Running Water: Student Water Use and Conservation in Smith Houses

Project Partners: Lauren Robertson and Hannah Jaris
Report by: Lauren Robertson
Smith College
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Abstract

In this project, we assess students' behavior towards water on campus and design methods of conservation to target the largest water consumptive behaviors. Analysis of the Smith water bills demonstrates that the largest water uses comes from Smith housing. In order to examine students' discretionary water use, we focus on residents of non-dining houses. We designed a survey that focused on various behaviors (i.e. brushing teeth, washing face, shaving) involving discretionary water use; in our estimation, running water for these behaviors is equivalent to wasted water. With the help of house presidents, we distributed the survey to 300 residents from six non-dining houses. The survey asked students to comment on the frequency and duration of time that they ran water while performing these behaviors. Students responded to additional questions about number of water bottles used per day and other water consumptive behaviors. The results of the survey showed that running water while waiting for a desired temperature (hot/cold), and washing face were the largest consumptive behaviors students performed, while brushing teeth and shaving were the lowest water consumptive behaviors. The immediate significance of these findings identifies the largest consumptive behaviors for targeting students' water use and conservation should address conservation methods. Other studies should examine the campus-wide attitude towards water and the role of water education in increasing students' water conservation.

Introduction

The American College and University's Climate Commitment

In 2007, President Carol Christ of Smith College signed the American College and University Presidents' Climate Commitment. This agreement, signed by 434 other colleges and universities requires each college/university to design a Climate Action Plan. The Plan will address methods to reduce carbon gas emissions and energy consumption within two years. The initial steps of the Climate Action Plan involve the development of a complete emissions inventory. The inventory comprises all forms of energy use resulting in carbon emissions, including electrical use for heating buildings and houses. Once Smith College has drafted its emission inventory, it will choose from a list of methods to reduce carbon emissions, design its own techniques, and set target dates for achieving carbon neutrality (Cole, 2007).

Multiple methods of both minimizing emissions and offsetting emissions will constitute the steps towards reaching carbon neutrality. Two techniques for reducing carbon emissions are efficiency changes or conservation. Energy efficiency requires capital to switch from an older to a newer technology. An efficient appliance or technology is one that uses less energy to provide the same level of energy service. Conservation on the other hand, involves a behavioral change, or using less of what you have. Five-college Sustainability Director, Dano Weisbord and the Sustainability Committee are responsible for the Climate Action Plan's development and evaluation. David Smith's Environmental Science and Policy Seminar students have been enlisted by Dano Weisbord to investigate issues of efficiency and conservation relating to Smith College's environmental sustainability.

Smith College's Climate Action Plan

Electricity to heat water accounts for a large percentage of Smith College's energy uses in all buildings. Water efficiency and conservation are therefore relevant to the Climate Action Plan. Member colleges and universities who have signed on to the Climate Action Plan have already initiated large-scale, water efficiency projects. For example, Harvard University has installed dual-flush toilets, waterless urinals, infrared faucet sensors, low-flow faucets and low-flow showerheads and successfully reduced water consumption by 40% in some buildings (Harvard University, 2008).

Smith College has undertaken various, smaller projects to begin to address water efficiency. One project relevant to water is the installation of 25 low-flow showerheads in student housing (out of approximately 650 showerheads). This summer, Sustainability Director, Dano Weisbord is looking to switch 550 to low-flow showerheads, model Bricor B150CH. The low-flow shower heads will save 6,000,000 gallons of water and 2,760 MMBtus (measurement of electricity) annually, for a total annual savings of $77,734 (Dano Weisbord, May 7th 2009). The cost of the project is $45,000 to make the initial swap to low-flow showerheads. In addition to shower efficiency changes, solar panels for domestic water production have been instituted on Conway House, a 10-unit residence for Ada Comstock Scholars (Smith College, *Operational Initiatives*). In 2002, Resident and Dining Services changed all washing machines to front-loading Maytag Neptune washers, which generated a savings of 1,164,000 gallons of water annually (Smith College, *Operational Initiatives*). Housing services has also equipped the majority of the houses with waterless hand sanitizer (Smith College, *Operational Initiatives)*. Efficiency changes such as these need to become more numerous (in all houses) and standard (in all new and renovated buildings) in an effort to reduce Smith's water use and water utility bills.

Unlike efficiency changes which require capital and technological inputs in order to generate reduced outputs, conservation techniques require a change in behavior or reduced use. In the current global economic climate, Smith College is examining the viability of energy and carbon reduction through conservation methods. Preliminary analysis of Smith's water bills showed student housing to be the largest consumers of water on campus as compared to academic buildings; therefore, our study focused on analyzing students' behavior towards water use in order to identify the largest consumptive behaviors to be addressed in subsequent conservation studies.

Methodology

Analysis of Houses' Water Bills

We began the study by meeting with Sustainability Director, Dano Weisbord and then independently evaluating the Smith College's water bill data from December 2004 to December 2008. The water bill data is organized by pay periods (three months). Without water monitors in buildings and houses, the water utility bills were the only way to examine water use and general trends on campus. We analyzed houses' water use compared to academic buildings. Then we assessed dining houses and non-dining houses' water use. In another meeting with Dano Weisbord, we decided to focus on student housing, specifically non-dining houses, in order to study students' discretionary behavior towards water. From the houses without dining, we chose six houses of varying size (# of residents) and locations on campus (Green Street to Center campus); these houses were Park, Sessions, Haven/Wesley, Jordan and Lawrence.

<u>Design and Distribution of Survey</u>

The objective of the survey was to identify students' behavior towards water use for behaviors where running water was discretionary. We made the assumption that discretionary behaviors included ones that did not require water to be running while performing the action: brushing teeth, washing face, shaving, washing dishes, waiting for desired temperature (hot/cold), or filling water bottles. This assumption is based on the fact that when you wash dishes, the water can be turned off until required for rinsing. We designed a survey that asked students to comment on frequency (how many times per day), and for what duration of time (minutes/day) they run the water while performing the latter behaviors (Appendix 1). The survey also requested information on the number of water bottles used per week, the number of loads of laundry washed and dried per week, and provided a space for any additional behaviors involving water.

We distributed the surveys through the House Presidents to over 300 students and 31 students responded. We gave residents a week and a half to answer the survey. Upon receiving a low response rate, we extended the deadline and requested that the house presidents re-send the survey to all residents in order to increase the survey's response rate. For the most part, students answered all questions. In some cases, students' indicated that they did not run the water while performing a particular behavior, but for the same behavior listed an amount of time. For these responses, we assumed that the students first response that they did not run the water while performing that behavior.

Assumptions for Survey & Analysis

After careful analysis of the surveys, we determined the *discretionary* frequency and duration of time for performing this action as equivalent to or one or greater. Thus, the running of water once per day while washing face, or for one minute per day, was significant. We then used this model to examine the survey results. The behaviors (i.e. washing face, brushing teeth) for which more than 50% of the students ran water once plus per day or for one minute plus per day, we identified as the largest consumptive behaviors. Conversely, the lowest consumptive behaviors were ones that more than 50% of the students responded as performing zero times per day, or performing less than once per day or for less than one minute.

Showerhead Efficiency

In order to assess water flow efficiency in the showers, we measured in seconds how long it took to fill a gallon. These results were compared to low-flow showerheads that fill two and a half gallons in one minute, and conventional showerheads that fill three to five gallons in one minute (Table 1).

Results

Preliminary analysis of Smith College's water utility bills showed that houses used more water than academic buildings over all pay periods from December 2004 to December 2008 (Figure 1). After normalizing for the number of students in the house, students in dining houses used approximately 5,000 gallons of water per pay period as compared to residents of non-dining houses who used approximately 3,000 gallons per pay period (Figure 2 & Figure 3).

Results from the surveys showed the largest water consumptive behaviors to be running water while washing face, and waiting for the desired temperature (hot/cold). The lowest water consumptive behaviors are brushing teeth per day and shaving per week.

The frequency and duration of time students ran the water for the largest consumptive behaviors differed. In the case of face washing, 68% of the students polled responded that they run the water for one to two times a day while washing their face (Figure 4). Similarly, 67% of the students responded that they ran the water for at least one minute, and up to four minutes per day while washing face (Figure 5). Students polled (15%) ran the water for four minutes while washing face (Figure 5). Of the students polled, 81% ran the water one to ten times a day, and 81% ran the water for one to ten minutes per day, while waiting for it to reach a desired temperature (hot/cold) (Figure 6 & Figure 7). Students polled (50%) ran the water for two to ten minutes per day while waiting for it to reach a desired temperature (Figure 7).

The lowest consumptive behaviors, running water while brushing teeth and shaving, showed higher percentages of students reporting <u>not</u> running the water while performing the behavior. Students polled (66%) reported <u>not</u> running the water while brushing teeth per day (Figure 8), and 52% while shaving per week [1](Figure 9).

For additional behaviors, 83% of the students reported using zero plastic water bottles, 10% reported using one, and 3% reported using 7 per day (Figure 10). In the spaced provided for survey recipients' comments on other behaviors that they perform that uses water, one or more students mentioned the duration of time spent showering,

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[1] includes zero to less than once a week

the frequency of hand washing per day, and frequency of flushing the toilet. For example, students said they flushed the toilet six times per day, washed hands five times per day, and showered for thirty minutes per day.

Results from testing the efficiency of shower heads are inconclusive; data indicates that Lawrence and Sessions House shower heads were almost all within the range or more efficient than low-flow shower heads.

Figures

Smith College Water Utility Bills

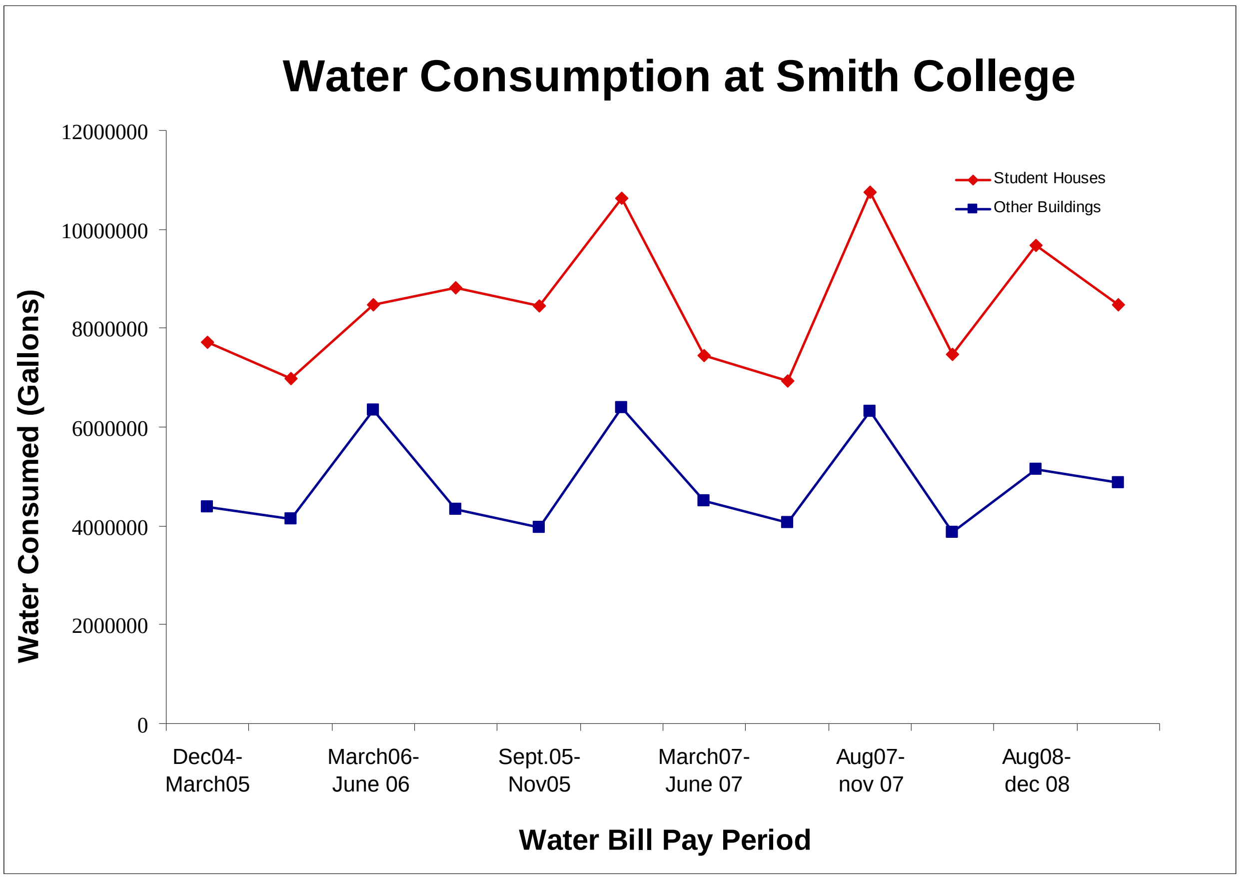

Figure 1: Comparison between water consumption in student houses verse other buildings (including academic and non-academic buildings) shows that student houses consume more water in gallons than academic buildings over all pay periods from Dec. 2004 to Dec. 2008.

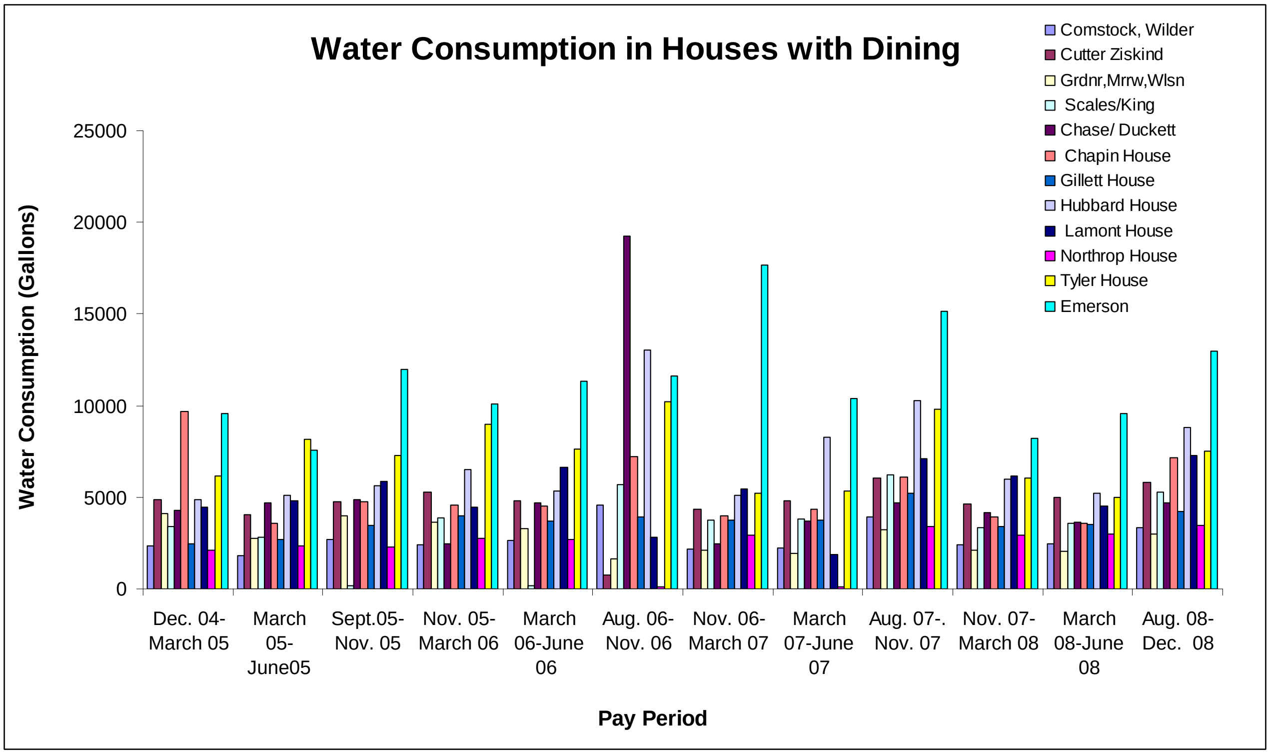

Figure 2: The figure above shows water consumption in houses with dining, i.e. with industrial dishwashers. The house with dining were kept separate from those without dining under the assumption that students do not have control over when the industrial dishwashers are running, for how long they run, or how often. Because our study focused on individual student behavior, we kept dining and non-dining separate. When the data is normalized by the number of students in each house, on average, students in dining houses consume approximately 5,000 gallons of water in any given pay period.

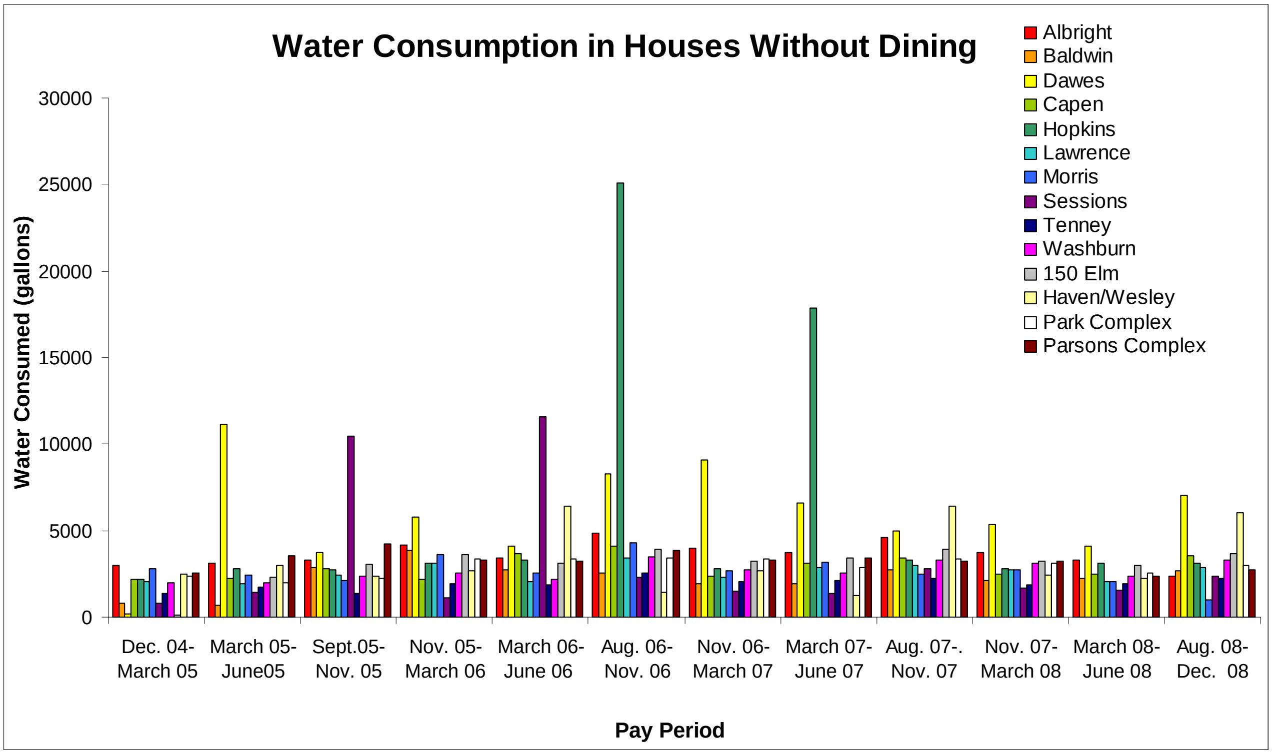

Figure 3: The above figure shows the amount of water consumed by houses without dining, i.e. those without industrial dishwashers. These values have been normalized by the number of students in each house. After normalization the average amount of water consumed by student in non-dining house per pay period is about 3,000 gallons. The outliers in the data, i.e. Hopkins house for Aug. 06-Nov. 06, can be attributed to the fact that some houses have water connections used by the grounds keepers in the spring and summer months when students are still on campus.

The summer pay periods were left out of analyses because during those months the majority of the student body is not on campus.

Results from Survey:

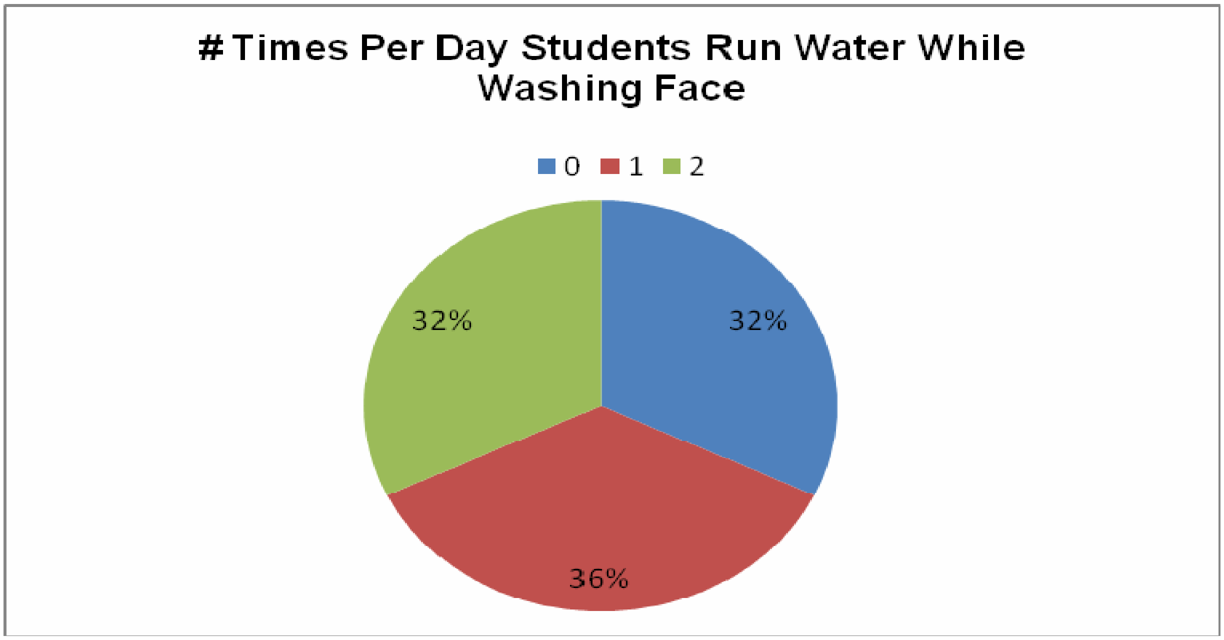

Figure 4: Results from the survey show that 68% of the students polled run water one to two times per day while brushing teeth.

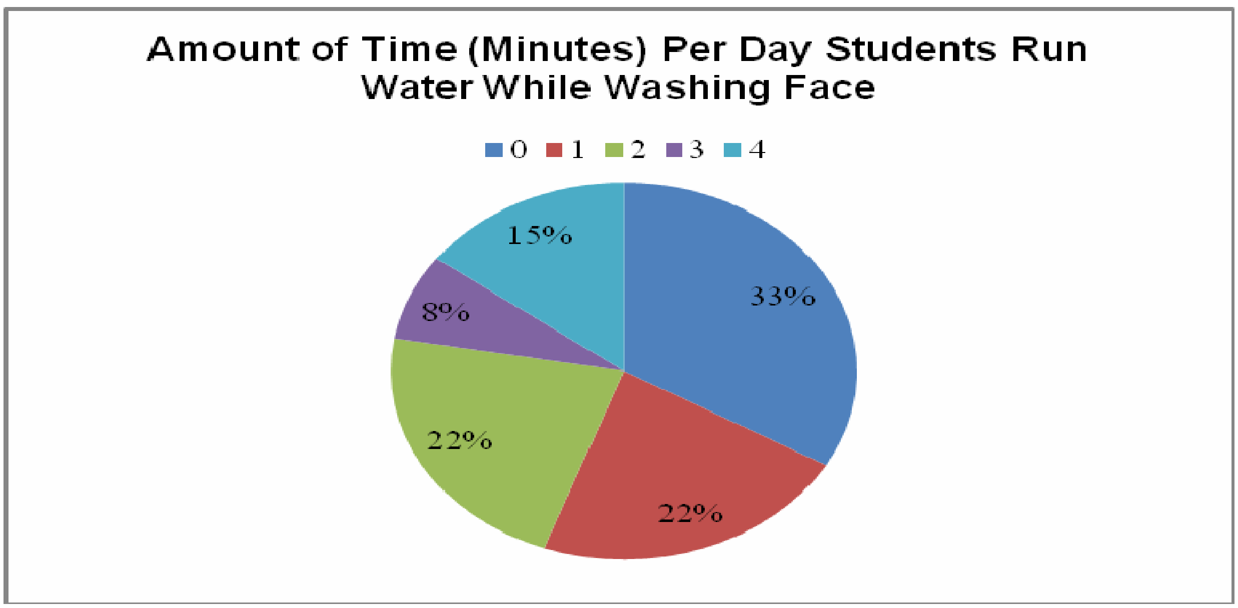

Figure 5: Results from survey indicate that 67% of students polled run the water for one to four minutes per day while washing face. Of the students polled, 15% ran the water for four minutes per day while washing face.

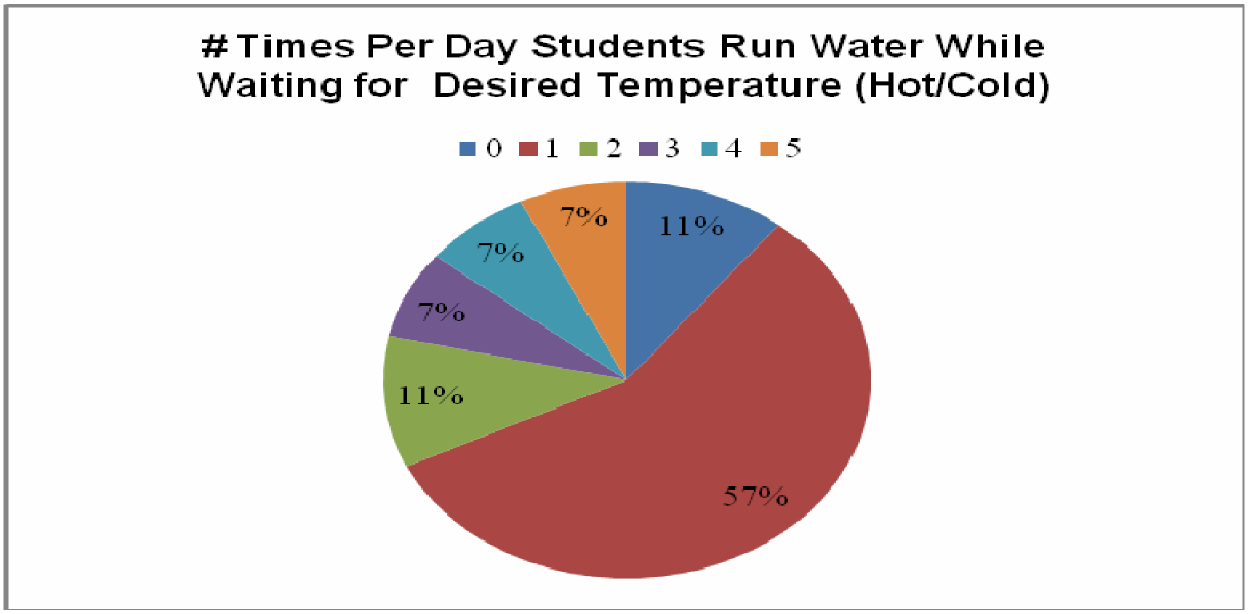

Figure 6: Results from the survey show that 89% of students polled run water one to five times per day while waiting for the water to reach a desired temperature.

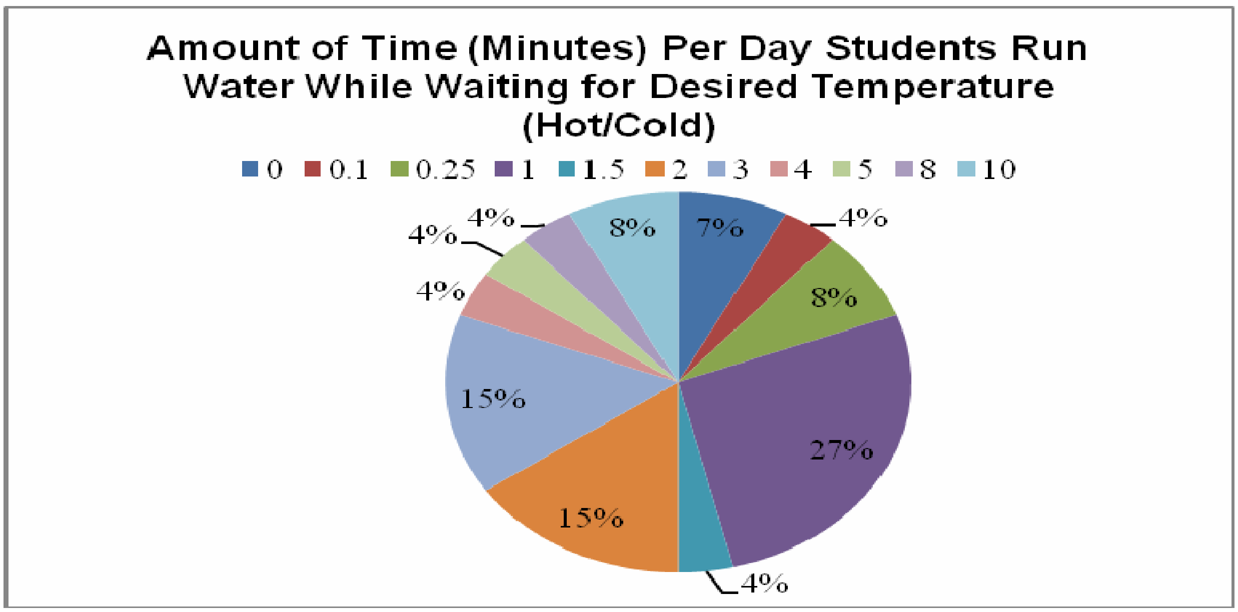

Figure 7: Results from survey show that 81% ran the water for one to ten minutes per day, while waiting for it to reach a desired temperature (hot/cold). Of the students polled, 50% ran the water for two to ten minutes a day, waiting for it to reach a desired temperature.

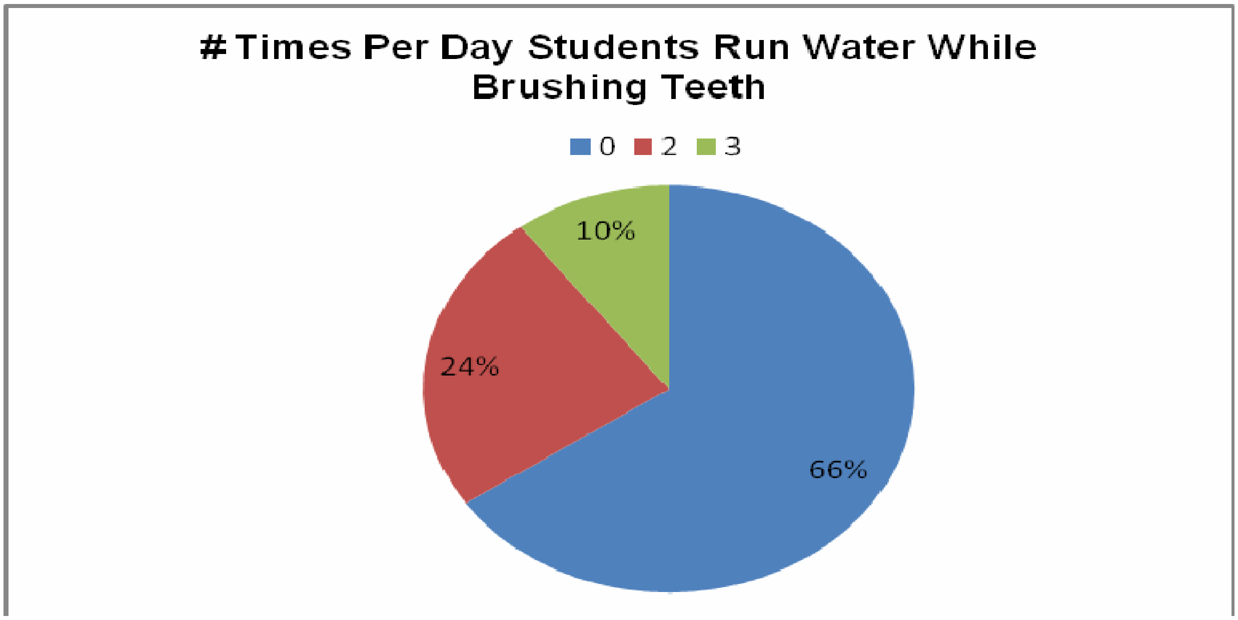

Figure 8: Results from suvey show that 66% of students polled <u>do not</u> run the water, 24% twice per day, and 10% three times per day while brushing teeth.

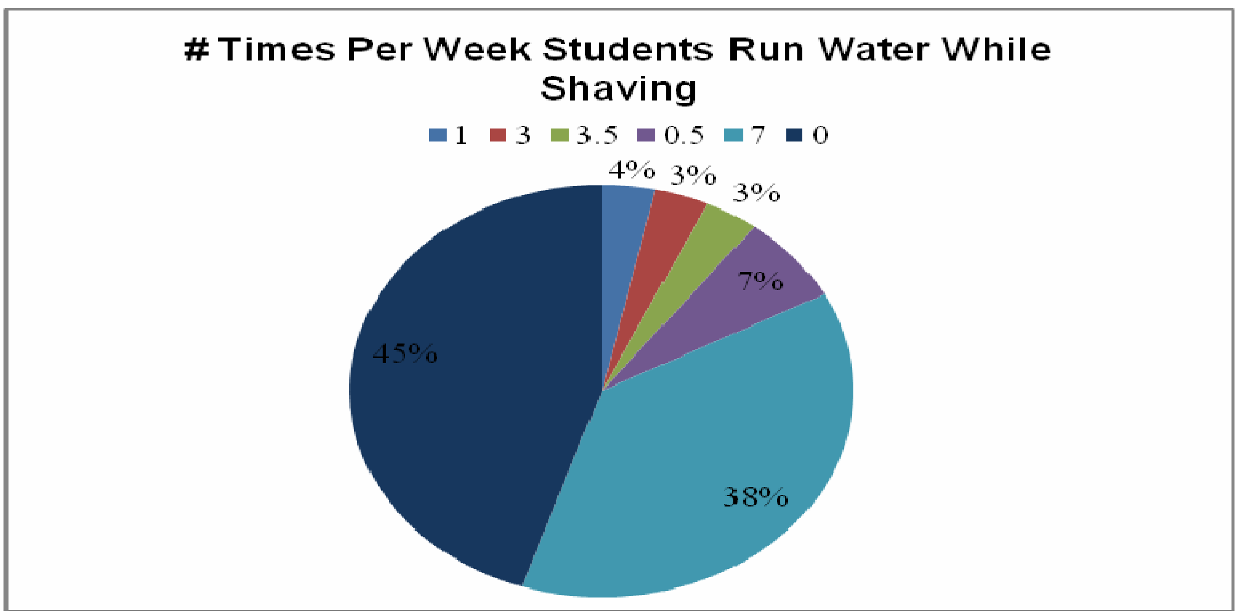

Figure 9: Results from survey show that 52% of the students polled <u>do not</u> run the water while shaving (this includes the 7% that reported shaving 0.5 times per week or shaving once every other week).

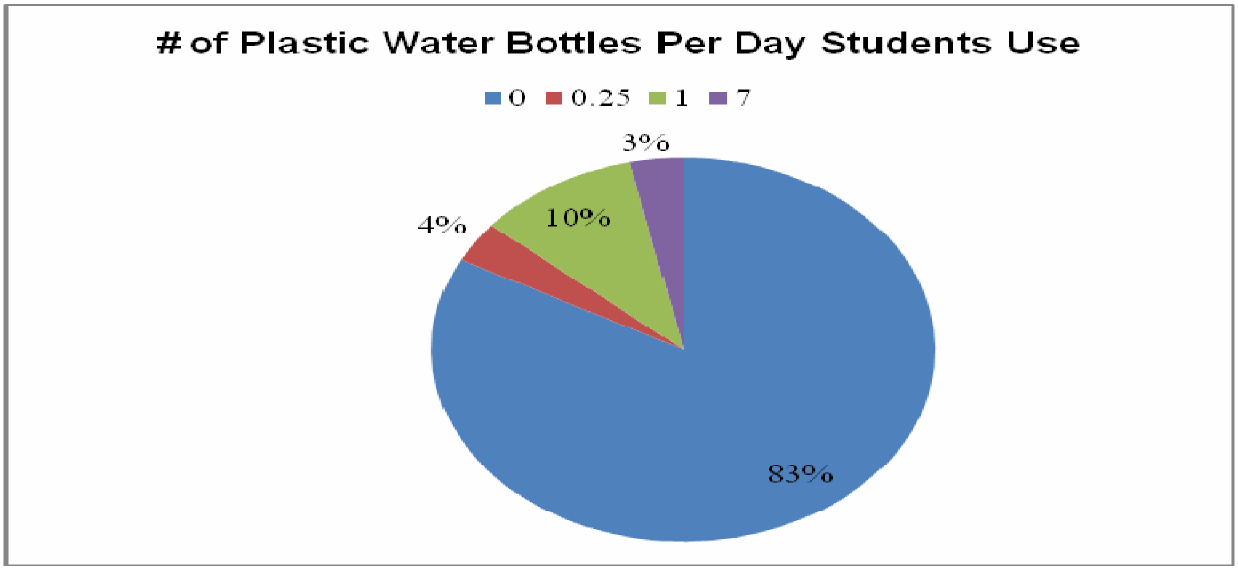

Figure 10: Results from the survey indicate that 83% of the students reported using zero plastic water bottles, 10% reported using one, and 3% reported using seven per day.

Measurements of Efficiency for Smith Shower Heads

Table 1: This table reflects the efficiency of the shower heads as measured in Lawrence House and Sessions House. Two trials were performed for each floor, for a total of six trials per house. The data shows the time it took to collect one gallon per minute. Results should be compared to 2.5 gallons per minute for low-flow showerheads, and 3-5 gallons per minute for conventional showerheads. These comparisons indicate that showerheads in Lawrence and Sessions House are within or lower than the flow rate of water efficient showerheads.

Lawrence House:

Trial Number	Location	Time (sec)	Gallons/Min.
1	Fl.1	30	2
2	Fl.1	35	1.7
1	Fl.2	37	1.6
2	Fl.2	30	2
1	Fl.3	35	1.7
2	Fl.3	40	1.5

Sessions House:

Trial Number	Location	Time	Gallons/Min.
1	Fl.1	30	2
2	Fl.1	30	2
1	Fl.2	35	1.7
2	Fl.2	40	1.5
1	Fl.3	30	2

2	Fl.3	35	1.7

Appendix 1: Water Survey

Fellow Smithie-

We are working on our Environmental Science and Policy Final Project measuring student water use on campus. In order to do this we need to estimate the water use placed on the dormitories. If you could take the time to complete this survey we would greatly appreciate it. This survey is anonymous and can be returned to Hannah Jaris's mailbox, #. Students who complete this survey and return the slip at the end will be entered into a raffle for one of two $25 gift certificates in town. Your contribution will help us develop energy efficiency and conservation proposals to Smith College. Please complete this survey by April 6th 2009. Questions can be directed to the e-mail addresses below. Thank you in advance for your help.

Sincerely,

Hannah Jaris and Lauren Robertson
hjaris@email.smith.edu , ltrobert@email.smith.edu

What class year are you? ________________________

Please fill out the table as well as possible.

	How many times per day do you perform this action?	How many minutes on average do you perform this action?	Other Information Examples:
Run the water while brushing teeth			
Run the water while washing your face			
Run the water while shaving			
Run the water while washing dishes			
Run the water while waiting for it to reach a more desired temperature (cold or hot)			
Run the water while filling up a			

water bottle			

How many plastic water bottles do you use each week? ___________

How many loads of laundry do you wash each week? ___________

How many loads of laundry do you dry each week? ___________

Please describe any other behavior that you perform that uses water with details about number of times a day (or per week) and for what duration of time:

Discussion

Largest Consumptive Behaviors

The largest consumptive behaviors were students of running water while washing face, and waiting for water to reach the desired temperature. The 67% of students, who reported running water while washing face for one minute or more, may have been indicating the time spent rinsing their face. In other words, it may not have been clear to all survey participants that running water meant water not being used or wasted water. Nevertheless, the 15% of the students polled who reported running the water for four minutes represent a population exhibiting significant discretionary water use. Running water from the average faucet for one minute is equivalent to four gallons of water (Rubin, 1996); the 15% of students polled who run water for four minutes while washing their face, use 20 gallons of water per day just for this behavior. From data concerning the percentage of students (66%) not running the water while brushing teeth, there may be considerable opportunity to increase students' conservation of water while washing face.

For students' waiting for the water to reach a desired temperature, 81% reported running the water between two and ten minutes per day. Using the average faucet's water flow, students use eight to forty gallons of water per day waiting for it to reach a desired temperature (hot/cold). Conservation techniques of targeting this behavior hold less viability than issues of efficiency. Switching faucets to infrared faucet sensors, which hold water at a specific temperature and work by a sensor will be more effective in reducing the amount of water used for this behavior.

Lowest Consumptive Behaviors

The lowest consumptive behaviors, while performed by less than 50% of students polled, still hold viability in targeting water conservation. From the survey results, students seem to have implemented water conserving methods on their own, as shown by 66% of the students polled reporting that they do not run the water while brushing teeth; however, there still remains 34% of the students polled who run the water while brushing their teeth for at least one minute. Water conservation projects should acknowledge the importance of turning off water when it is not needed for use, such as when brushing teeth.

The other lowest consumptive behavior, running the water while shaving, showed 52% of the students not running the water for a week. The percentage of the students polled who are running water while performing this behavior (48%) may actually make it a more significant consumptive behavior. Unlike teeth brushing, a frequent behavior essential for hygiene and health, shaving is less daily in occurrence but should still be addressed with conservation measures. Running water while shaving is common, and students can turn off the water while shaving and/or and fill a cup with water to use during shaving.

Additional Behaviors

Students' responses on their use of plastic water bottles showed that 83% do not use plastic water bottles. This data may reflect positively the initiatives within dining services and across campus in reducing the plastic water bottles and providing re-usable, aluminum alternatives. One very large outlier was someone who used seven water bottles per day; conservation efforts to rid the campus of plastic water bottles and provide more affordable, re-usable options for water (including water coolers, fountains etc.) should be expanded in houses and across campus.

The Gaps in Our Survey

Several gaps exist in the survey's design and response rate which affect the significance of this study for assessing students' behavior towards water. First, we did not include the largest water consumptive behaviors as recognized by the national water organizations: showering, hand washing and toilet flushing. We wanted to focus on discretionary behaviors towards water, for example water running while brushing teeth, and the latter three, in our estimation, all presupposed the running of water. The last question on the survey provided students with the opportunity to comment on additional water consumption behaviors, and several students commented on long showers (30 minutes), hand washing (5 times/day) and toilet flushing (6 times/day). Overall though, our analysis lacks extensive data on the frequency and duration for which students perform these behaviors and where (in their house or throughout campus).

Secondly, we asked questions about the frequency and duration of time spent filling up water bottles. We did not clarify whether frequency and duration included when the water was entering the water bottle or rinsing the dish, or water going down the drain. Water conservation efforts should urge students to fill up water bottles in dining halls where water is kept cold. When washing dishes, students should turn off the water while scrubbing, use less soap, and/or fill the sink with water to decrease water consumption and waste; water conservation methods in regards to dish washing should in particular target students living in the Friedman Apartment complexes because they cook their own food and wash their own dishes.

The third challenge which inhibits the significance of the data is a low survey response rate. We utilized the house leadership of the six houses to disperse the surveys to over 300 residents. We set a deadline and extended it to incorporate more survey responses, but ultimately 36 students total responded. The difficulties of gathering volunteer survey response were not greatly alleviated by the offering of a raffle prize. In future studies, we recommend that the surveys are required and more widespread in order to gather more significant data on behaviors regarding water in Smith houses.

Finally, survey participants who volunteered to answer questions regarding their behavior towards water may be more water conscious or more conservative in their water uses than non-survey participants. Increasing the number and variability of survey participants, will affect the significance of the findings.

Issues of Efficiency: Showerheads

Results from measuring the water flow and showerhead efficiency in Lawrence and Sessions House indicates impossibly low flow rates, often below standard low-flow showers. This data is inconclusive and not significant based on gathering technique and measurement methods. In discussion with Dano Weisbord, he indicated that only 25 out of over 650 shower heads have been switched and it is unlikely that Lawrence and Sessions received the majority of these efficiency changes. Further studies would measure the shower pressure, which may have a greater influence in consumption of water; low water pressure often leads students to take longer showers to wash away all soap. A number of students also complained about the length of time it takes to wait for showers to become warm. Waiting for the water to reach a desired temperature often results wasted water. This summer, Dano Weisbord will be initiating a project to install over 550 low-flow showerheads across campus. Subsequent studies may focus on students' duration of showers post the implementation of the efficient technology, and students' attitude towards water pressure.

Recommendations

This study initiated an investigation into students' behavior towards water use and conservation in six select houses. Other studies may continue to identify students' as well as faculty and staff's attitude and behavior concerning water use and conservation, especially as institutional budgets become tighter. In the meanwhile, students ought to initiate projects and programs to reduce water use through individual and campus-wide conservation methods. These water conservation methods require small-scale changes and are therefore feasible and influential.

Reframe Attitudes About Water

One of the best ways to reframe an attitude is through education. Provide students with specific facts about the relationship between water and energy use (13.5% of energy in a house is used to heat water), water beyond a climate impact (scarce resource, imperative to life, so conserve!), and behaviors associated with wasted water (4 gallons of water every minute the faucet runs).

Facts to Share

- Cut 1 min off shower time--- saves 700 gallons/month
- Turn off the water while shaving---saves 4 gallons/day
- Turn off water while brushing teeth--- saves 4 gallons/day

(Kinetico Incorporated, 2008).

Incorporate House Leadership

Education and water conservation in Smith houses requires incorporation and empowerment of the role of house presidents and house representatives, specifically the Earth Representatives. This network of house leadership should disperse facts in showers, bathroom stall doors, above sinks and in house literature and chronicles. Some Smith houses have taken the initiative to incorporate water projects into their development of house community. Morrow House for example has used their house budget to switch to low-flow shower heads and students are happy with the change, commenting on the equivalent water pressure.

Integrate Water Issues into Academic Curriculum

The importance of water necessitates a place within the academic curriculum of Smith College. Engineering projects to develop and implement water monitoring systems in all houses will help to measure water use. Oberlin College and Brown University are developing a program to institute water monitoring systems in all renovated and non-renovated houses through a program called the P-3 Competition. The researchers for this project found that when energy and water use measurements were accessible on the internet, students began to become more interested and engaged in water conservation (U.S. E.P.A). The P-3 Challenge is becoming a campus-wide competition and a similar program could be incorporated into Smith College's Energy Competition.

Students Know Best

Students know which behaviors they perform, which ones they are most willing to change, and how they would be willing to change. Involving the students in one or several campus-wide discussions about water behaviors and attitudes would elicit not just excitement and awareness among students, but creative ideas for water conservation.

Don't Forget the Technology

Many of these issues extend beyond conservation. In order to reach carbon neutrality, Smith College will most likely have to rely on efficiency methods such as dual-flush toilets, infrared sensor faucets, front-loader washers, and energy saving refrigerators and dishwashers. Sometimes, technology improvement results in a synergistic change in people's behavior; don't underestimate the role catchy, fun facts can have in educating people on water use. They may just help to cut a couple minutes off of a shower or stop someone from running the water while both her hands are washing her face.

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