study will focus on a small water agency, Rancho California Water District. (District) located within Southern California and will explore its existing water conservation program using high water use efficiency devices on residential customers. The goal for this research project is to determine if water conservation is driven by certain demographic factors such as household size, education and socio-economics. The results could improve the District’s understanding on how to allocate funds for water conservation efforts toward educating certain demographic groups.
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In the last two decades there has been an initiative in place by State and local public water agencies to conserve water, particularly in Southern California where drought is prevalent in this region. In 2009, California’s Governor signed into law the Water Conservation Act of 2009 (often referred to as SBx7-7 legislation). SBx7-7 requires individual retail water suppliers to set water conservation targets for 2015 and 2020 to support the State’s goal of reducing urban potable per capita water use 20% by 2020 (WBMD 2011). It required all water suppliers to increase water use efficiency. The existence of water conservation programs throughout the state has been obvious. Local, state, and federal governments are eager to implement water conservation ideas to create sustainable environments (Wu 2009). However, the meaning of water conservation has changed quite a bit since the 1930s, at the time water professionals saw the term to mean more on how to capture water from watersheds and having the ability to store it. “The emphasis these days, however, seems to be in the area of water conservation and demand management as exemplified by the August 1998 EPA [U.S. Environmental Protection Agency] Water Conservation Plan Guidelines (1). These guidelines, Basic, Intermediate and Advanced, contain recommendations for water systems of all sizes, from small systems serving
less than 10,000 people to large systems serving over 100,000. The Advanced guidelines include replacements and promotions, reuse and recycling, water-use regulation, and integrated resource management (Moss 2012)". Conservation programs integrated using different strategies to bring about awareness to the public and enhance efficiency with consumption. Efforts such as advertising and rebates on certain high efficiency devices have helped immensely see (Appendix A). These highly efficient water devices can vary from toilets to clothes washers to irrigation systems. Each type of device, individually and collectively, help to conserve water in urban settings as well as bring awareness to the public on the importance of protecting against wasteful usage. The research will determine if certain demographic groups are more able to purchase high efficiency devices than others, and if a correlation exists between certain demographic groups and owning a high efficiency device.

**Background**

Rancho California Water District (District/RCWD) serves the area known as Temecula/Rancho California, which includes the City of Temecula, parts of the City of Murrieta and unincorporated areas of southwest Riverside County. The elevation of the Temecula Valley floor ranges from 900 to 1,200 feet above sea level, however, the District pumps water to a maximum elevation of 2,850 feet for some pressure zones in its service area. In the
surrounding foothills, the elevation may vary from 1,200 to 2,900 feet above sea level, with slopes often exceeding 20 percent or more. RCW D’s current service area represents 155,000 acres, and the District has 940 miles of water mains, 36 storage reservoirs, 47 groundwater wells, and 44,000 service connections. More than 120,000 people are served by RCW D.

The District is independent and overlaps with other local public agency jurisdictions. Also, there are several public agencies, including the County of Riverside, that operate within the District’s jurisdiction. Local agencies are exclusively responsible for the administration of their own fiscal affairs, and the District is not entitled to operating surpluses of, or responsible for operating deficits of any of the other entities.

The District is considered a minor special district that adheres to the California Water Code. RCW D is governed by a large number of distinct statutory authorizations; this allows the District to provide designated water services. The District is responsible for planning and providing the financial means to ensure reliable water and wastewater system operations.

**Literature Review**

Understanding what drives water conservation and how the public perceives conservation is important to this research study. The decades from 1980 through 2009 saw significant advances in water conservation in the United States (Vickers 1999). These developments included reduction of
water use through requirements for efficient plumbing fixtures and household appliances and passage of federal legislation providing conservation planning guidelines and incentives for conservation (Rashid 2010).

There is a benefit for a municipal water district to have a conservation program in place. It allows for reducing, deferring and eliminating the need for expansion of water and wastewater assets. Many states now require, recommend, or encourage water system planners to prepare a conservation plan pursuant to the Safe Drinking Act (SDWA amendments) (SDWA 1996) and other laws. The importance of a conservation program is evolving every year and municipalities are being subject to new and increasing regulations and/or limitations on water supplies. Utilities are asking customers to use water efficiently and, especially in today’s economy, customers have a vested interest in keeping utility bills low (Ash 2012).

Assuring that customers are taking advantage of high efficiency devices is beneficial to the longevity and success of a water utility. Efforts to promote water conservation have developed in different strategies. USEPA’s WaterSense® labeling program is the water counterpart to the ENERGY STAR program. WaterSense® tests and labels products such as high-efficiency toilets, faucets, and showerheads. Other products such as weather and sensor-based irrigation control technologies are slated for WaterSense® labeling in the near future (Bracciano 2008).
Furthermore, the State [of California] mandating water retailers to decrease consumption of water is crucial in not losing any type of federal funding and/or grants all that can lead to substantial operating cost. As urban growth pressures existing water supplies, residential water conservation becomes more important because increased urban populations exert more demand on usually finite water supplies. Understanding why people do or do not practice water savings practices is fundamental for implementing successful public policies (Andersen 2008).

**Design and Implementation**

The study was carried out in two parts. Part I determined the location of existing high efficiency water devices within the District’s service area and generated correlations with different demographic variables. Part II used a survey to tally responses related to water conservation practices and concerns.

**Part I**

District staff provided a database containing a list of existing customers with high efficiency devices such as toilets, clothes washers and/or irrigation systems. Since 2004, the District has collected this information to grasp an understanding in where these high efficiency devices are located within the District’s watershed area. The collection of the data
was done on a volunteer basis; customers were not obligated to provide the District with this information. Yet, during a period of eight years, the District was able to attain more than 1,000 customer replies with information regarding their ownership of water efficient devices and records. All personal information was stored in a spreadsheet document. The research required that the spreadsheet contain the customer’s information to be geocoded for further spatial analysis. Once, the location of the efficiency devices were located in the study area, the project proceeded in acquiring the 14 census blocks that fell within the southern part of Riverside County, California as well as the District service area. As shown in Figure 1, the census blocks are outlined in a red boundary and acquired from the 2000 U.S. Census database. The points in the figure represent a current location of the high efficiency water devices within the region. A total of 1,049 high efficiency devices were installed since the start of the collection program. Each point contains a home address, type of device, manufacturer name and customer’s name. The District’s Water Conservation staff developed the database to maintain a historical archive of all existing water efficiency devices.
Pursuing this further, information from the GIS Riverside County Database and the District was used for this part of the analysis. The U.S. Census Data was vital in determining certain variables for the study area. Table 1 shown below describes the variables that were used for this analysis and the type of measurements for each variable. The U.S. Census block data presented a clear representation of the demographics in relation to the quantity of high efficiency devices in the region.
Table 1 Variables of Analysis and Measurement

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Description of Variable</th>
<th>Level of Measurement</th>
<th>Unit of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Level</td>
<td>Level of Income per Census Block</td>
<td>Ordinal</td>
<td>Categorical</td>
</tr>
<tr>
<td>Average Household Size</td>
<td>Average Household Size</td>
<td>Ordinal</td>
<td>Categorical</td>
</tr>
<tr>
<td>Owner Occupied Home</td>
<td>Owners who Occupy Home</td>
<td>Ordinal</td>
<td>Categorical</td>
</tr>
<tr>
<td>Renter Occupied Home</td>
<td>Renters who Occupy Home</td>
<td>Ordinal</td>
<td>Categorical</td>
</tr>
<tr>
<td>High Efficiency Devices</td>
<td>Water Conservation Devices</td>
<td>Ordinal</td>
<td>Categorical</td>
</tr>
</tbody>
</table>

Analysis 1: High Efficiency Devices and Median Household Income by Census Block

This analysis determines if there is a correlation between median household income and household owners who use high efficiency devices within a census block. The theory is that higher income residents within a particular census block will have more efficiency devices. Thus, decreasing water consumption within a household. However, to correctly state the null hypothesis it needs to be posed as such. The more income a person makes the less likely the individual will spend on high efficiency devices.

First step, extracting the median income household from the U.S. Census data and use ESRI® ArcGIS spatial join tool will determine how many high efficiency devices can be found within each Census Block. The spatial join tool within ArcGIS transfers the attributes from one feature class to another feature class, based on the spatial relationship between the features in the two feature classes (ESRI). The overlaying of the geocoded points on top of the Census Block polygon can then be accomplished. Second, the points are categorized by count and proportional symbols are used to display
the high efficiency devices shown in Figure 2. The results gave a count for each polygon and thus placing this count within a geodatabase. The export tool was used to extrapolate the count and placed into a spreadsheet.

Figure 2: High Efficiency Devices and Median Household Income per Census Block

The correlation coefficient was then used to calculate the final results. Using a correlation statistical technique it can show how strong the pair of variables is related. The outcome demonstrated that there is a strong correlation between people who have higher incomes and census blocks with
higher efficiency devices. The correlation coefficient showed 0.35, which is considered a strong relationship as shown Table 2. This null hypothesis is rejected and makes the analysis a Type I error.

Table 2 Correlation Coefficient – High Efficiency Devices and Income

<table>
<thead>
<tr>
<th>Count by Census Block</th>
<th>Income</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>89892</td>
<td>0.350327134</td>
</tr>
<tr>
<td>44</td>
<td>68410</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>78840</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>66082</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>79955</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>76529</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>65768</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>57823</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>81532</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>78212</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>77825</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>64949</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>42665</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>82830</td>
<td></td>
</tr>
</tbody>
</table>

Analysis 2: High Efficiency Devices and Average Household Size

The second analysis requires that the null hypothesis states that there is no relationship if the household size increases and high efficiency devices increase in a census block. Similar to the median income household analysis the information is extracted from the census block table and imported into a spreadsheet. The overlaying of the geocoded points on top of the Census Block polygon is then completed. Next, the points are categorized by count and proportional symbols are used to display the high efficiency devices related to average household size as shown in Figure 3.
After processing the analysis, the findings found a weak correlation between average household size and high efficiency devices, as shown in Table 3. The result is only 0.13, which does not appear to have any correlation and accept the null hypothesis with a Type II error.
Analysis 3: High Efficiency Devices and Owner Occupied vs. Renter Occupied

This particular analysis will determine if homeowners are more willing to purchase high efficiency devices for their primary homes compared to homes that are renter occupied.

First, the analysis will create a null hypothesis stating owners who occupy their homes have less high efficiency devices than those who do not occupy. The correlation results will then be compared to high efficiency devices and occupied renters.

As in the previous analysis, the homeowner’s information is extracted from the census block table and imported into a spreadsheet. The overlaying of the geocoded points on top of each Census Block polygon is then updated.
The points are categorized by count and proportional symbols are used to display the high efficiency devices related to owner occupied homes as shown in Figure 4.

Figure 4 demonstrates that there is a strong correlation between owner occupied and high efficiency devices. After processing the statistical analysis it is concluded that the correlation coefficient is 0.34, signifying a strong relationship and the null hypothesis can be rejected with a Type I
error, as shown in Table 4. In addition, it is interesting to point out that this relationship is as strong as the link with income and high efficiency devices.

<table>
<thead>
<tr>
<th>Count by Census Block</th>
<th>Owner Occupied</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>1037</td>
<td>0.345401786</td>
</tr>
<tr>
<td>44</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>369</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1037</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>1037</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>1037</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>1037</td>
<td></td>
</tr>
</tbody>
</table>

The next step is to determine the correlation between high efficiency devices and homes occupied by renters. The analysis will require the use of "Renters Occupied Home" information from the census data and compare it to the high efficiency devices. As in the previous analysis, the renter's information is extracted from the census block table and imported into a spreadsheet. The overlaying of the geocoded points on top of each Census Block polygon is then updated. The points are categorized by count and proportional symbols are used to display the high efficiency devices related to renter occupied homes as shown in Figure 5.
Figure 5 High Efficiency Devices and Renters Occupied

Figure 5 demonstrates a strong correlation between renter occupied homes and high efficiency devices. After processing the statistical analysis, it can be concluded that a correlation of -0.35 signifies a strong relationship and the null hypothesis can be reject with a Type I error, as shown in Table 5.
Though the analysis shows that owner occupied and renter occupied correlation reject the null hypothesis with a Type I error, this analysis does not give an indication that one result is more reliable than the other. On a side-by-side comparison, the correlation results are not strong enough to demonstrate a difference between high efficiency devices and homeowner vs. renter occupied.

### Table 5: Correlation Coefficient – High Efficiency Devices and Renter Occupied

<table>
<thead>
<tr>
<th>Count by Census Block</th>
<th>Renter Occupied</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>108</td>
<td>-0.35234106</td>
</tr>
<tr>
<td>44</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>482</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>328</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>482</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>108</td>
<td></td>
</tr>
</tbody>
</table>

**Part II**

A survey was developed and distributed to approximately 5,000 existing customers within RCWD’s service area. The survey asked a series of 10 questions on a range of water related issues and concerns such as water supply, high efficiency devices, homeownership vs. renter and basic socio-demographic information. Each questionnaire took about five minutes to
complete. The survey was developed and administered using an online survey tool website called SurveyMonkey®. The survey was to be distributed in mid-March 2013, however, delays occurred during this process. The District elected Board of Directors had some concern with the questionnaire. One Director has concern that two particular questions in the survey seemed a bit invasive; questions related to income level and education completion seemed too intrusive to the customer's privacy. The survey was re-evaluated by the District's Water Conservation staff and clarified to the Board of Directors that the survey was to be used only for internal purposes and fulfilling a research project. One week later the survey received approval by the Board, however, the distribution of the questionnaire was delayed and published online the week of March 25, 2013 for a response timeframe of only two weeks (see Appendix C for timeline).

The study used the District's existing customer email distribution list and system to publish the survey in an effort to achieve a sample result from the total population of 44,000 existing customers within the District service area. Of the 5,000 customer emails sent out, 358 survey responses were received, representing a 6.5% response.

A sample formula was used to accurately detect the target population, as shown in Figure 6. A confidence interval of ±5.16 was achieved and the confidence level of 95% based on a population of 44,000 was used.
Figure 6 Sample Size Formula

\[
SS = \frac{Z^2}{c^2} \times (p) \times (1-p)
\]

Where:

- \(Z\) = Z value (e.g., 1.96 for 95% confidence level)
- \(p\) = percentage picking a choice, expressed as decimal (.5 used for sample size needed)
- \(c\) = confidence interval, expressed as decimal (e.g., .04 = ±4)

As mentioned, the survey contained 10 questions and was designed to create a rapport with the respondent. Questions regarding education and income were placed at the end of the questionnaire to avoid any withdraw from the responder. The first five questions dealt with water conservation concerns and how the respondent felt regarding present and future water supply within the region. The remaining survey questions asked about the household size, education and income.

Survey answers were coded and entered into Microsoft Excel. For all questions, missing values were excluded from the analysis. The first level of analysis was to generate frequency tables, while the second level of analysis evaluated the impacts of four demographic factors such as household size, education, income and owner vs. renter occupied. These demographic factors was tested using cross-tabulation tables (Babbie 1992).
Results

Review of the results from all the analyses done in this study provides an understanding of the correlation between the use of high efficiency devices and demographic groups. The results were fragmented into two parts; one dealing with secondary data and the second part with primary data (survey responses).

Part I

Analysis I shows a strong correlation between higher income residents and high efficiency devices found within the census blocks. This is likely due to a resident’s higher income and available funds in purchasing and researching such devices. However, what is found in part II of the survey results will tell a different story.

Analysis II did not demonstrate a strong correlation between household size and high efficiency devices. The expectation of the analysis was to assume that larger household sizes would be more willing to attain high efficiency devices; however, the demographic data did not support this hypothesis.

Analysis III required two correlation results to be compared side-by-side; homeowners vs. renter occupied. Although the correlation of having high efficiency devices was strong independently, when compared, it did not
demonstrate any major differences and thus rejecting the null hypothesis. However, as mentioned previously this analysis has different results with the survey information and demonstrate a significance correlation this will be discussed in the next section.

**Part II**

The first level of analysis was to generate frequency tables for each of the 10 questions from the survey responses (see Appendix D). The second level of analysis was to evaluate the impacts of four demographic factors such as household size, education, income and owner vs. renter occupied. For most of the cross-tabulation analysis, Question 1 from the survey "How concerned are you about water conservation?", was used as the independent variable while the others as the dependent variables with an exception to the last table dealing with homeowner vs. renter. The reason for using question 1 as an independent variable, it gauges where a responder is more likely to use a high efficiency device.

**Water Conservation and Household Income**

Respondents who answered the question about being very concerned of water conservation almost half (47%) had an income between $50,000 to $79,999. However, households that had incomes ranges from $25,000 to $50,000 and $75,000 to $100,000 had similar percentages for being very
concerned about water conservation, as shown in Table 6. These results demonstrate that a household income range of $50,000 to $80,000 is more willing to purchase a high efficiency device than a household making $100,000 and up. Definitely a different result when comparing the previous analysis from part I, using the correlation coefficient.

Table 6 Cross-Tabulation Water Conservation and Income

<table>
<thead>
<tr>
<th>Water Conservation</th>
<th>Household Income</th>
<th>$0-24,999</th>
<th>$25,000-49,999</th>
<th>$50,000-74,999</th>
<th>$75,000-99,999</th>
<th>$100,000 and up</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
</tr>
<tr>
<td>Not Concerned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Water Conservation and Education

Of respondents who are very concerned about water conservation, 82% have a high school diploma. The percentage of "very concerned" about water conservation dropped substantially to 15% for those with some college education. However, the percentage of those that are "somewhat concerned" about water conservation did rise significantly to 78% for respondents that are college graduates, as shown in Table 7.

Table 7 Cross-Tabulation Water Conservation and Education

<table>
<thead>
<tr>
<th>Water Conservation</th>
<th>Education Level</th>
<th>Less Than HS</th>
<th>HS Diploma</th>
<th>Some College</th>
<th>College Graduate</th>
<th>Post Graduate</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td></td>
<td>2.77%</td>
<td>82.23%</td>
<td>15.02%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
<td>15.19%</td>
<td>78.48%</td>
<td>6.33%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Not Concerned</td>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>2.01%</td>
<td>59.60%</td>
<td>19.20%</td>
<td>17.77%</td>
<td>1.43%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
Water Conservation and Household Size

Of respondents who are very concerned about water conservation, 60% have a household size of one to two people, while nearly 40% have in a household size of three to four people, as shown in Table 8.

<table>
<thead>
<tr>
<th>Water Conservation</th>
<th>1 to 2</th>
<th>3 to 4</th>
<th>5 to 10</th>
<th>11 and up</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td>60.87%</td>
<td>39.13%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td>0.00%</td>
<td>85.07%</td>
<td>13.43%</td>
<td>1.49%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Not Concerned</td>
<td>0.00%</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>45.70%</td>
<td>51.34%</td>
<td>2.67%</td>
<td>0.30%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Water Conservation and Owner vs. Renter

Of respondents that are homeowners, 100% are very concerned about water conservation, while only 16% of renters are very concerned, as shown in Table 9. The results show that homeowners of owner-occupied homes are more willing to invest in their property.

<table>
<thead>
<tr>
<th>Occupied Home</th>
<th>Water Conservation</th>
<th>Very Concerned</th>
<th>Somewhat Concerned</th>
<th>Not Concerned</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owned</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
<td></td>
</tr>
<tr>
<td>Renter</td>
<td>16.00%</td>
<td>70.40%</td>
<td>13.60%</td>
<td>100.00%</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>70.67%</td>
<td>24.58%</td>
<td>4.75%</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

Pursuing this further, an important question for domestic water use within the region is, "What portion of the District's customers are more willing to purchase a high efficiency device?" Household income appears to influence the willingness to spend on these devices. While the middle class demonstrates a strong support for purchasing these devices, the higher income households fall short of investing in any type of device. It appears that higher income customers are more willing to pay higher tiered water rates for consuming more water.

In the same manner, conservation and education does not seem to influence higher-educated customers. One might reason that residents with a formal education would more likely practice water conservation, although the study results show otherwise.

Areas for Further Research

The survey results provide an ample amount of new opportunities to assert new conservation efforts. Water conservation programs can focus their resources on certain demographic groups. As an example, the study found that 85% of respondents whose household size were three to four
people, were "Somewhat concerned about a water conservation program". These percentages could appeal to a water conservation department and direct its resources in persuading these demographic groups to become "Very concerned about water conservation". Perhaps by focusing on certain demographic groups a trickle-down effect can occur and persuade other customers to becoming more conscious of water consumption.

Conclusion

Municipal water districts increasingly turn to water conservation as they experience greater difficulty in trying to develop new water supplies. Most RCWD customers are concerned about water conservation and both current and future water supplies. Respondents of the survey were motivated to conserve water for both future water demands and economic reasons.

The goal is to focus on key demographic groups and provide available resources to promote water conservation. This focus will have the trickle down effect and provide more exposure to other demographic regions. The results can lead to further understanding towards attitudes on water conservation. It is in the public interest to have water conservation programs that are successful and accessible to all.
References


Appendix A

Brochure Announcement
INDOOR WATER USE EFFICIENCY

BATHROOM

You use more water in the bathroom than in all of the other rooms combined! This is where you shower, shave, wash hands, brush teeth and flush the toilet.

- Switch to an ultra-low-flow showerhead. This could save you as much as 2.5 gallons every minute you shower.
- Take shorter showers—try to keep it less than 5 minutes.
- Install ultra-low-flush toilets or place a plastic bottle filled with water or sand in your toilet tank to reduce the amount of water used in each flush.
- Put dye tablets or food coloring in your toilet tank and wait to see if the color appears in the bowl (without flushing). If it does, you have a leak!
- Check to assure that your toilets flapper valve doesn’t stay open after flushing.
- When taking a bath, start filling the tub with the drain already plugged instead of waiting first for the water to get warm. Adjust the temperature as the tub begins to fill.
- Turn the faucet off while you shave, brush your teeth and lather up your hands.
- Don’t use the toilet as a garbage can. Place a trash can next to the toilet and use it instead.
- Buy an electric razor or fill the sink with a little water to rinse your razor, instead of rinsing in running water.
- Take a short shower instead of a bath. While a five minute shower uses a 12 to 25 gallons, a full tub requires about 70 gallons.

SINKS

The faucets in your bathroom sinks generally use about 2.5 gallons of water per minute (gpm). By turning off the water when you brush your teeth, you can save approximately 3 gallons of water! Filling the basin to rinse your razor when you shave can save about 4 gallons.

Installing a faucet aerator is a simple and inexpensive way to reduce water use in the bathroom. Faucet aerators reduce output from 2.5 gpm to 1.5 gpm! This is a savings of about 40%! 
INDOOR WATER USE EFFICIENCY

TOILETS

The toilet is the highest water-consuming device in the home, making up about 27% of indoor water use. Depending on the type of toilet you have, modifying the amount of water it flushes or replacing it with an ultra-low flush toilet could save you lots of water.

Upgrade Your Existing Toilet

If your home is older than 1992*, chances are your toilets use between 3.5 and 5 gallons of water per flush. Some older toilet models even use as much as 7 gallons per flush!

You can easily reduce the amount of water used per flush by displacing some of the water in the toilet’s tank. Simply place a water-resistant object, such as a plastic bottle, inside the tank. Each gallon you can displace represents thousands of gallons you will save each year. Modifying your toilet in such a manner should not adversely impact its operation, however, if it does, consider replacing it with a newer model.

Install an Ultra-Low Flush Toilet

Since 1992*, all residential-type toilets manufactured in the U.S. use no more than 1.6 gallons per flush. If you have an old-syle toilet, replacing it with a newer model will save you lots of water and money.

While these low-flow toilets have, in the past, had a bad rap, newer toilet models have been reengineered to perform better. If you would like to replace your toilet, take a look at how the Consumer Reports Magazine rated the new ultra-low flush designs.

* In 1992, the U.S. Congress passed water conservation legislation prohibiting the construction of certain high-flow plumbing fixtures.
INDOOR WATER USE EFFICIENCY

SHOWERS & BATH

Showers and baths consume about 18% of the water used indoors. You can save water in the shower by installing low-flow showerheads, keeping each shower short and sweet, and running the water only when it is needed to lather up and rinse off.

Install Low-Flow Showerheads

If your home was built before 1992*, chances are your showerheads put out about 5 gallons of water per minute (gpm). Multiply this by the number of minutes you’re in the shower, and the water adds up fast!

\[5 \text{ gpm} \times 10 \text{ min} = 50 \text{ gallons}\]

Most showerheads in homes built after 1992* deliver no more than 2.5 gallons of water per minute. Some even emit less than this and still provide a great shower!

\[2.5 \text{ gpm} \times 10 \text{ min} = 25 \text{ gallons}\]

Install a low-flow showerhead today and begin saving lots of water!

If you would like to replace your showerhead, take a look at how the Consumer Reports Magazine rated showerheads.

Keep Showers Short & Sweet

Taking unnecessarily long showers wastes water. Reducing the length of your shower by just one minute could save you up to 1,825 gallons of water each year.

Run Water Only When Needed

By far the best way to save water in the shower is to only run the water when needed. This practice can reduce the water used to less than 10 gallons each shower and will save you money each year.

* In 1992, the U.S. Congress passed water conservation legislation prohibiting the construction of certain high-flow plumbing fixtures.

Rancho California Water District
OUTDOOR WATER USE EFFICIENCY

SPRINKLER SYSTEMS

A sprinkler system can be a convenient and valuable tool when irrigating your landscape. However, if used improperly, it results in substantial amounts of water waste.

Plan your landscaping before you put the pipe in the ground. Where are your lawn areas going to be? Where will your shrubs, trees and flowers be? Make sure you place plants with similar watering needs together—this is called “hydrozoning”. When you turn on a valve to water your grass, you don’t want your low water-use shrubs to receive the same amount of water.

Not only do you need the same plant types in each watering zone, but you also need to have the same sprinkler heads. Never install a spray head and a rotor head on the same valve. Different head types put out very different amounts of water in the same time period. If you have mixed heads in the same zone, you will need to over-water certain areas to get sufficient water to the entire zone. Talk to certified professionals in the landscaping and irrigation businesses. Sprinkler manufacturers’ websites are a great resource when designing your system.

SPRAY HEADS

There are many varieties of sprinkler heads, but three general categories are: spray, rotor, and drip.

Spray heads either pop-up out of the ground or have a stationary fixed head. Spray heads are most commonly used on small areas; turf, shrubs or flower beds. There are heads designed to spray in all different patterns—depending on the area to be watered. The most common spray patterns are full, half and quarter circles. Some heads are adjustable to a wide variety of angles. In addition to circle patterns, spray heads can also spray rectangle and square patterns.
OUTDOOR WATER USE EFFICIENCY

Rotor heads come in two main styles: stream (driven by a gear) or impact. They are useful in covering large areas, and typically apply water more uniformly than spray heads. Rotors can spray in full or part circle patterns, and some brands are adjustable to a wide variety of angles.

The application rate of a rotor is usually lower than that of a spray head. Typical values are 0.5 to 0.8 inches per hour. This slower output allows them to be used on all soil types with less cycling.

Drip systems have become popular for irrigating non-turf areas. A drip system usually consists of a special tube or hose with holes or emitters along it. These emitters may be spaced with a fixed distance to cover uniform, closely spaced beds, or randomly to only water certain plants.
SPRINKLER MAINTENANCE

It is important to do a regular maintenance check on your sprinklers. If sprinklers are not kept in good working condition, they can waste water as well as have detrimental effects on your landscape. Turn on your sprinklers during daylight hours to inspect the system for broken, clogged or misaligned heads.

A common problem with sprinkler systems is pressure. Without correct pressure, your sprinklers will not be able to perform as designed. You may notice large brown areas of lawn where the sprinkler is not reaching, or shooting over.

High pressures can also damage nozzles and heads—sometimes even causing them to break off.

Spray heads should be operating at about 25 to 30 PSI, rotor heads 30 to 50 PSI. You may need a landscape or sprinkler professional to check the pressure at your sprinkler heads.

If your pressure is too high, pressure-reducing valves and heads may be installed, or you may be able to retrofit your existing heads with new nozzles instead of replacing them. Also, consult your manufacturer’s instructions and specifications to ensure proper pressure.
Appendix B

Survey Questions
1. How concerned are you about water conservation?
   - Very Concerned
   - Somewhat Concerned
   - Not Concerned
   - Don't Know

2. How concerned are you about water rates?
   - Very Concerned
   - Somewhat Concerned
   - Not Concerned
   - Don't Know

3. How concerned are you about today's water supply?
   - Very Concerned
   - Somewhat Concerned
   - Not Concerned
   - Don't Know

4. How concerned are you about future water supply?
   - Very Concerned
   - Somewhat Concerned
   - Not Concerned
   - Don't Know

5. How important is it to purchase a water efficiency device for your household?
   - Extremely Important
   - Very Important
   - Somewhat Important
   - Not at all Important

6. Is the house that you currently reside?
   - Owned by you or someone in this household
   - Rented by owner/landlord
7. How important is it to reward water efficiency by homes and to penalize water waste (for example, charging customers higher costs for excess use)?

- Extremely Important
- Very Important
- Somewhat Important
- Not at all Important

8. Including yourself, how many people currently live in your household?

- 1 to 2 people
- 3 to 4 people
- 5 to 10 people
- 11 and up

9. What is the highest level of education you have completed?

- Less Than High School
- High School/GED Graduate
- Some College
- College Graduate
- Postgraduate Degree

10. What is your approximate average household income?

- $0-24,999
- $25,000-$49,999
- $50,000-$74,999
- $75,000-$99,999
- $100,000 and up
## Appendix C

### Project Management Timeline

#### Capstone Project - Thesis

<table>
<thead>
<tr>
<th>Mon Feb 18</th>
<th>ISO WEEK</th>
<th>08</th>
<th>09</th>
<th>10</th>
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<td>MAY</td>
<td>JUN</td>
<td>FEB</td>
<td>MAR</td>
<td>APR</td>
<td>MAY</td>
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<td>APR</td>
<td>MAY</td>
<td>JUN</td>
<td>FEB</td>
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<td>JUN</td>
<td>FEB</td>
<td>MAR</td>
<td>APR</td>
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<td>11</td>
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<td>18</td>
<td>25</td>
<td>01</td>
<td>08</td>
<td>15</td>
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### Research
- R1 - Research Topic Idea
- R2 - Data Sources
- R3 - Select Project Idea

### Capstone Proposal
- C1 - Data Sources
- C2 - Network with Industry Experts
- C3 - Generate Survey Questionnaire
- C4 - Survey Distribution
- C5 - Capstone Project Proposal Submission

### Writing Capstone
- W1 - Introduction Section
- W2 - Literature Review Section
- W3 - Project Design Section
- W4 - Analysis
- W5 - Results
- W6 - Discussion

### Review
- R1 - Review and Incorporate Feedback

### Deliverables
- D1 - Deliver final research paper

### Presentation
- Capstone project presentation
Appendix D
Frequency Tables

Question 1

How concerned are you about water conservation?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td>70.7%</td>
<td>253</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td>24.9%</td>
<td>89</td>
</tr>
<tr>
<td>Not Concerned</td>
<td>4.4%</td>
<td>16</td>
</tr>
<tr>
<td>Don't Know</td>
<td>0.0%</td>
<td>0</td>
</tr>
</tbody>
</table>

answered question 358  
skipped question 0

Question 2

How concerned are you about water rates?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td>76.0%</td>
<td>272</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td>20.7%</td>
<td>74</td>
</tr>
<tr>
<td>Not Concerned</td>
<td>3.1%</td>
<td>11</td>
</tr>
<tr>
<td>Don't Know</td>
<td>0.2%</td>
<td>1</td>
</tr>
</tbody>
</table>

answered question 358  
skipped question 0

Question 3

How concerned are you about today's water supply?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td>55.6%</td>
<td>199</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td>36.0%</td>
<td>129</td>
</tr>
<tr>
<td>Not Concerned</td>
<td>8.1%</td>
<td>29</td>
</tr>
<tr>
<td>Don't Know</td>
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<td>1</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>0.0%</td>
<td>3</td>
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</tbody>
</table>

answered question 358  
skipped question 0
### Question 4

**How concerned are you about future water supply?**

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Concerned</td>
<td>67.6%</td>
<td>242</td>
</tr>
<tr>
<td>Somewhat Concerned</td>
<td>27.1%</td>
<td>97</td>
</tr>
<tr>
<td>Not Concerned</td>
<td>4.5%</td>
<td>16</td>
</tr>
<tr>
<td>Don't Know</td>
<td>0.8%</td>
<td>3</td>
</tr>
<tr>
<td>Other (please specify)</td>
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</table>

**Answered question:** 358  
**Skipped question:** 0

### Question 5

**How important is it to purchase a water efficiency device for your household?**

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Important</td>
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<td>126</td>
</tr>
<tr>
<td>Very Important</td>
<td>14.5%</td>
<td>52</td>
</tr>
<tr>
<td>Somewhat Important</td>
<td>47.2%</td>
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</tr>
<tr>
<td>Not at all Important</td>
<td>3.1%</td>
<td>11</td>
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</tbody>
</table>

**Answered question:** 358  
**Skipped question:** 0

### Question 6

**Is the house that you currently reside?**

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owned by you or someone in this household</td>
<td>65.1%</td>
<td>233</td>
</tr>
<tr>
<td>Rented by owner/landlord</td>
<td>34.9%</td>
<td>125</td>
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</table>

**Answered question:** 358  
**Skipped question:** 0
**Question 7**

How important is it to reward water efficiency by homes and to penalize water waste (for example, charging customers higher costs for excess use)?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
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<tr>
<td>Not at all Important</td>
<td>6.6%</td>
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<td>7</td>
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<tr>
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<td></td>
<td>24</td>
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answered question | 346  
skipped question | 12

**Question 8**

Including yourself, how many people currently live in your household?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
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<tr>
<td>1 to 2 people</td>
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<tr>
<td>3 to 4 people</td>
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<td>5 to 10 people</td>
<td>20.7%</td>
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</tr>
<tr>
<td>11 and up</td>
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answered question | 337  
skipped question | 21

**Question 9**

What is the highest level of education you have completed?

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
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</thead>
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<td>Less Than High School</td>
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</tr>
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<td>High School/GED Graduate</td>
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<tr>
<td>Some College</td>
<td>19.2%</td>
<td>67</td>
</tr>
<tr>
<td>College Graduate</td>
<td>17.8%</td>
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</tr>
<tr>
<td>Postgraduate Degree</td>
<td>1.4%</td>
<td>5</td>
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answered question | 349  
skipped question | 9
**Question 10**

**What is your approximate average household income?**

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0-24,999</td>
<td>6.1%</td>
<td>19</td>
</tr>
<tr>
<td>$25,000-$49,999</td>
<td>16.2%</td>
<td>53</td>
</tr>
<tr>
<td>$50,000-$74,999</td>
<td>36.4%</td>
<td>119</td>
</tr>
<tr>
<td>$75,000-$99,999</td>
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</tr>
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<td>$100,000 and up</td>
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*answered question 327*

*skipped question 31*