

Analysis of City of Davis 2010 Urban Water Management Plan

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Abstract

With a growing population, the water demand in the city of Davis will increase, further depleting its aquifer. In order to prevent groundwater overdrafting, which can lead to degrading water quality and reducing our supply of water, we need to collect data on past population and water use per capita (WUPC) in order to predict future water use. Having different projected scenarios enables policy makers to prepare more effective alternative methods and policies. This analysis of data provided by the City of Davis 2010 Urban Water Management Plan compares two different methods of projecting future water demand in Davis until 2035. Our calculations were very basic and only considered indoor water use for WUPC. The entire Urban Water Plan was not compared, only in relation to population, water demand, and indoor conservation. The goal was to see the discrepancy, if any, and evaluate the need of the City of Davis to use a consulting company to gather and project this data. This analysis of the data can reduce costs and influence more inclusive and informative decisions on water management.

Introduction

Our intent was to question the data the City of Davis 2010 Urban Water Management Plan provided. In order to achieve this goal, we will need to collect past data on population, city water consumption and water use per capita. However, the problem we encountered in the process of researching was the discrepancy in the population data given from the two legitimate sources: U.S Census Bureau and City of Davis 2010 Urban Water Management Plan. From this discrepancy arose the difference in the annual water consumption, as well as the daily water use per capita. Because of the recognized importance of the data, we decided to adopt the population data from the Census Bureau, and project data based on it, then compare our results with the data from the Davis Water Plan. What motivated us to carry out this project was the potential impact it could have on policy makers, decision makers in the scientific communities, stakeholders, and community members. The subsequent sections will explore how we have predicted our projections in the categories of future population growth, water use per capita, indoor conservation scenarios in order to analyze the accuracy and feasibility of Davis' UWP.

Objective

The main objective of this project is to compare the data provided by City of Davis 2010 Urban Water Management Plan (Davis UWMP) with our data on future population, water demand, and conservation methods.

1. Analyze the data provided by Davis UWMP and compare it to our calculated results.
2. Demonstrate how much water the City of Davis can conserve in the future with conservation methods to reduce the water use per capita.
3. To compare the methods used and whether it is worth hiring a consultant company to get the same results.
4. The products are numbers, tables and charts that display the discrepancies arisen from the data collected from two different sources in the categories of population, WUPC and baseline and conservation scenarios.

Data Sources

Data was drawn from the City of Davis 2010 Urban Water Management Plan that was prepared for the City of Davis on July 2011. The water plan provided data for the amount of groundwater pumped between the years 1995 to 2010. Population data was collected from the U.S. Census Bureau to calculate our projected population, projected water consumption and the WUPC in Davis.

The water plan provided statistics regarding the average daily household water use of toilets, clothes washers, showers, faucets, and leakage. The quantity of water used by efficient water devices was collected and averaged using numbers released by the City of Davis Public Works Department. We used these statistics to compare to Davis' future estimated WUPC released in their water plan.

Methods and Assumptions

Steps to Project Davis' Future Population Growth

1. Collect population data from the Davis UWMP (Department of Water Resource's numbers) and plot to obtain a linear regression model.
2. Repeat Step 1 with data from the U.S. Census Bureau.
3. Use the model with the highest R-value to project Davis' population up to 2035.

Steps to Calculate Davis' WUPC

4. Collect data on the amount of water supplied to Davis from 1995- 2010.

5. Divide this amount by Davis' population with appropriate unit conversions to obtain the WUPC.

Steps to confirm the accuracy of Davis' estimated future indoor WUPC:

6. Collect and average the data on how much water is used by normal and low-flow conservation appliances and indoor leakage levels from the City of Davis Public Works Department website. (Standard consumption)
7. Collect and average the data on the amount of times a household uses these appliances a day from the Davis UWMP. (Daily use)
8. Multiply these two amounts together (Standard consumption * Daily use) to obtain the daily WUPC for both a baseline and conservation scenario.
9. Take the WUPC from both the baseline and conservation scenarios to calculate a weighted sum that totals the daily indoor WUPC for the year 2020. *

*We assume 75% of Davis households will switch to low-flow devices and 25% will fix their leakages by 2020.

Calculations/Results

The following numbers, tables and graphs reflect the result from comparing the data on population, WUPC and baseline and conservation scenarios.

Figure 1- *Discrepancy is approximately 6% in this graph while comparing the population data from these two sources.*

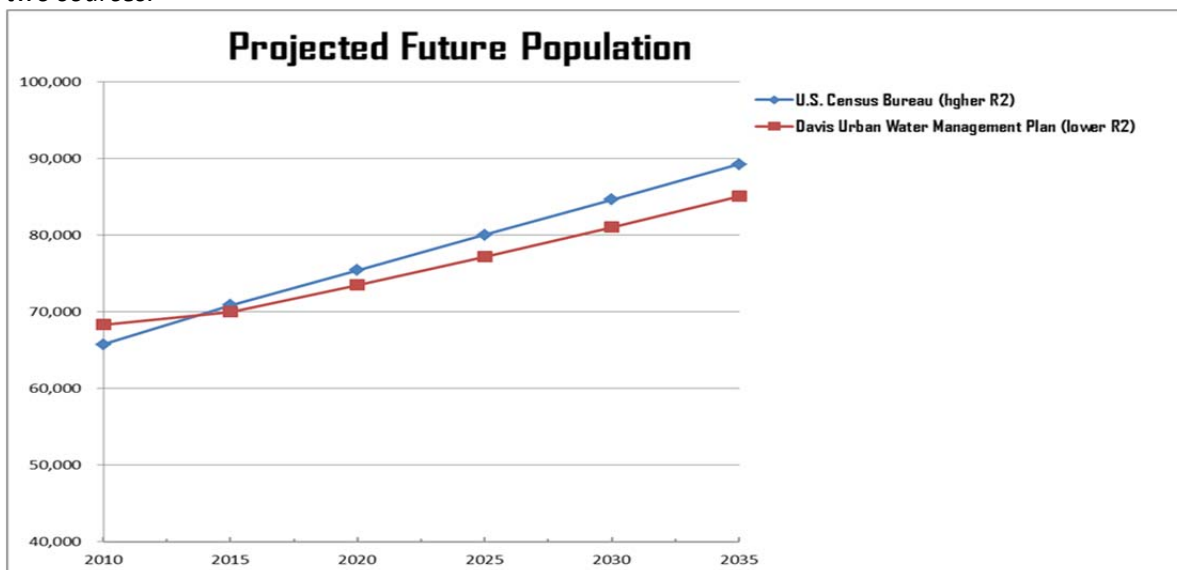


Figure 2- *Estimated baseline scenario with no conservation techniques.*

| Baseline | | | | | | |
|---|----------------------|--------|-------------|---------|-----------------|-----|
| Indoor Water Use (gpd/person) | Standard Consumption | | Daily Use | | Indoor Wat. Use | |
| | Quantity | Unit | Quantity | Unit | Quantity | (%) |
| Laundry (see table on the right) | 11.7 | gpd* | 0.81 | day | 9.5 | 11% |
| Dishwasher (see table on the right) | 16.5 | gpd* | 0.3 | day | 5.0 | 6% |
| Faucets (4.5 gpm X 6 minutes = 27 gpd) | 27.2 | gpd* | 1 | day | 27.2 | 31% |
| Shower (2.03 gpm X 10 minutes = 20.3 gpd) | 2.03 | gpm | 10 | minutes | 20.3 | 23% |
| Toilet (3.07 gpf X 12.7 times/day = 40 gpd) | 3.07 | gpf*** | 4.233333333 | flushes | 13.0 | 15% |
| Leakage | 12.46666667 | gpd* | 1 | day | 12.5 | 14% |
| Total Indoor Water Use (gpd/person) | | | | | 87.4 | |

* gpd: gallons per day; ** gpm: gallons per minute and *** gpf: gallons per flush

Figure 3- *Estimated conservation scenario with efficient devices and reduced leakage*

| Scenario I : Conservation Indoor | | | | | | |
|--|----------------------|--------|-----------|---------|-----------------|--|
| Indoor Water Use (gpd/person) | Standard Consumption | | Daily Use | | Indoor Wat. Use | |
| | Quantity | Unit | Quantity | Unit | Quantity | |
| Laundry (27.5 gallons/load) | 9.2 | gpd* | 0.81 | day | 7.4 | |
| Dishwasher (8 gallons/load) | 8.0 | gpd* | 0.3 | day | 2.4 | |
| Faucets (2.0 gpm X 6 minutes = 10.8 gpd) | 12 | gpd* | 1 | day | 12.0 | |
| Shower (2.0 gpm X 10 minutes = 20 gpd) | 2 | gpm | 10 | minutes | 20.0 | |
| Toilet (1.6 gpf X 4.23333 times/day) | 1.6 | gpf*** | 4.233333 | flushes | 6.8 | |
| Leakage | 9.35 | gpd* | 1 | day | 9.4 | |
| Total Indoor Water Use (gpd/person) | | | | | 57.9 | |

* gpd: gallons per day; ** gpm: gallons per minute and *** gpf: gallons per flush
 *****We assume a household in Davis consists of 3 people

Figure 4- Estimated future indoor WUPC based on a weighted sum of baseline users and conservation users.

| Projected Future WUPC | | | | | | | |
|--|------------------------|----------------------------------|--------------------------|---------------------------|--------------------------------------|--------------------------|-------------------------|
| Indoor Water Use (gpd/person) | Baseline (gpd/ person) | Baseline Users (% of Population) | Actual WUPC (gpd/person) | Conservation (gpd/person) | Conservation Users (% of population) | Actual WUPC (gpd/person) | Total WUPC (gpd/person) |
| Laundry | 9.5 | 0.25 | 2.375 | 7.4 | 0.75 | 5.55 | 7.925 |
| Dishwasher | 5.0 | 0.25 | 1.25 | 2.4 | 0.75 | 1.8 | 3.05 |
| Faucets | 27.2 | 0.25 | 6.8 | 12 | 0.75 | 9 | 15.8 |
| Shower | 20.3 | 0.25 | 5.075 | 20 | 0.75 | 15 | 20.075 |
| Toilet | 13 | 0.25 | 3.25 | 6.8 | 0.75 | 5.1 | 8.35 |
| Leakage | 12.5 | 0.75 | 9.375 | 9.4 | 0.25 | 2.35 | 11.725 |
| Total Indoor Water Use (gpd/person) | | | | | | | 66.925 |

Figure 5- Our projections of water conservation for indoor use. The baseline and conservation scenarios sum to the total projected WUPC.

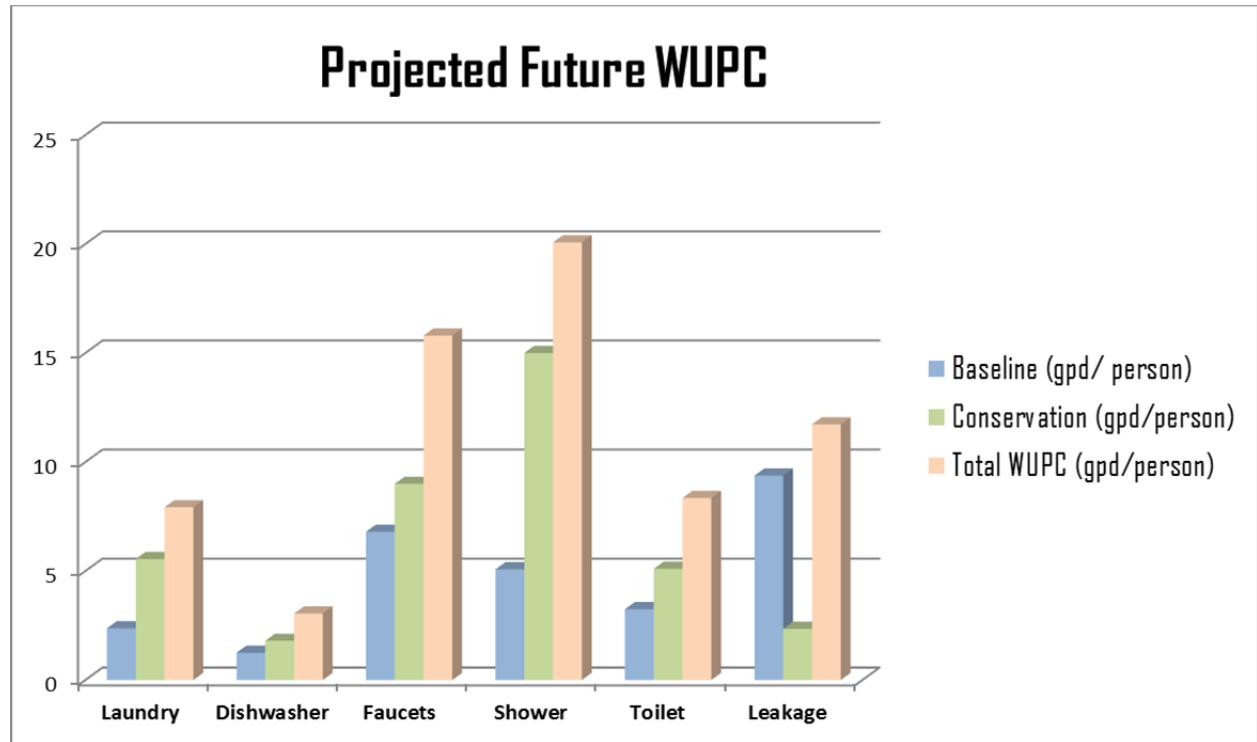


Figure 6- Demonstrates the WUPC of the Water Plan and our calculated WUPC.

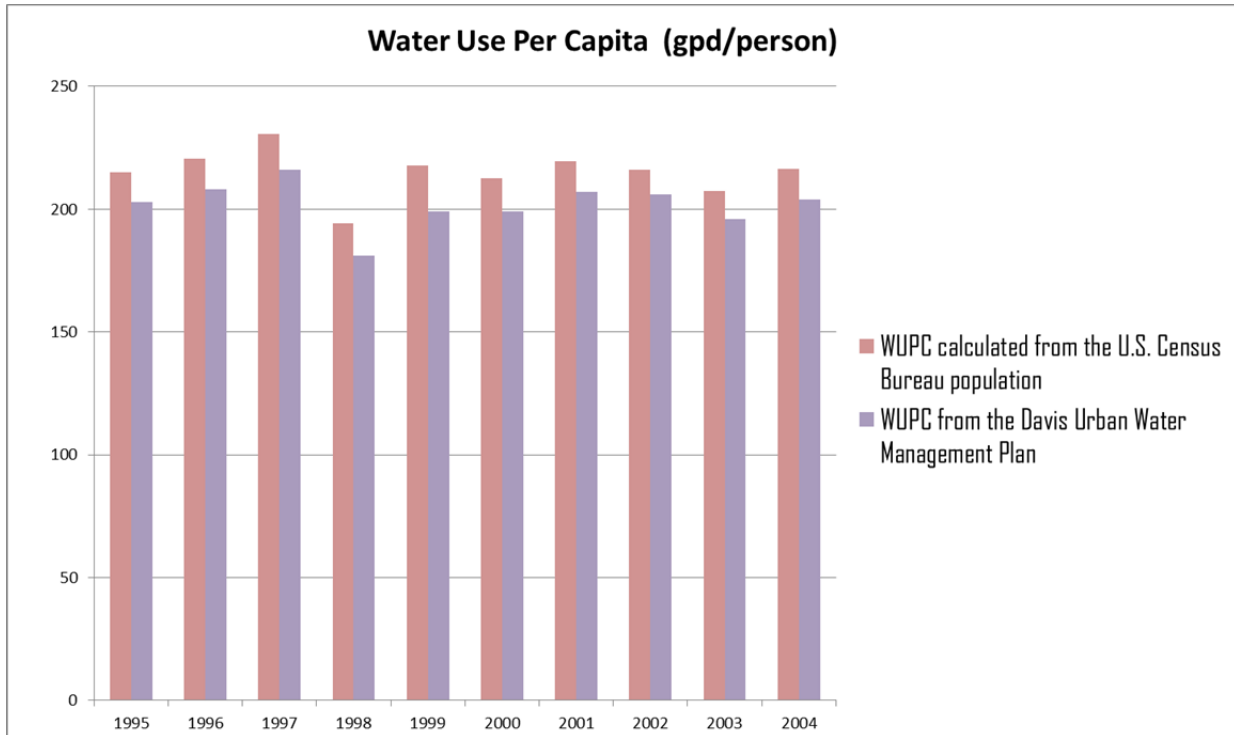


Figure 7- A breakdown of Davis’ future WUPC through various methods. We excluded Commercial, Industrial, and Institutional (CII) indoor uses as a factor in our projections.

| Table 6-4. Approach to Meeting the 2020 gpcd Target | | | | |
|---|-----------------|--------------|--|------------------|
| | 3-yr aver, gpcd | Future, gpcd | Remarks | ac-ft/yr savings |
| Residential indoor | 64 | 57 | toilet and CW 75% penetration, 25% leakage reduction | 539 |
| Residential outdoor | 64 | 55 | 15% reduction | 789 |
| CII indoor | 11 | 10 | 5% reduction | 45 |
| CII outdoor | 12 | 10 | 10% reduction | 94 |
| Landscape indoor | 1 | 1 | 0% reduction | -- |
| Landscape outdoor | 4 | 3 | 10% reduction | 29 |
| Other indoor | 3 | 2 | 0% reduction | 22 |
| Other outdoor | 9 | 9 | 10% reduction | 78 |
| Unaccounted-for | 17 | 13 | 25% reduction | 356 |
| Total | 185 | 161 | -- | 1,952 |

Conservation Results:

The Davis Water Plan estimates Davis' future indoor WUPC to be 60 gpcd. This number reflects both residential use and leakage. We estimated Davis' future indoor WUPC to be 67 gpcd. There is a 10% discrepancy between the two estimates.

Conclusions

With a 10% discrepancy between our estimated future WUPC to Davis' estimated WUPC in the conservation scenario, we conclude that the Davis UWP's goal of reaching an indoor WUPC of 60 gpcd is feasible. We did not use as many factors as the water plan considered, but still was within a similar range. We assume this discrepancy is due to socioeconomic factors that the city considered and we excluded. The discrepancy is also relatively small and consistent in the other categories of our comparison--at approximately 6% in population, city water consumption past WUPC. This result of having similar data projected from two different, legitimate sources, will likely give policy makers and decision makers from different businesses in Davis, who base their decisions on these data, a steady level of confidence at work.

Recommendation/Limitations

We found various limitations while projecting our own conservation scenario. The available technological information and statistical data we had only provided us with several conservation methods for consideration, such as the water use from faucet, shower, toilet, dishwasher, laundry and Leakage. While we could hypothesize and encompass a few more conservation methods in our scenario, we could not find the technological and financial means to collect available data for materializing those methods on our projection. And the discrepancy between the project from our conservation scenario and the one from the Davis Water Plan mainly arose from this discrepancy on available data and technological, financial means. Also, we were limited on the verification of the data from the Davis Water Plan. We initially wanted to search on their method of formulating the data on population and to encompass those methods onto our own projection. However, the lack of information on those methods limited us.

References

Brown and Caldwell. (2011). "City of Davis 2010 Urban Water Management Plan."

City of Davis. (2012). "Water use in your home." Water Conservation, <<http://public-works.cityofdavis.org/water/water-conservation/water-use-in-your-home>> (Dec. 7, 2012).

Data Collectors, (2012), "Davis(city), California Population." <<http://www.census.gov/>> (Dec. 1, 2012).