Reducing Water Consumption in Occidental College Dormitories

Zureena Valli
ENV 246: Environmental Problem Solving
Professor Brown
May 10, 2000

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Treat the Earth well. It was not given to you by your parents. It was loaned to you by your children.

-- Kenyan proverb

Introduction

Water is a resource that is taken for granted. Many seem to think that it is renewable, but this is not the case. It is estimated that between the years of 1970 and 1993, per capita water supplies dropped by one-third, as a result of a worldwide population increase of 1.8 billion.[1] In fact, population increase is considered to be one of the environmental challenges facing us in the new millennium. As population increases on a global scale, as well as a local scale, and water use continues at its present rate, water supplies will decrease. If this occurs, the price of water will increase significantly.

Another phenomenon that is occurring, called global warming, is affecting our supply of water. With global warming, the levels of atmospheric gases reach unnaturally high levels due to emissions from the burning of fossil fuels. Consequently, this causes the earth's atmosphere to become unusually warm. Over the past seven years, global warming has caused a trend of increasing temperatures worldwide. These warmer temperatures affect California as well. California relies on the snow packs of the Sierra Nevada Mountains as a major source for water. However, it is predicted that if the state continues using water at the current rate and temperatures continue to increase, there will not be enough water available in these snow packs to supply parts of the state.

Similarly, the amount of water used by humans has an effect on coastal waters. Seawater is a solution of different minerals and nutrients that are the

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[1] Brown, Lester, Hal Kane, and Ed Ayres. Vital Signs: The Trends That Are Shaping Our Future. New York: W. W. Norton & Company, 1993.

same ones found in sewage sludge. However, there are four nutrients found readily in sewage, which are in short supply in seawater. These are: nitrogen, phosphorus, silicon, and iron.

> The influx of nutrients ... may be augmented by human activities, such as runoff from agricultural lands laden with fertilizers and animal wastes, discharge from sewage treatment plants or seepage from septic tank systems, ...[2]

When these nutrients are introduced into the marine environment in large quantities, algal blooms (also known as red tides or brown tides) are produced. These algal blooms can be harmful to the surrounding marine environment because the blooms grow on the surface at a rapid rate, pushing out the surrounding diversity and causing less light to penetrate the lower levels of water. Consequently, the algae that normally grows underneath the surface waters, dies because it is not receiving enough light. The bacteria which breaks down the dead algae uses dissolved oxygen for this process, and therefore, the more dead algae, the less dissolved oxygen is available to other organisms.

Another effect that sewage has on marine waters is pathogen contamination. A pathogen is a disease producing bacteria, virus, or protozoan. Possible indicators of pathogens are total coliform, fecal coliform, and Enterococcus Bacteria. "These coliform and bacteria come from the environment in the form of soils and decaying vegetation, from animal and human waste and

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[2] Thorne-Miller, Boyce. The Living Ocean: Understanding and Protecting Marine Biodiversity. Washington D.C.: Island Press, 1999.

from storm water/urban runoff."[3] As a result, Southern California beaches are often closed down to swimmers when pathogens reach unhealthy levels. However, by conserving water, the frequency of high levels of pathogens can be reduced.

Water is an especially big concern for Southern California. The climate of this area of the country is arid, causing weather conditions to range from extremely hot in the summer, to mildly cool in the winter (as opposed to extremely cold in the winter). Therefore, water use is more frequent in this part of the country (see Appendix 1). Rain is sporadic and infrequent as well, occurring only during certain times of the year. In some cases Southern California does not receive enough rain at all, and at such times, conserving water becomes critical.

During the past century, there were numerous, severe water shortages in the Southern California area and as a result, strict water rationing measures were implemented and enforced.

> In 1991, five years into the worst drought that the city [of Los Angeles] has ever experienced, the Mayor and the City Council imposed the toughest water-rationing measures in the city's history, and officials predicted that even more stringent measures may be necessary by the end of the year...[4]

These measures were targeted at practices in which water was used for irrigation purposes. Watering lawns and other turf areas was strictly prohibited between

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[3] "Water Quality in Los Angeles County." *UCLA Marina Aquatic Center Water Quality Policy.* Los Angeles: n.p., 1998.

[4] "California Water Plan." *ACWA California Water Facts.* 2000. http://acwanet.com/waterfacts/[illegible]waterplan.html (5 Apr. 2000).

the hours of 10 a.m. and 5 p.m., for example. However, the use of water for domestic purposes in commercial institutions and businesses was also monitored. Restaurants could not serve water to their customers, unless requested. There were penalties for violating these restrictions as well, ranging from written warnings to the temporary restriction of water flow or even, the termination of one's service.

In 1998, it was estimated that the average Los Angelino used approximately 136 gallons of water per day.[5] The annual water demands in Los Angeles during this year were about 628,000 acrefeet (AF), equating to roughly 205 billion gallons (or 274 million HCF) of water. Moreover, the "City's water demand is expected to grow to almost 750,000 AF/Y [acrefeet per year], a 20 % increase to support an additional 900,000 residents expected by 2015."[6]

The Need to Conserve Water at Occidental College

Occidental College is considered a commercial institution in the Los Angeles area, due to the amount of water consumed at the college. Therefore, the amount of water that is consumed at the college has an impact on the community. For this reason, it is important to practice water conservation techniques. In addition, it is environmentally responsible to try and conserve water; water is not a finite resource. Lastly, Occidental College can benefit, financially, from conserving water because less water will be purchased from its

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[5] "Water Services Facts in Brief." *LADWP Home Page*. 1998. http://www.ladwp.com/[illegible]8/wsfib.htm (26 Apr. 2000).

[6] "City of Los Angeles Water Services: Water Supply Fact Sheet." *DWP Water Services: Water Supply*. 1996. http://www.ladwp.com/water/supply/facts/index.htm (2 Apr. 2000).

supplier, the Los Angeles Department of Water and Power. Currently, the college is paying roughly $85,600 per academic year (218 days) for domestic water use in the dormitories alone. Moreover, domestic water use accounted for only thirty-three percent of all water consumed on campus in the 1998 – 1999 academic year.[7] Once irrigation costs are added to this figure, the total cost of water in the last academic year was approximately $2.56 million.' Therefore, by reducing the amount of water that is used on campus, the annual cost of water consumed can be reduced considerably.

Examples of Other Academic Institutions

On college campuses across the nation, there is a fairly new movement called environmental stewardship. This movement, led by students, focuses on strategies for modifying existing conditions on campus with the ultimate goal of becoming environmentally friendly. Students of schools such as, Harvard, Brown, and Columbia have formed committees and insisted on change.

In 1992, students at Brown University joined together to conduct research on the possibility of reducing the amount of water used during showers. Their proposal recommended that every single showerhead on campus be fitted with a low-flow showerhead. The cost-benefit analysis proved to show such tremendous savings that the University replaced the existing showerheads to the new, proposed showerheads. The total annual cost savings of this project was

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[7]Pals, Craig. The Analysis of Water Use and Sewer Discharge at Occidental College. Los Angeles: Occidental College Press, 1998.

projected at $45,800 (including heating and sewage costs), whereas the total cost of the project was $11,368. This project was so successful that the project paid for itself in only four months.

A similar project was done at Columbia University in New York in 1996. Every showerhead, toilet, and faucet aerator on campus was replaced with low-flow fixtures. This project proved to be incredibly successful. The annual cost savings, including energy and sewage costs, totaled $235,000. While the cost of the project was $626,000, the project paid for itself in 1.8 years with the help of a $203,000 rebate from New York City; without this rebate, the payback period would have been extended to 2.3 years.[8]

Occidental College's Status

Currently, Occidental uses a mixture of low-flow fixtures and "regular" fixtures (see Appendix 2). All toilets in dormitory restrooms are either the 3.5 gallons per flush (gpf) or 1.6 gpf types; the 3.5 gpf toilets greatly outnumber the 1.6 gpf types at approximately 7:3, respectively (see Appendix 6). Faucet aerators in dormitory bathrooms are all 2.45 gallons per minute (gpm), while all showerheads in the dormitories are the 2.5 gpm models.

The existing policy at the college is to replace a toilet, showerhead, or sink fixture/faucet aerator when it ceases to function correctly. However, in doing this, the rate at which low-flow fixtures are replaced is slow and consequently, the

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[8] Eagan, David, and Julian Keniry. Green Investment, Green Return: How Practical Conservation Projects Save Millions on America's Campuses. N.p.: [National Wildlife Federation?], 1998.

college cannot enjoy the financial benefits that are synonymous with switching from regular to low-flow.

Methodology

The research for this paper was conducted primarily through the use of surveys, water audits, and interviews, although an extensive array of literature was consulted. First, literature was consulted to determine whether implementing a water-conserving project on campus might be beneficial. This was accomplished by looking at what practices other academic institutions had applied. Once this was determined, a water audit was developed (see Appendix 3) and sent to the Energy Manager of Occidental College, Craig Pals. With this new information, a survey was created (see Appendix 4) and sent to every resident in every dorm on campus. When the surveys were returned, the data was organized, analyzed, and entered into spreadsheets (see Appendix 5). Interviews with individuals at Occidental College Facilities and LADWP were also conducted to gather information. Once all this information had been collected, the cost-benefit portion (see Appendix 6) was calculated. This proved to be the most time-consuming part of the project.

The Proposed Solution

The proposed solution is for all dormitory bathrooms to contain low-flow fixtures. Replacing all existing, regular fixtures with low-flow fixtures can do this. Since approximately 30% of low-flush toilets are installed in the dormitories (see

Appendix 6), there will be no need to replace all toilets in the dormitories with the low-flush type. However, this project is extremely costly. The payback period for this particular project is estimated to be approximately 362 years (see Appendix Showers on campus are currently fitted with a 2.5 gpm showerhead, and it is possible to bring this down to a 1.9 gpm fixture. This is a very feasible project because the annual cost savings of the project is $8,5081 and the payback period is only 1.4 years (see Appendix 6).

Unless a means of financing the project is researched (i.e. donations of money or toilets), this project does not seem likely. In this case, the current policy of replacing an old toilet with a low-flush toilet when the old one becomes dilapidated seems to be the best strategy, financially. While this may not be the best policy in relation to the environment, it must be taken into consideration that the college is experiencing financial difficulty at the present time and such a move (replacing all toilets) will only add to the financial stress facing Occidental College.

In addition, faucet aerators are an ideal way to reduce the water flow in taps, without replacing the entire fixture. At present, sinks in the dormitories are fitted with 2.45 gpm fixtures, but by inserting a faucet aerator, water flow can be restricted to 1.0 gallon per minute. This is a fairly simple procedure because the faucet aerator is inexpensive and easy to install. This project is also realistic because in only 1.5 months, the project pays for itself (see Appendix 6).

The LADWP Rebate

From time to time, the Los Angeles Department of Water and Power (LADWP) offers rebate and incentive programs to its customers. The purpose of these programs is to motivate customers to conserve energy and water. These programs range from an ultra low-flush toilet exchange, where the customer can exchange his/her toilet for an ultra low-flush one, to a low-flow washing machine exchange program. These programs are open to the LADWP's residential, as well as commercial customers.

Since the LADWP considers Occidental to be a commercial institution, the college qualifies for one the rebate incentive programs offered by the LADWP. At this time, the LADWP has only one program that Occidental is eligible to apply for. This program, the toilet rebate program, offers commercial institutions a rebate of seventy-five dollars for each low-flush toilet bought to replace an older, more "wasteful" model. The only requirement is that the institution be an LADWP customer and purchase a DWP-approved low-flush toilet. In addition, the college must show a receipt of purchase for the low-flush toilets bought.

Conclusion

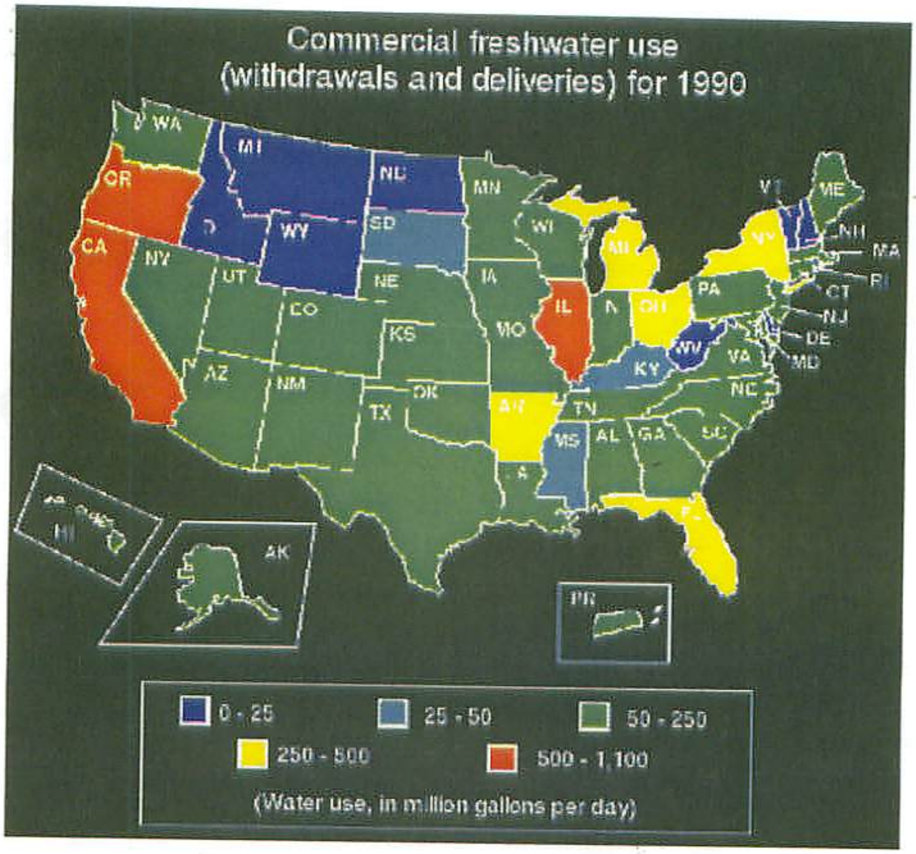
Water is not a finite resource. It is extremely important to reduce water consumption, not only on a global scale, but on a local scale as well. Evidence shows that water availability is decreasing and will continue to do so, unless water-conserving practices are followed. In an effort to conserve water and save money, academic institutions across the country have implemented projects to reduce domestic water consumption in campus dormitories by replacing water fixtures with low-flow fixtures. To determine the possibility of completing such a project at Occidental College, research was conducted through the use of interviews, surveys, and water audits. The following recommendations are based on the findings presented in this report. First, two projects that can be done at Occidental College to reduce water consumption in campus dormitories are replacing the showerhead fixtures and faucet aerators. These projects both have short payback periods and therefore, can save the college money immediately. Next, it is not recommended that toilets be replaced because the time for the project to pay for itself is too great. However, it is recommended that more research be done to determine if there are alternate means for obtaining low-flush toilets at a significantly reduced cost.

Acknowledgements

I wish to thank the following individuals for contributing to this project in one way or another:

Andrea Brown, UEPI
Craig Pals, Occidental College Facilities
Laroy Hansen, Occidental College Facilities
Heidi Bass, LADWP
David Olmstead, LADWP
Mary Loquvam, Mary Loquvam Consultancy
Darren Jack, Occidental College
Nicole Drake, Occidental College
Miriah Mortimer, Occidental College
Marcos Gualberto, Occidental College
Tomoyuki Oshino, Occidental College
David Trocchia, Columbia University Facilities
Harold Hewitt, Occidental College Administration
Theodore Mitchell, Occidental College Administration

APPENDIX 1



http://water.usgs.gov/watuse/graphics/comap.st2.color.gif

APPENDIX 2

TYPE	REGULAR	LOW-FLOW
Toilet	3.5 gpf	1.6 gpf
Showerhead	2.5 gpm	1.9 gpm
Faucet Aerator	2.45 gpm	1.0 gpm

APPENDIX 3

Water Consumption Audit Questions

1. How are HCF units converted to gallons?

2. How many gallons did Occidental consume per square foot of building space (and per capita?)?

3. What has been the overall trend of water consumption over the past two years?

4. How have these costs changed over the past two years?

5. Is there an official campus water-saving program in place? If so, which of these are included:

   - performing waste audits
   - Leak detection and repair
   - Low-flow showerheads in new restrooms
   - Low-flow showerheads in existing restrooms
   - Low-flow toilets in new restrooms
   - Low-flow toilets in existing restrooms
   - Low-flow sink fixtures in new restrooms
   - Low-flow fixtures in existing restrooms
   - Xeriscaping in new landscaped areas
   - Xeriscaping in existing landscaped areas
   - Efficient irrigation system:
     - drip
     - automatic timers

- automatic sensors

- Use of reclaimed water
- Other measures

6. Are there any estimates of water savings from such programs? If so, how much?
7. What California state water regulations must the college adhere to?

APPENDIX 4

Survey of Water Consumption in Dorms

I am conducting research on student consumption of water in dorms. I would greatly appreciate it if you could take the time to fill out questionnaire to the best of your ability. Please be as honest and detailed as possible. This is completely anonymous. Please return this survey to your RA as soon as possible. If you have any questions, please feel free to e-mail me at vallli@oxy.edu or call x4797. Thank you for your time and cooperation.

1. On average, how many minutes do your showers last? ________________
2. How many showers a week do you take, on average? __________________
3. Do you take more showers at a particular time of the year (i.e. a sport season) than others? ________
4. If so, for about how many weeks do you take more showers and what is the duration of each shower? ____
5. How many times a day do you flush the toilet in your dorm? ______________
6. Below is a table of tasks normally performed at a sink. Please give a fairly accurate estimate of the amount of time water is used for the following tasks. If you usually let the water run while completing the tasks listed below, mark the left-hand column. If you usually turn the water on and off during the completion of these tasks, then mark the right-hand column.

Task	Average time (min. or sec.) water is used if you usually run the faucet continuously	Average time (min. or sec.) water is used if you usually turn the faucet on and off
Brushing of teeth		
Washing of face		
Washing of hands		
Washing of dishes		
Shaving		

7. Do you have any comments or suggestions on how water consumption can be reduced in the dorms?

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____

Thank you for taking the time to respond to this questionnaire.

APPENDIX 5

Bell-Young	
Surveys sent out	107
Surveys returned	19
Percentage returned	17.80%
Sample Size	19
Avg. min./shower	13.0 min
Avg. # showers/wk	7.3
Avg # toilet flushes/day	4
Avg. time to brush teeth	48.9 sec
Avg. time to wash face	50.5 sec
Avg. time to wash hands	25.6 sec
Avg. time to wash dishes	2.9 min
Avg. time for shaving	2.2 min

Women's Center	
Surveys sent out	12
Surveys returned	7
Percentage returned	58.30%
Sample Size	7
Avg. min./shower	12.4 min
Avg. # showers/wk	7.6
Avg # toilet flushes/day	3.8
Avg. time to brush teeth	1.1 min
Avg. time to wash face	1.3 min
Avg. time to wash hands	34.6 sec
Avg. time to wash dishes	4.8 min
Avg. time for shaving	n/a

Wylie	
Surveys sent out	60
Surveys returned	10
Percentage returned	16.70%
Sample Size	10
Avg. min./shower	10.0 min
Avg. # showers/wk	7.1
Avg # toilet flushes/day	3.4
Avg. time to brush teeth	2.8 min
Avg. time to wash face	1.4 min
Avg. time to wash hands	1.2 min
Avg. time to wash dishes	7.5 min
Avg. time for shaving	2.1 min

Stearns	
Surveys sent out	94
Surveys returned	9
Percentage returned	9.60%
Sample Size	9
Avg. min./shower	12.7 min
Avg. # showers/wk	9.3
Avg # toilet flushes/day	4.1
Avg. time to brush teeth	1.7 min
Avg. time to wash face	1.5 min
Avg. time to wash hands	1.0 min
Avg. time to wash dishes	3.5 min
Avg. time for shaving	2.2 min

Newcomb	
Surveys sent out	129
Surveys returned	17
Percentage returned	13.20%
Sample Size	17
Avg. min./shower	15.9 min
Avg. # showers/wk	6.9
Avg # toilet flushes/day	3.9
Avg. time to brush teeth	1.8 min
Avg. time to wash face	1.3 min
Avg. time to wash hands	2.2 min
Avg. time to wash dishes	4.4 min
Avg. time for shaving	6.6 min

Braun	
Surveys sent out	108
Surveys returned	19
Percentage returned	17.60%
Sample Size	19
Avg. min./shower	10.9 min
Avg. # showers/wk	7.2
Avg # toilet flushes/day	4.7
Avg. time to brush teeth	1.2 min
Avg. time to wash face	1.4 min
Avg. time to wash hands	48.7 sec
Avg. time to wash dishes	6.2 min
Avg. time for shaving	3.8 min

Pauley	
Surveys sent out	108
Surveys returned	3
Percentage returned	2.80%
Sample Size	3
Avg. min./shower	21.7 min
Avg. # showers/wk	7.3
Avg # toilet flushes/day	2.8
Avg. time to brush teeth	33.2 sec
Avg. time to wash face	1.7 min
Avg. time to wash hands	31.6 sec
Avg. time to wash dishes	1.0 min
Avg. time for shaving	15.0 min

Chilcott	
Surveys sent out	82
Surveys returned	14
Percentage returned	17.10%
Sample Size	14
Avg. min./shower	14.7 min
Avg. # showers/wk	8.1
Avg # toilet flushes/day	3.9
Avg. time to brush teeth	1.8 min
Avg. time to wash face	2.1 min
Avg. time to wash hands	37.8 sec
Avg. time to wash dishes	2.4 min
Avg. time for shaving	5.0 min

Stewart-Cleland	
Surveys sent out	131
Surveys returned	30
Percentage returned	23.00%
Sample Size	30
Avg. min./shower	14.9 min
Avg. # showers/wk	7.2
Avg # toilet flushes/day	4.6
Avg. time to brush teeth	2.6 min
Avg. time to wash face	2.5 min
Avg. time to wash hands	1.3 min
Avg. time to wash dishes	4.6 min
Avg. time for shaving	6.0 min

Norris	
Surveys sent out	146
Surveys returned	11
Percentage returned	7.50%
Sample Size	11
Avg. min./shower	17.0 min
Avg. # showers/wk	7.3
Avg # toilet flushes/day	4.5
Avg. time to brush teeth	1.8 min
Avg. time to wash face	1.9 min
Avg. time to wash hands	39.5 sec
Avg. time to wash dishes	7.6 min
Avg. time for shaving	5.7 min

Erdman	
Surveys sent out	107
Surveys returned	8
Percentage returned	7.50%
Sample Size	8
Avg. min./shower	14.4 min
Avg. # showers/wk	7.6
Avg # toilet flushes/day	3.5
Avg. time to brush teeth	51.5 sec
Avg. time to wash face	1.3 min
Avg. time to wash hands	44.6 sec
Avg. time to wash dishes	5.1 min
Avg. time for shaving	1.6 min

All Dormitories (not incl. Haines)	
Surveys sent out	1084
Surveys returned	147
Percentage returned	13.60%
Sample Size	147
Avg. min./shower	14.3 min
Avg. # showers/wk	7.5/wk
Avg. # showers/day	1.1/day
Avg # toilet flushes/day	3.9/day
Avg. time to brush teeth	1.5 min
Avg. time to wash face	1.6 min
Avg. time to wash hands	54.9 sec
Avg. time to wash dishes	4.5 min
Avg. time for shaving	5.0 min

APPENDIX 6

	TOILETS - BEFORE					
DORM*	No. of Toilets	Total 3.5 gpf	Total 1.6 gpf	Flush/dorm/day	Avg. gpf	gal/dorm/day
Braun	18	18	0	507.6	3.5	1,776.60
Pauley	16	15	1	302.4	3.38	1,022.10
Stearns	18	18	0	385.4	3.5	1,348.90
Women's Center	5	0	5	45.6	1.6	72.90
Bell-Young	20	20	0	428	3.5	1,498.00
Stewart-Cleland	22	19	3	602.6	3.24	1,952.40
Chilcott	15	13	2	319.8	3.24	1,036.10
Erdman	20	14	6	374.5	2.93	1,097.20
Newcomb	24	24	0	503.1	3.5	1,760.80
Wylie	20	2	18	204	1.79	365.10
Norris	52	52	0	657	3.5	2,299.50
Haines*	26	3	23	413.4	1.81	748.25
TOTAL	256	198	58	4743.4		14,977.85
PERCENTAGE:		77.30%	22.30%			

OCCIDENTAL		Cost/Academic Year
Gal/day	14,977.85	$ 12,047.95
Gal/academic yr**	3,265,171.30	

*Averages for all dorms used to calculate info. for Haines b/c of missing data

**Assume # of days in academic yr = 218.

TOILETS - AFTER REPLACEMENT				
DORM*	No. of Toilets	Toilets at 1.6 gpf	Flush/dorm/day	gal/dorm/day
Braun	18	18	507.6	812.16
Pauley	16	16	302.4	483.84
Stearns	18	18	385.4	616.64
Women's Center	5	5	45.6	72.90
Bell-Young	20	20	428	684.80
Stewart-Cleland	22	22	602.6	964.16
Chilcott	15	15	319.8	511.68
Erdman	20	20	374.50	599.2
Newcomb	24	24	503.1	804.96
Wylie	20	20	204	326.40
Norris	52	52	657	1,051.20
Haines*	26	26	413.4	661.44
TOTAL	256	256	4743.4	7,589.38
PERCENTAGE:		100.00%		

OCCIDENTAL		Cost/Academic Year	Cost Savings	Percent Decrease
Gal/day	7,589.38	**$6,104.79**	**$5,943.16**	**50.67%**
Gal/academic yr**	1,654,484.84			

*Averages for all dorms used to calculate info. for Haines b/c of missing data

**Assume # of days in academic yr = 218.

Water Savings for Toilets

Water Detail for Toilets	Before replacement	After replacement
Gallons/flush	1.6 - 3.5	1.6
Avg.# flushes/day	3.9	3.9
Gallons/day	14,229.60	7,589.38
# Students affected	1084	1084
Gallons used/academic year (218 days)	3,102,052.80	1,654,484.84
Total water savings/academic year (gallons)		**1,447,567.96**

Cost Detail for Toilets		After Replacement
# fixtures		198
Est. labor time/fixture		2 hrs.
Labor cost/hour		$25 (incl. benefits)
Fixture cost		$186.00
Total est. installation cost		$1,841,400.00
Mgmt./contingency as specified in contract (5%)		$92,070.00
Actual project cost total		**$1,933,470.00**
Actual project cost total (with LADWP Rebate)		**$1,153,845.00**

Cost Savings

Water purchase savings/year	Payback period	Payback period with Rebate
$5,341.29	**362 yrs.**	**216 yrs.**

SHOWERS -- Before Replacement		
DORM*	gpm	gal/dorm/day
Braun	2.5	3,013.50
Pauley	2.5	5,859.00
Stearns	2.5	2,984.50
Women's Center	2.5	372.00
Bell-Young	2.5	3,477.50
Stewart-Cleland	2.5	4,879.70
Chilcott	2.5	3,013.50
Erdman	2.5	3,852.00
Newcomb	2.5	5,127.70
Wylie	2.5	1,500.00
Norris	2.5	6,205.00
Haines*	2.5	3,789.50
TOTAL		44,073.90

OCCIDENTAL		Cost/Academic Year
Gal/day	44,073.90	**$ 35,452.39**
Gal/academic yr**	9,608,110.20	

*Averages for all dorms used to calculate Haines info. b/c of missing data.

**Assume # of days in academic yr = 218.

SHOWERS - AFTER REPLACEMENT		
DORM*	gpm	gal/dorm/day
Braun	1.9	2,290.26
Pauley	1.9	4,452.84
Stearns	1.9	2,268.22
Women's Center	1.9	282.72
Bell-Young	1.9	2,642.90
Stewart-Cleland	1.9	3,708.61
Chilcott	1.9	2,290.26
Erdman	1.9	2,927.52
Newcomb	1.9	3,897.09
Wylie	1.9	1140.00
Norris	1.9	4,715.80
Haines*	1.9	2,880.02
TOTAL		33,496.24

OCCIDENTAL		Cost/Academic Year	Cost Savings	Percent Decrease
Gal/day	33,496.24	$26,943.87	$8,508.52	24%
Gal/academic yr**	7,302,180.32			

*Averages for all dorms used to calculate info. for Haines b/c of missing data

**Assume # of days in academic yr = 218.

Water Savings for Showerheads

Water Detail for Showers	Before replacement	After replacement
Avg. min./shower	14.3	14.3
Avg. # showers/day	1.1	1.1
# Students affected	1084	1084
Gallons/minute (gpm)	2.5	1.9
Gallons/day	44,073.90	33,496.24
Gallons used/academic year (218 days)	9,608,110.20	7,302,180.32
Total water savings/academic year (gallons)		**2,305,929.88**

Cost Detail for Showerheads		After Replacement
# fixtures		223
Est. labor time/fixture		.25 hrs.
Labor cost/hour		$25 (incl. benefits)
Fixture cost		$8.00
Total est. installation cost		$11,150.00
Mgmt./contingency as specified in contract (5%)		$557.50
Actual project cost total		**$11,707.50**

Cost Savings	
Water purchase savings/year	**Payback period**
$8,508.51	**1.4 yrs.**

	SINKS		
DORM*	gpm	# min. H2O used***	gal/dorm/day
Braun	2.45	14.6	2,933.10
Pauley	2.45	17.7	4,683.40
Stearns	2.45	14.3	3,293.30
Women's Center	2.45	9.3	273.4
Bell-Young	2.45	8.1	2,123.40
Stewart-Cleland	2.45	21.6	6,932.50
Chilcott	2.45	14.4	2,892.90
Erdman	2.45	11.2	2,936.10
Newcomb	2.45	25.2	7,964.40
Wylie	2.45	19.5	2,866.50
Norris	2.45	17.5	6,259.70
Haines*	2.45	16.1	4,181.10
TOTAL		189.5	47,339.80

OCCIDENTAL		Cost/Academic Year
Gal/day	47,339.80	$ 38,079.42
Gal/academic yr**	10,320,076.40	

*Averages for all dorms used to calculate info. for Haines b/c of missing data
**Assume # of days in academic yr = 218.
***Assume the following for sinks (# times done ea. day):

Brush teeth	2
Wash face	1
Wash hands	6
Wash dishes	0.5
Shaving	0.75

SINKS - AFTER REPLACEMENT		
DORM*	gpm	gal/dorm/day
Braun	1	1,197.20
Pauley	1	1,911.60
Stearns	1	1,344.20
Women's Center	1	111.60
Bell-Young	1	866.70
Stewart-Cleland	1	2,829.60
Chilcott	1	1,180.80
Erdman	1	1,198.40
Newcomb	1	3,250.80
Wylie	1	1170.00
Norris	1	2,555.00
Haines*	1	1,706.60
TOTAL		19,322.50

OCCIDENTAL		Cost/Academic Year	Cost Savings	Percent Decrease
Gal/day	19,322.50	$15,542.73	$22,536.69	59%
Gal/academic yr**	4,212,305.00			

*Averages for all dorms used to calculate info. for Haines b/c of missing data

**Assume # of days in academic yr = 218.

Water Savings for Facuet Aerators

Water Detail for Faucet Aerators	Before replacement	After replacement
Gallons/minute (gpm)	2.5	1
Avg. # min. water is running/day	15.7	15.7
Gallons/day	43,158.70	19,322.50
# Students affected	1084	1084
Gallons used/academic year (218 days)	9,408,596.60	4,212,305.00
Total water savings/academic year (gallons)		**5,196,291.60**

Cost Detail for Faucet Aerators		After Replacement
# fixtures		526
Est. labor time/fixture		.25 hrs
Labor cost/hour		$25 (incl. benefits)
Fixture cost		$0.95
Total est. installation cost		$3,123.13
Mgmt./contingency as specified in contract (5%)		$156.16
Actual project cost total		**$3,279.29**

Cost Savings	
Water purchase savings/year	**Payback period**
$19,173.47	**1.5 mos.**

Bibliography

Brion, Penelope, Bradley Leon, and Linh Thai. Greening Occidental: A preliminary assessment of campus environmental practices. Los Angeles: Occidental College Press, 1998.

Brown, Lester, Hal Kane, and Ed Ayres. Vital Signs: The Trends That Are Shaping Our Future. New York: W. W. Norton & Company, 1993.

"California Water Plan." *ACWA California Water Facts.* 2000. http://acwanet.com/waterfacts/calwaterplan.html (5 Apr. 2000).

"City of Los Angeles Water Services: General Information." *DWP Water Services Making It Happen: Water Conservation.* 1996. http://www.ladwp.com/water/conserv/generalinfo/index.htm (14 Feb. 2000).

"City of Los Angeles Water Services: Water Conservation Tips For Your Business." *DWP Water Services Making It Happen: Water Conservation.* 1996. http://www.ladwp.com/water/conserv/business/index.htm (14 Feb. 2000).

"City of Los Angeles Water Services: Water Supply Fact Sheet." *DWP Water Services: Water Supply.* 1996. http://www.ladwp.com/water/supply/facts/index.htm (2 Apr. 2000).

Creighton, Sarah H. Greening the Ivory Tower: Improving the Environmental Track Record of Universities, Colleges, and Other Institutions. Cambridge: MIT Press, 1998.

Eagan, David, and Julian Keniry. Green Investment, Green Return: How Practical Conservation Projects Save Millions on America's Campuses. N.p.: [National Wildlife Federation?], 1998.

"Energy Management." *Physical Plant Management.* 1993. http://norms.csun.edu/ppm/genergy.htm#water (5 Apr. 2000).

Fetter, Rob and Alyssa Mudd. "The Brown, the Green, and the Grey: Auditing Water Use at Brown University." 1993. http://www.brown.edu/Departments/Br...Green/esproj/watr4193/watr4193.html (14 Feb. 2000).

Finkelstein, Sarah, Sarah Rollet, and Graham Bullock. "Chapter 6: Water Use." *Princeton Environmental Reform Committee (PERC) Environmental Audit of Princeton University*. 1995. http://www.princeton.edu:80/~perc/Percchap6.htm (14 Feb. 2000).

Hansen, Laroy. Personal Interview. 22 Mar. 2000.

---. Personal Interview. 24 Apr. 2000.

---. Telephone conversation. 27 Apr. 2000.

---, ed. "Re: some questions." E-mail to Zureena Valli. 28 Apr. 2000.

Hewitt, Harold. Personal Interview. 8 Mar. 2000.

"High Efficiency Toilets." *EPA Office of Water: Office of Wastewater Management Water Efficiency Program*. 2000. http://www.epa.gov/owm/toilets.htm (24 Feb. 2000).

Isenberg, Michael. "Campus Environmental Audit: Water Usage, Wastewater, Storm Runoff." *Campus Environmental Audit*. 1996. http://dolphin.upenn.edu/~pennenv/audit/water/index.html (14 Feb. 2000).

Keniry, Julian. Ecodemia: Campus Environmental Stewardship at the Turn of the 21st Century. N.p.: [National Wildlife Federation?], 1995.

Kubani, Dean and City of Santa Monica Task Force on the Environment. Sustainable City Progress Report: Initial Progress Report on Santa Monica's Sustainable City Program. [Los Angeles?]: n.p., 1996.

---. Sustainable City Progress Report Update: Updated Progress Report on Santa Monica's Sustainable City Program. [Los Angeles?]: n.p., 1999.

Loquvam, Mary. Personal Interview. 7 Apr. 2000.

Los Angeles Department of Water and Power. Water Conservation Technical Assistance Program For Los Angeles' Commercial, Industrial and Institutional Customers. [Los Angeles]: n.p., 1995.

"Los Angeles Department of Water and Power High-Efficiency Clothes Washer Rebate Program." *DWP Water Services Making It Happen: Water Conservation*. 1999. http://www.ladwp.com/water/conserv/washers/index.htm (14 Feb.2000).

Mitchell, Theodore. Personal Interview. 8 Mar. 2000.

"Municipal & Industrial Discharge." *Santa Monica Bay Restoration Project: Human Impacts*. 1996. http://www.smbay.org/human/61.htm (7 Apr. 2000).

Olmstead, David. Telephone Conversation. 28 Apr. 2000.

---. Telephone conversation. 10 May 2000.

Orr, David W. Ecological Literacy: Education and the Transition to a Postmodern World. SUNY Ser. In Constructive Postmodern Thought. Albany: SUNY Press, 1992.

Pals, Craig. The Analysis of Water Use and Sewer Discharge at Occidental College. Los Angeles: Occidental College Press, 1998.

---. Personal Interview. 11 Feb. 2000.

---. Personal Interview. 7 Mar. 2000.

---. Personal Interview. 22 Mar. 2000.

---, ed. "Re: H2O water audit questions." E-mail to Zureena Valli. 6 Mar. 2000.

---, ed. "Re: Outline for ENV246 H2O project." E-mail to Zureena Valli. 3 Mar. 2000.

---. Personal Interview. 24 Apr. 2000.

---. "Re:." E-mail to Zureena Valli. 10 May 2000.

Smith, April A. and The Student Environmental Action Coalition. Campus Ecology: A Guide to Assessing Environmental Quality & Creating Strategies for Change. Los Angeles: Living Planet Press, 1993.

Thorne-Miller, Boyce. The Living Ocean: Understanding and Protecting Marine Biodiversity, 2nd ed. Washington D.C.: Island Press, 1999.

Trocchia, Tony. "Re: 1996 Water Conservation Project." E-mail to Zureena Valli. 20 Mar. 2000.

"ULF Toilet Distribution Program: List of Community-Based Organizations As of September 28, 1999." *DWP Water Services Making It Happen: Water Conservation*. 1999. http://www.ladwp.com/water/conserv/ulfcbo.htm (14 Feb. 2000).

"Water Efficiency Service Company Directory." *WaterWiser: The Water Efficiency Clearinghouse*. 2000. http://www.waterwiser.org/frameset2.cfm?b=8 (24 Feb. 2000).

"WaterWiser Drip Calculator." *WaterWiser: The Water Efficiency Clearinghouse (Books)*. 2000. http://www.waterwiser.org/frameset.cfm?b=2 (24 Feb. 2000).