WATER

Our H_2Ouse. Our Water Use.

UC DAVIS

Water Jury Narrative

Tom Ryan
Staff Project Manager
tomryan@ucdavis.edu

Brooke Carey
Student Project Manager
becarey@ucdavis.edu

Geoffrey Mangalam
Student Project Manager
gmmangalam@ucdavis.edu

Our Story

With its second entry into the Department of Energy Solar Decathlon, the University of California at Davis (UC Davis) is proud to continue its history of appealing design and student-driven engineering, with its new team name: the Blue Mustangs. Since its inaugural entry in Solar Decathlon 2015, UC Davis has capitalized on the project as an opportunity for students to explore designs that can adress a need. For the agriculturally-focused UC Davis, the lack of suitable housing for migrant farmworkers was a social and environmental problem that felt close to home for the 2015 team. To address this problem, the 2015 entry “Aggie Sol” presented below market-rate ZNE housing, featuring night-time radiant cooling via rooftop sprinklers and a purpose-built floorplan catered to low-income agricultural workers. For the 2017 home, defining the problem scope and determining how the Blue Mustangs could address the problem would be the starting point. Amid a severe drought in California in 2015, the problem seemed obvious, but refining the problem scope and how to tackle such a problem would come to be an extensive and iterative process. Eventually "Our H_2Ouse" (pronounced “Our House”) arose, and similar to the UC Davis 2015 entry, we continue the philosophy of addressing environmental and social needs. Our H_2Ouse balances innovative and experimental systems with a simple and adaptable implementation, designed around our three pillars to be drought-resilient, educational, and inclusive.

Our State

The Governor of California, Jerry Brown, announced the "end of the drought" in April of this year; however, California’s struggle is far from over. With California housing the largest U.S. state population and producing the largest total agricultural output in the United States[1,2], there are still concerns regarding sustainably sourcing the 50-100 million acre-feet of water required annually to sustain this high living standard. Due to the cyclical nature of drought years in California, combined with the continued growth and development of the state's population and cities, the need for sustainable and renewable water management will only grow more pressing. In the past 5 years, numerous state government initiatives have responded to these looming issues, largely by setting long-term goals for water reduction as well as incentives for renewable water production and use (See initiatives on the left). Many of these initiatives involve increases in water efficiency use within the residential sector, which while exerting some of the smallest consumption rates, has enormous potential for effective conservation strategies[4]. Although technological advances can increase efficiency, California demonstrated the importance of user behavior conservation and cooperation during its most recent drought. With state-wide mandatory conservation in 2015, Californians successfully reduced their urban water consumption by 25%, and Jerry Brown called on California's population to "make water conservation a way of life", rather than a temporary practice[5]. It is at this pivotal and chaotic time that UC Davis has developed Our H_2Ouse as a model residential solution to help combat these very real issues at home. Our H_2Ouse embodies this goal by providing an inclusive residence, dedicated to occupant engagement and education, and providing a means to an uncompromising water conservative lifestyle.

Our Vision

Recognizing the water and energy problems plaguing California, the Blue Mustangs developed Our H_2Ouse to create feasible and desirable homes using California-specific strategies. This house is an inclusive, drought resilient home, and provides salient information feedback for its residents. While Our H_2Ouse displays new and innovative technology it also uniquely works hand-in-hand with current technologies. Our H_2Ouse addresses the most pervasive and unpredictable factor in energy and water savings: user behavior. The virtually untapped resource of user behavior modification can exploit the efficacy of “smart” technologies by modifying the user inputs associated with such technologies, thus bridging the gap between the potential water/energy savings and the realized water/energy savings. Addressing energy savings for one home through user behavior requires motivation through education and salient reminders that facilitate long-term lifestyle changes. But to truly impact energy reduction — reduction that reaches beyond one home and begins to address a growing problem — requires statewide collective action. Because Our H_2Ouse has been designed to support a wide-range of housing applications, it is the hope of UC Davis students and faculty that Our H_2Ouse can continue to promote inclusive, drought-conscious, and innovative residential development while decreasing the environmental impact of the residential sector.

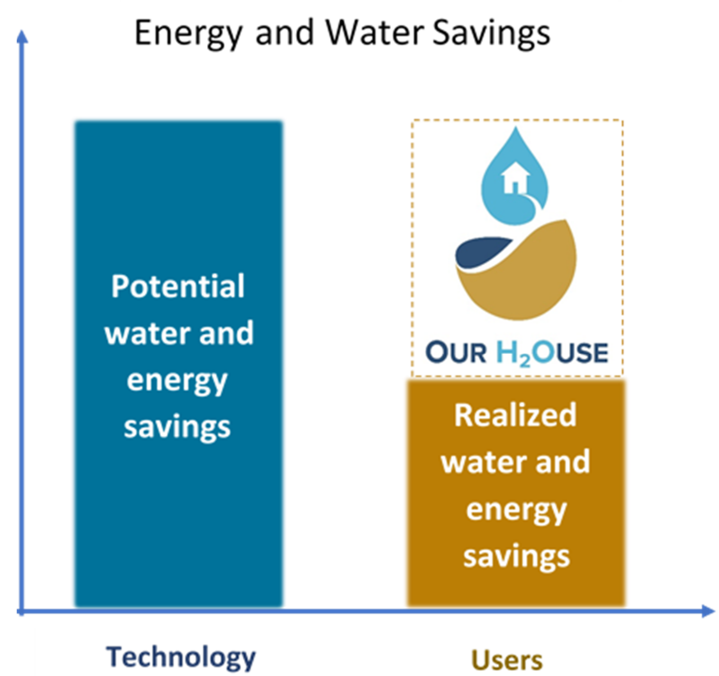

Figure 1: Our H_2Ouse bridges the gap between potential and realized water/energy savings by addressing the user in addition to just the technology

Our H_2Ouse

Overview

Our H_2Ouse balances innovative and experimental systems with simple and adaptable implementation, designed around three pillars: drought-resilience, education, and inclusiveness. As inclusiveness (economic and social) is one of the main themes of Our H_2Ouse, teams emphasized cost-effective strategies over simply selecting technology that could save the largest total amount of water. As such, the water conservation strategies employed by Our H_2Ouse are a diverse mix of new and re-tooled original ideas, combined with some of the simplest and oldest methods of water reclamation, treatment, storage, and reuse. Due in part to the incredible publicity surrounding California's most recent drought, many new technologies have grown in popularity due to their very low water use, and/or their ability to reclaim and treat water to very high levels and standards. However, although this technology is undoubtedly water efficient, much of it remains very expensive and/or too maintenance-intensive for the average home buyer. As such, a major overarching selection criteria for much of the water conservation devices and methods within and around Our H_2Ouse is the real-life feasibility, cost-effectiveness, and maintenance of health and safety standards when utilized in a home over the course of many years. Instead of making the home's operation the sole method of water conservation, Our H_2Ouse includes occupants in the conservation experience by keeping them conscious of their water use and teaching them about the positive impact and value that use-reduction brings.

Interior

Fixture and Appliance Selection:

Even though students decided occupant behavior is a major driver of water conservation in the home, there was still significant time dedicated to selecting the most water efficient appliances that fell within budget. We thoroughly analyzed EPA WaterSense product directories and chose Niagara dual flush (0.5gal/0.95 gal) Original Stealth toilet and an American Standard Moments Selectronic Touchless Bathroom Faucet (0.5gal/minute). With zero water used, composting toilets offer the highest level of water efficient waste management, but were ultimately not selected due to low marketability relating to cultural and societal unwillingness to dealing with human waste (even in a fully safe and decomposed form), as well as the greater amount of maintenance, inputs, cleaning, and potential health/safety risks from unsuccessful decomposition. Although not listed within WaterSense product directories, the Hydrao showerhead was selected due to its providing occupants with dynamic light displays to keep them conscious of their water use while showering, as well as goal setting options.

In addition, the shower head has an inline thermostatic shutoff valve that prevents excess water waste while occupants wait for hot water to be brought forth. Once hot water is flowing from the head, the valve shuts off flow and is only resumed once occupants pull a switch to resume withdrawal. For the dishwasher, we chose the Bosch 300 Series Dishwasher with features such as half load cycles and leak detection and protection, ultimately resulting in the savings of 484 gallons of water per year compared to standard models. For the washing machine, we chose the Beko front loading washer, an Energy Star tier 1 rated clothes washing machine with automatic water adjustment based upon load size. The appliances selection results in Our H_2Ouse eliminating many instances of everyday wastage at no cost to occupant convenience or comfort.

Water Monitoring and Information Feedback Devices:

At the end of the research phase[11-19], the controls and monitoring team determined that an innovative and effective approach to water monitoring should involve a single main-line ultrasonic sensor that uses an algorithm to disaggregate different water flows[15]. However, after consultation with faculty mentors, this approach was determined to be too much of an undertaking for students within the time and budget constraints of the project. Purchasing accurate pulse meters for every hot and cold water line proved prohibitively expensive as is common when designing within a budget, we found a great alternative. We decided that every hot and cold water line would have less expensive, but acceptable sensors cross-checked by a robust and highly accurate mainline sensor. This approach allows for fact-checking by a single, high accuracy (+/- 1.5% at normal flow) sensor mounted on the mainline. In this way, the system still possesses high accuracy while also being able to discern where and how much each water line is drawing from the mainline.

Because an emphasis was placed on overcoming the lack of awareness and reference that occupants have while using water, Our H_2Ouse features original devices that show occupants and/or the community real time occupant water consumption to easily overcome the behavioral status quo: occupant-level and community-level devices that show real time water consumption. The prominent occupant-level interior device is a tablet-based heads up display (HUD) that presents water (and energy) use summaries in easily customizable formats and layouts. However, the tablet itself is integrated into the home by placing it behind a piece of two-way mirrored glass in the bathroom vanity. In this format, occupants are greeted by information summaries while looking at themselves in the mirror in the morning and night, as they brush their teeth, shave, and use the vanity. The tablet is easily removable and can be carried-to and placed-in any other alternate areas of the home depending on occupant preference. While the tablet does afford the occupants some control capabilities over the homes energy and water management, the primary purpose is to regularly engage occupants in recognition of their energy and water use as well as the broader environmental and economic implications of their resource consumption. This flexibility is a key innovation of the UI, as the development of effective feedback is still very much in flux. By allowing occupants the ability to alter the location and format with where and how they are displayed information, the hope is that they themselves can custom create a platform that they find most helpful and beneficial.

The user interface (UI) of Our H_2Ouse's system emphasizes easily understandable and customizable information feedback formats about water consumption, as well the relevant consequences that each rate of use produces. The device features summary economic costs that the occupants can expect based off their current water usage, as well as a comparison to usage goals that occupants can set for themselves. Goal setting is now recognized as one of the more effective ways to bring about changes in human behavior, as seen in its use by wearable calorie and step-counting devices as well as many other self-improvement initiatives. Another innovative feature of this device is the flexibility of its UI. Occupants can adjust different settings on the device such as how many occupants are living within the home, set goals for water use over different timespans, and choose different formats for how they want data displayed to them. The remaining interior devices are real-time water meters placed in visible proximity to the kitchen and bathroom sink as well as the shower. Through the sequential illumination of individual LEDs, these water meters allow occupants to gain instant understanding of the amount of water they are using.

To further expand upon the influence of Our H_2Ouse, a community-level feedback device was created to educate, inspire, and facilitate awareness of water resource responsibility. The sole exterior device is a dynamic water feature purposely made visible to the passersby, located at the front of the house on the north side entry deck, and unlike traditional fountains, loses very little liquid to evaporation. This feature, placed prominently at the front of the house, directly relates to the home's total water consumption compared to an average household's total water consumption. The ambient, eco-feedback display mimics ecological processes, such as the filling and draining of reservoirs with a limited water supply, providing homeowners a more physical and relatable depiction of water conservation. The occupants are rewarded with this dynamic water feature as they save increasing amounts of water, compared to the average. This rewards positive behavioral changes and motivates occupants with a friendly neighborhood challenge, increasing neighborhood accountability and inter-household accountability, as it turns household occupants into a conservation team.

Our H_2Ouse not only engages its occupants in water conservation, but the whole community. Our system can be upscaled, with water features for many individual houses as well as a hub for a neighborhood-level water feature which aggregates the water-saving data, allowing neighborhoods to team up and challenge other neighborhoods to this conservation game. The Blue Mustangs are confident that behavioral changes and a cultural shift towards a new water conservation status quo can be inspired with collective action and see success much like the success of the exercise technology, Fitbit®—just replace steps with drops.

Exterior

Greywater

Research into greywater recovery systems provided students with an incredible range of options. Constructed wetland systems were deemed infeasible for single family home applications due to the variability in water quality and production from a single household, as well as the complexity and health and safety risks associated with assuring adequate retention times and overall system functionality. Technical solutions ranged from expensive, multi-filter and tank systems to nominal gravity-fed "laundry to landscape" methods, featuring nothing more than a length of hose and a height differential.

While the first type of option provided an effluent that was of very high quality (low turbidity, high dissolved oxygen, etc.) almost all of these systems were very expensive to purchase and maintain, as well as requiring significant professional help for installation and upkeep. However, a benefit of these systems that must be addressed is their ability to filter and disinfect water to quality standards that allow for non-potable indoor reuse. Initially the decision to adopt this technology seemed obvious, yet cost-benefit analysis showed that these systems did not provide any cost-effective advantages over simply selecting the most water efficient fixtures and appliances, and using a lower-cost physical filter to provide greywater irrigation for 100% of ornamental landscaping water demand.

The lower-end systems had much more attractive prices and maintenance levels, yet admittedly resulted in lesser quality water that usually had higher levels of suspended fine particulate (turbidity). At first this was considered an incredible issue, as the drip irrigation emitters that were being considered were notorious for quickly clogging. Within water recycling systems, it is imperative to minimize the chances of clogging so as to reduce the amount of required maintenance that exposes humans to potential health and safety risks from pathogenic bacteria.

We needed to find a solution. After significant research, a comprehensive Decision Analysis and Resolution (DAR), we found the solution to this problem lay in a dual-stage physical filtration system and the use of a submersible irrigation pump that was designed to handle large diameter solids and still remain unclogged. The first filtration stage is 4 pieces of Matala® filter material within an "Aqua2use" greywater diverter, whose interstitial spaces grow progressively finer, resulting in a gradient of 3D structure and filtration ability. This gradient is key to providing the "Aqua2use" with exceptional performance that only requires cleaning every 4-6 months. By placing the finest (first to clog) filters at the end of the filtration stage, the amount of particulate they have to deal with is minimized, allowing the whole system to maximize the amount of time it can provide effective filtration before clogging. The second and final stage of filtration takes place directly within the drip emitters that finally dispense water to the plant. Using molded-plastic turbulent flow insets, as well as a built-in inlet barb filters, our emitters provide some of the most long-term and consistent application efficiencies. Clogging is further reduced by dispensing irrigation only when dry soil is detected via a soil moisture sensor that monitors soil dielectric constant, a sensing format that while potentially sensitive to high salinity levels commonly found in greywater, was, based off user reviews, deemed to provide the greatest level of sensing accuracy while still remaining cost-effective. This sensor communicates with a fully open-source "garduino" irrigation system that uses an OpenSprinkler Pi valve controller to provide accurate and appropriate irrigation scheduling options.

Rainwater

The decision about whether to use rainwater was a much more challenging decision to reach. On the one hand, rainwater is a relatively clean, naturally occurring water source that offers a wider range of irrigation options than greywater. However, the home's target markets of Sacramento and Yolo county receive relatively little amounts of rain, most of which comes only in the winter months of the year, and is usually very expensive to store. The majority of this cost comes from the purchase of tanks, which on a small, boutique scale can cost as much as much as $7.40 per gallon of storage ($370 for a single 50 gallon rainwater hog tank from rainwaterhog.com). Despite this, there was significant motivation to collect rainwater to irrigate the home's edible garden, a design feature that was included to increase market appeal for home buyers interested in growing their own food. The home's central theme of water efficiency mainly rested upon the elimination of outdoor potable water use, so this statement could not be made unless rainwater was used for edible garden irrigation.

The first step was to ensure that enough rainwater could be collected to meet the greater water demand of a soil-based garden format. A two-part calculation was performed, the first part predicting crop water needs based upon estimates from the UC Agriculture and Natural Resources Cooperative Extension[8]. The next step required the prediction of the amount of rain that could be collected from Our H_2Ouse 's roof surface area in drought years[9], as well as verification that the home had adequate storage for such an amount. The results of the calculation confirmed Our H_2Ouse had sufficient roof square footage and storage capacity to meet edible plant water demand, even in the most extreme annual drought conditions.

The challenge then was to design the most safe and cost-effective method for potentially months-long rainwater storage and irrigation. We solved this by creating an integrated structure of intermediate bulk containers (IBCs) beneath the south deck. These reclaimed, food-grade, IBCs will function at the competition to hold potable, grey, fire (suppression), and potentially rain water, and at the final permanent location will function to hold just grey water (2 tanks) and rainwater (5 tanks). At a cost of $120 and with a storage capacity of 275 gallons, these IBCs provide some of the most cost effective storage prices ($0.44/gallon) and are easily sourced second-hand from agricultural and commercial industries. Other useful features include a heavy-duty structural steel frame, a 2" threaded male ball valve, volumetric measurement markings, and an easily accessible 6" screw lid located at the top. These last two features are key to long term rainwater storage, as it allows occupants to easily and accurately dose their rainwater supplies with small amounts of bleach or chlorine that minimize health and safety risks from the potential growth of pathogenic bacteria. The tanks are fed by a standard rain gutter system that possesses a gravity-operated 100 micron mesh physical filter for removal of large and small debris, and a horizontal, sub-deck first flush diverter that removes the first most-heavily contaminated load of rain water.

Ornamental Plant Selection

Within California's residential sector, roughly half the water demand does not even come from humans, but from plants[3]. Expansive lawns and assemblages of non-native plants create significant water demand for irrigation purposes, especially in the arid southern areas of the state. And while altering human behavior to be more water-conservative is a challenging goal of relatively unknown complexity, urban exterior water use demonstrates some of the greatest potential for effective conservation strategies that stem from thorough planning and foresight[4]. Given this fact, one of the first steps of the landscape planning process for Our H_2Ouse was using evapotranspiration calculations to determine whether the combined water demand from ornamental landscaped areas would exceed the annual amount of greywater produced by the home. This process was conducted under the guidance of the 2015 Model Water Efficient Landscape Ordinance set forth by the state government to help individuals and organizations more appropriately select planted area sizes, as well as plant species[10]. Phrased succinctly, the ordinance calls for the calculation of a "Maximum Allowable Water Allowance" (MAWA) that is then compared to an "Estimated Total Water Use" (ETWU) calculation, with ET_o (reference evapotranspiration rates) sourced from UC cooperative extension-based "Water Use Classification of Landscape Species" (WUCOLS). Acceptable landscapes will not have an ETWU that exceeds their MAWA, a criteria that the landscape of Our H_2Ouse fulfills simply because it is a landscape that is 100% irrigated with onsite collection of rainwater and greywater sources, and as such does not require an allowance from state potable water supplies. In fact, based off calculated predictions of daily greywater production vs. plant water demand, it will likely be the case that many days the home's greywater is not even needed for landscape irrigation. This achievement mainly results from the fact that we selected plants that are native to hot, arid environments, and/or have far-reaching root systems that can retrieve soil solution from deep depths within the soil profile. Despite the selection of these drought tolerant plant species, the landscaping of Our H_2Ouse still features an array of bright and lush color tones that will satisfy the biophilic requirements of home occupants and provide improved curbside market appeal.

Edible Garden Format Selection

Due to the limited rain fall within California, hydroponic and aquaponic systems were considered for the edible garden format. These systems are beginning to gain high consumer appeal as they are often referenced as the "future of farming" due to their very high levels of water, nutrient and space efficiency, runoff prevention, and user controllability. While the underlying mechanisms through which they operate are indeed fascinating, they were ultimately deemed too resource and maintenance intensive for the average gardener. To begin, they are completely water-based, and as such require the almost-constant running of a pump and aerators. In addition, they both have high initial costs, with continuing expenditures for nutrient solution (usually produced through the energy intensive Haber-Bosch process) or fish feed and stock, filter cleaning and replacement, rooting media, and pH buffers. Finally, maintenance of such systems requires much more technical skill and oversight as fluctuations in flow rate, nutrient concentrations, pH, temperature, or other water quality parameters can lead to significant reductions in system functionality. On the other hand, soil based systems require no power to function, have significantly less maintenance and monitoring requirements, and can only require nutrient inputs that are sourced from composted occupant food waste.

Drip irrigation was initially considered for the edible garden, but ultimately was decided against because it would require the purchase of another pump, valve, and emitter system. In addition, it was predicted that home owners who do garden would want to regularly interact-with and check-on their crops, and may then want to use irrigation events as such an opportunity. To allow home owners an interactive gardening experience, while still maintaining high water application efficiency, clay pot irrigation was selected. This system is reliable, low cost, efficient, and foregoes the substantial amounts of plastic pipe and emitters needed for any kind of modern irrigation system[7]. Within Our H_2Ouse, this ultra-low tech method involves nothing more than a terra cotta pot with the bottom drainage hole plugged with a wine cork. Water is withdrawn from the rainwater tank via a drill pump and dispensed into the terra cotta pot. To minimize evaporative loss once filled, the pot is covered with the saucer that is traditionally placed underneath it. Water within the pot is slowly withdrawn on an as-needed basis simply through gradients in soil matric potentials that develop due to plant evapotranspiration, which just like drip irrigation, effectively eliminates any circumstances of runoff.

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Appendix

Rain Water Calculations

Part 1: Calculate edible plant water demand

Reference:
http://ucanr.edu/sites/scmg/files/185639.pdf

Within California, vegetable growth in summer months averages a water demand of 1" per sq. Ft. (0.623 gallons).

Our H_2Ouse features 3 rolling planters, each with 8 sq. Ft. (4'x2') of planted space = 24 sq. Ft. Total planted space.

24' x 0.623 = 14.952 gallons of water per week = total weekly plant water demand

52 full weeks in a year: 52 weeks x 14.952 gallon = 777.5 gallons of water per year to meet 100% water demand from edible plants.

Assume 90% irrigation efficiency from clay pot irrigation = 777.5/0.90 = 864 gallons needed for application to meet 100% of water demand from edible plants.

	2010	2011	2012	2013	2014	2015
January	6.31	1.71	2.6	0.78	0.09	0.06
February	2.76	3.04	0.5	0.16	4.04	2.67
March	1.19	5.48	3.7	1.02	1.53	0.25
April	2.97	0.07	1.79	0.57	1.85	0.91
May	0.43	0.88	0	0	0.01	0.02
June	0.01	1.57	0.04	0	0.01	0
July	0.06	0	0.04	0	0	0
August	0	0.61	0	0	0.01	0.01
September	0	0.02	0	0.64	0.42	0.07
October	0.83	1.08	0.71	0	0.83	0.19
November	2	1.09	3.39	0.73	1.3	1.48
December	5.16	0.33	5.01	0.38	8.32	1.45
Total	21.72	15.88	17.78	4.28	18.41	7.11

Jan Average	1.9250
Feb Average	2.1950
Mar Average	2.1950
Apr Average	1.3600
May Average	0.2233
Jun Average	0.2717
Jul Average	0.0167
Aug Average	0.1050
Sep Average	0.1917
Oct Average	0.6067
Nov Average	1.6650
Dec Average	3.4417

2010 Average	1.8100
2011 Average	1.3233
2012 Average	1.4817
2013 Average	0.3567
2014 Average	1.5342
2015 Average	0.5925

All Values are in inches	
(green)	Normal years
(orange)	Drought years

Part 2: Calculate amount of rain Our H_2Ouse roof square footage can collect in a drought year.

Reference(s): https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1052.pdf

Rainwater averages calculated from annual USGS data records: https://waterdata.usgs.gov/ca/nwis/rt

Use most extreme drought year in last six years (2013) = 4.28" of rain fall per year

Supply (gallons) = (Catchment area (FT^2) x Rainfall (FT) x Runoff Coefficient x 7.48 gal/CF

Use low estimate for runoff coefficient for roof material = 0.90

Subtract 0.10 (estimate) to represent first flush diversion = 0.90-0.1 = 0.80

Our H_2Ouse roof square footage = 1,134 sq. Ft. Of TPO roof membrane

Convert inches to feet = 4.28/12 = 0.3566667

1,134 x 0.356667 x 0.80 x 7.48 = 2,420.28887

Our H_2Ouse roof can harvest roughly 2,000 gallons of water in drought years.

Confirm sufficient storage: 5 IBC tanks (275 gallons each) = 5 x 275 = 1,375 gallons of storage.

Conclusion:

Our H_2Ouse has enough roof square footage and storage to supply edible plants with yearlong water rainwater supplies assuming adequate water quality parameters are achieved and maintained.

Grey Water Calculations

Part 1: Calculate Estimated Total Water Use of ornamental plant water demand as stated by 2015 California Model Water Efficient Landscape Ordinance.

ETWU = (ET_o) x (0.62) x [((PF*HA) / IE) + SLA)]

ET_o= Reference Evapotranspiration (inches per year)

PF= Plant Factor from WUCOLS (0.3 for Our H_2Ouse landscape – all low water use plants)

HA= Hydrozone Area; High, Medium, and Low water use areas (square feet)

IE= Irrigation Efficiency (0.90 for drip irrigation)

SLA = Special landscaped area including edible plants (water demand calculated separately in rainwater calculations using alternate UC extension estimates).

ETWU = (52.5) x (0.62) x [(0.3 x 100 / 0.90)] = 1,085 gallons per year

Total ornamental plant water demand is 1085 gallons per year.

Estimate 0.90 irrigation efficiency from drip irrigation = 1085/0.90 = 1,206 gallons per year

1,206 gallons of water needed for application to meet 100% of ornamental plant water demand.

Part 2: Calculate estimated greywater production of (single) family + (4) student housing greywater production scenarios

Consult attached excel sheets for calculation summaries.

Family greywater production per month: 4209.455055 gallons

Student greywater production per month: 3,663.6 gallons

Conclusion:

Annual greywater production far exceeds annual water demand from ornamental plants. Using rainwater an greywater collection and storage, Our H_2Ouse eliminates potable outdoor water usage.

Additional Calculations

Students

4 students - 2 male & 2 female

Data Entry		
Student	**Water Use Level**	
Student 1	2	Enter a value between 1 & 3, with 1 being a low water user and 3 being a high water user
Student 2	2	
Student 3	1	
Student4	3	

DO NOT EDIT ANYTHING BELOW THIS LINE

Ideal Indoor Personal Water Usage

Student 1 - Medium Water Use

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	5	---	0.5	4.5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	0.50	1.2	0.6	
Bathroom Faucet: hand washing	10	0.42	1.2	5	
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6	
Kitchen Faucet: wash hands	3	0.33	1.5	1.5	
Kitchen Faucet: washing dishes	1	8.00	1.5	12	
Cooking	---	---	---	0.5	
Shower	1	12.00	2	24	
Total Water Use Per Day				**49.2**	61% This percentage of the used water ends up as greywater!
Total Greywater Production Per Day				**30.2**	

Student 2 - Medium Water Use

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	5	---	0.5	4.5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	0.50	1.2	0.6	
Bathroom Faucet: hand washing	10	0.42	1.2	5	
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6	
Kitchen Faucet: wash hands	3	0.33	1.5	1.5	
Kitchen Faucet: washing dishes	1	8.00	1.5	12	
Cooking	---	---	---	0.5	
Shower	1	12.00	2	24	
Total Water Use Per Day				**49.2**	61% This percentage of the used water ends up as greywater!
Total Greywater Production Per Day				**30.2**	

Student 3 - Low Water Use

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	4	---	0.5	3	A half flush should be used for lighter uses (mainly liquids)
	1	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	0.50	1.2	0.6	
Bathroom Faucet: hand washing	8	0.33	1.2	3.2	
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6	
Kitchen Faucet: wash hands	3	0.25	1.5	1.125	
Kitchen Faucet: washing dishes	1	5.00	1.5	7.5	
Cooking	---	---	---	0.5	
Shower	1	8.00	2	16	
Total Water Use Per Day				**33.025**	62% This percentage of the used water ends up as greywater!
Total Greywater Production Per Day				**20.4**	

Student 4 - High Water Use

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	6	---	0.5	5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	2	0.50	1.2	1.2	
Bathroom Faucet: hand washing	11	0.50	1.2	6.6	
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6	
Kitchen Faucet: wash hands	4	0.33	1.5	2	
Kitchen Faucet: washing dishes	1	10.00	1.5	15	
Cooking	---	---	---	0.5	
Shower	1	15.00	2	30	
Total Water Use Per Day				**61.4**	63% This percentage of the used water ends up as greywater!
Total Greywater Production Per Day				**38.4**	

Water Use Information

Total Water Use Per Day	Total Water Use Per Day (per person)	
195.745 gallons	**48.93625** gallons	These values also include clothes washer use
Total Water Use Per Month	Total Water Use Per Month (per person)	
5872.35 gallons	**1468.0875** gallons	

Potable Water Use Per Day	Potable Water Use Per Day (per person)	
178.745 gallons	**44.68625** gallons	These values include all activities that use potable water (not greywater). This is everything except the toilet, which uses treated greywater
Potable Water Use Per Month	Potable Water Use Per Month (per person)	
5362.35 gallons	**1340.5875** gallons	

Greywater Production Per Day	Greywater Production Per Day (per person)	
122.12 gallons	**30.53** gallons	These values also include greywater production from the clothes washer
Greywater Production Per Month	Greywater Production Per Month (per person)	
3663.6 gallons	**915.9** gallons	

Time	School Year								Summer/Breaks								Holidays				Vacation/Traveling			
	Weekday				Weekend				Weekday				Weekend											
	Husband	Wife	Kid 1	Kid 2	Husband	Wife	Kid 1	Kid 2	Husband	Wife	Kid 1	Kid 2	Husband	Wife	Kid 1	Kid 2	Husband	Wife	Kid 1	Kid 2	Husband	Wife	Kid 1	Kid 2
12am																								
1am																								
2am																								
3am																								
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6pm																								
7pm																								
8pm																								
9pm																								
10pm																								
11pm																								
	Days out of year: 185				Days out of year: 74				Days out of year: 60				Days out of year: 24				Days out of year: 10				Days out of year: 12			
	Husband: works an 8 hour day, 5 days per week Wife: stay at home mom, runs errands during the day Kid 1: goes to elementary school for 6 hours, attends after school sports for 2 hours Kid 2: goes to high school for 8 hours, plays sports and hangs out with friendsfor 3 hours afterwards				Family: Brunch/family meal out for 2hrs Husband: Wife: Kid 1 & 2: Spend time with friends				Husband: works an 8 hour day, 5 days per week Wife: Brings Kid 1 to activity and runs errands Kid 1: Goes to activity Kid 2: Hangs out with friends in the evening				Store/Shopping/Family Activity Husband: works an 8 hour day, 5 days per week Wife: Kid 1 & 2: Spend time at friends house				Everyone is home. There might be an extra couple of people staying.				Everyone is gone. There is no indoor water use			

Key	
	Away
	Home

Flow Rates		
K-faucet flow rate	1.5	gpm
B-faucet flow rate	1.2	gpm
	0.5	gal (half)
toilet	1	gal (full)
Shower flow rate	2	gpm

Model User - Husband				
For a typical day, this should be the goal water use for the husband				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	1.00	1.2	1.2
Bathroom Faucet: hand washing	10	0.50	1.2	6
Bathroom Faucet: brushing teeth	3	0.33	1.2	1.2
Kitchen Faucet: wash hands	3	0.50	1.5	2.25
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125
Shower	1	8.00	2	16
			Total	**32.775**

24.4

Model User - Wife				
For a typical day, this should be the goal water use for the wife				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	3
	1	---	1	
Bathroom Faucet: face washing	2	1.00	1.2	2.4
Bathroom Faucet: hand washing	8	0.50	1.2	4.8
Bathroom Faucet: brushing teeth	3	0.33	1.2	1.2
Kitchen Faucet: wash hands	6	0.50	1.5	4.5
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125
Shower	1	12.00	2	24
			Total	**41.525**

32.4

Model User - Baby (0-5)				
For a typical day, this should be the goal water use for the care of a baby				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.25
Toilet: dual flush	0	---	0.5	0
	0	---	1	
	0	0.00	0	0
Bathroom Faucet: brushing teeth	1	0.50	1.2	0.6
Extra Laundry Loads	0	0	0	1.467201166
Kitchen Faucet: bottle washing	1	5.00	1.5	7.5
Kitchen Faucet: hand washing (parent)	5	0.50	1.5	3.75
Bath/Shower	1	15.00	2	30
			Total	**43.56720117**

32.0672

Model User - Kid (6-12)				
For a typical day, this should be the goal water use for a kid				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	1.50	1.2	1.8
Bathroom Faucet: hand washing	8	1.50	1.2	14.4
Bathroom Faucet: brushing teeth	3	1.50	1.2	5.4
Kitchen Faucet: wash hands	3	1.00	1.5	4.5
Kitchen Faucet: rinse plate	3	0.50	1.5	2.25
Shower	1	15.00	2	30
			Total	**63.35**

51.6

Model User - Teen (13-18)				
For a typical day, this should be the goal water use for a teenager				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	1.50	1.2	1.8
Bathroom Faucet: hand washing	9	0.50	1.2	5.4
Bathroom Faucet: brushing teeth	3	0.50	1.2	1.8
Kitchen Faucet: wash hands	3	0.50	1.5	2.25
Kitchen Faucet: rinse plate	3	0.50	1.5	2.25
Shower	1	15.00	2	30
			Total	**48.5**

39

Additional:	gal/day
Clothes washer	5.51507
Dishwasher	0.66301
Cooking	1.42466
Total	**7.60274**

Husband				
Hours at Home	Weekdays	Weekends	Holidays	Weekend/Holiday will be used as 1 category
	16	20-22	24	
Weekday				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	3	---	0.5	2.5
	1	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	6	0.33	1.2	2.4
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	2	0.33	1.5	1
Kitchen Faucet: rinse plate	1	0.25	1.5	0.375
Shower	1	5.00	2	10
			Total	**18.175**
Weekend/Holidays				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	10	0.33	1.2	4
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	5	0.33	1.5	2.5
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125
Shower	1	8.00	2	16
			Total	**30.025**

8 cups/day

13.8

21.4

Wife				
Hours at Home	20- 24 hrs	The wife is gone for only around 4 hours at most, which wouldn't change her water usage much from weekdays to weekends		
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	3
	1	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	8	0.33	1.2	3.2
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	6	0.33	1.5	3
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125
Shower	1	15.00	2	30
			Total	**42.225**

34.6

General Family Indoor Water Use							
Dishwasher	110	loads/yr	2.2	gal/cycle	242	gal/yr	www.home-water-works.org
Cooking	10	gal/week	52	weeks/yr	520	gal/yr	estimated for normal use
Clothes Washer			392	loads/yr	2013	gal/yr	from Blomberg specs
				Total	**2775**	gal/yr	

"General Family Indoor Water Use" value is added in to the TOTAL in the "Total Water Usage" table

Extra Water Use During Holidays (assume an extra 4 people - husband, wife, & 2 kids)												
Activity	Wife		Kid 1		Kid 2		Husband		Total		Notes:
Shower	30	gal/day	30	gal/day	40	gal/day	16	gal/day	116	gal/day	Values taken from family members' weekend/holiday totals, cooking estimated
Toilet	3	gal/day	4.5	gal/day	4.5	gal/day	4.5	gal/day	16.5	gal/day	
Brushing Teeth	0.8	gal/day	1.2	gal/day	0.8	gal/day	0.8	gal/day	3.6	gal/day	
Handwashing	3.2	gal/day	6	gal/day	4	gal/day	4	gal/day	17.2	gal/day	
Cooking	---								2	gal/day	
								Total	155.3	gal/day	

"Extra Water Use During Holidays" value is added in to HOLIDAYS in the "Total Water Usage" table

Total Water Usage								
Time of Year		Days	gal/day	gal/year	total			
School Year	Weekday	185	150.15	27777.8	40172.8	gal/year	53.7032	ccf
	Weekend	74	167.5	12395		gal/year		
Summer/Breaks	Weekday	60	156.65	9399	13419	gal/year	17.9386	ccf
	Weekend	24	167.5	4020		gal/year		
Holidays	---	10	327.4	3274	3274	gal/year	4.3767	ccf
				Total:	**59640.8**	gal/year		
					79.7281	ccf		

Key		
	Estimated value	Produces Blackwater
		Produces Greywater
	Value From Credible Source	Produces Blackwater
		Produces Greywater

Greywater Usage								
Time of Year		Days	gal/day	gal/year	total			
School Year	Weekday	185	127.4	23569	33707	gal/year	45.0597	ccf
	Weekend	74	137	10138		gal/year		
Summer/Breaks	Weekday	60	129.4	7764	11052	gal/year	14.7744	ccf
	Weekend	24	137	3288		gal/year		
Holidays	---	10	275.4	2754	2754	gal/year	3.68156	ccf
				Total:	**49526**	gal/year		
					66.2066	ccf		

Kid 1 (Elementary School Aged)				
Hours at Home	School Days	Weekends	Holidays	Summer Days
	16	17	24	21
School Days				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	3
	1	---	1	
Bathroom Faucet: face washing	0	0.50	1.2	0
Bathroom Faucet: hand washing	6	0.50	1.2	3.6
Bathroom Faucet: brushing teeth	2	0.50	1.2	1.2
Kitchen Faucet: wash hands	2	0.33	1.5	1
Kitchen Faucet: rinse plate	1	0.33	1.5	0.5
Shower	1	15.00	2	30
			Total	**39.8**
Weekends				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	3.5
	1	---	1	
Bathroom Faucet: face washing	0	0.50	1.2	0
Bathroom Faucet: hand washing	8	0.50	1.2	4.8
Bathroom Faucet: brushing teeth	2	0.50	1.2	1.2
Kitchen Faucet: wash hands	3	0.33	1.5	1.5
Kitchen Faucet: rinse plate	3	0.33	1.5	1.5
Shower	1	15.00	2	30
			Total	**43**
Holidays				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	0	0.50	1.2	0
Bathroom Faucet: hand washing	10	0.50	1.2	6
Bathroom Faucet: brushing teeth	2	0.50	1.2	1.2
Kitchen Faucet: wash hands	5	0.33	1.5	2.5
Kitchen Faucet: rinse plate	3	0.33	1.5	1.5
Shower	1	15.00	2	30
			Total	**46.2**
Summer Days				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	3.5
	1	---	1	
Bathroom Faucet: face washing	0	0.50	1.2	0
Bathroom Faucet: hand washing	8	0.50	1.2	4.8
Bathroom Faucet: brushing teeth	2	0.50	1.2	1.2
Kitchen Faucet: wash hands	4	0.33	1.5	2
Kitchen Faucet: rinse plate	3	0.33	1.5	1.5
Shower	1	15.00	2	30
			Total	**43.5**

34.8

36

37.2

36

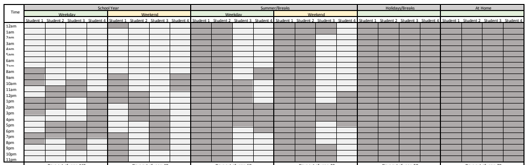
Kid 2 (High School Aged)				
Hours at Home	School Days	Weekends	Holidays	Summer Days
	13	18	24	19
School Days				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	4
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	7	0.33	1.2	2.8
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	2	0.33	1.5	1
Kitchen Faucet: rinse plate	1	0.17	1.5	0.25
Shower	1	20.00	2	40
			Total	**49.95**
Weekends				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	9	0.33	1.2	3.6
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	3	0.33	1.5	1.5
Kitchen Faucet: rinse plate	3	0.17	1.5	0.75
Shower	1	20.00	2	40
			Total	**52.25**
Holidays				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	10	0.33	1.2	4
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	5	0.33	1.5	2.5
Kitchen Faucet: rinse plate	3	0.17	1.5	0.75
Shower	1	20.00	2	40
			Total	**53.65**
Summer Days				
Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	9	0.33	1.2	3.6
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	4	0.33	1.5	2
Kitchen Faucet: rinse plate	3	0.17	1.5	0.75
Shower	1	20.00	2	40
			Total	**52.75**

44.2

45

45.4

45



School Year – Weekday	School Year – Weekend	Summer/Breaks – Weekday	Summer/Breaks – Weekend	Holidays/Breaks	At Home
Days out of year: 165	Days out of year: 48	Days out of year: 60	Days out of year: 22	Days out of year: 50	Days out of year: 20
11 weeks per quarter, 3 quarters	11 weeks per quarter, 3 quarters, subtracted the	Assume 50% capacity during summer, two summer sessions at 6 weeks each	Assume 50% capacity during summer, two summer sessions at 6 weeks each	Students go home: Winter Break (3), Spring Break (1), break before summer session (1), break after summer session 2 (2)	Students go home, days taken mainly from weekend days Assume each student goes home 2 times per quarter for 3 days Assume each student here for the summer goes home 1 time per session for 3 days

Key	
(grey)	Away
(light)	Home

Flow Rates		
K-faucet flow rate	1.5	gpm
B-faucet flow rate	1.2	gpm
toilet	0.5	gal (half)
	1	gal (full)
Shower flow rate	2	gpm

Student 1 & 3 are female, students 2 & 4 are male

Student - Low Water Use

For a typical day, this should be the goal water use for a student

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	3
	1	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	8	0.33	1.2	3.2
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6
Kitchen Faucet: wash hands	3	0.25	1.5	1.125
Kitchen Faucet: washing dishes	1	5.00	1.5	7.5
Cooking	---	---	---	0.5
Shower	1	8.00	2	16
			Total	33.025
				20.4

Student - Average Water Use

For a typical day, this should be the goal water use for a student

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	10	0.42	1.2	5
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6
Kitchen Faucet: wash hands	3	0.33	1.5	1.5
Kitchen Faucet: washing dishes	1	8.00	1.5	12
Cooking	---	---	---	0.5
Shower	1	12.00	2	24
			Total	49.2
				30.2

Student - High Water Use

For a typical day, this should be the goal water use for a student

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	6	---	0.5	5
	2	---	1	
Bathroom Faucet: face washing	2	0.50	1.2	1.2
Bathroom Faucet: hand washing	11	0.50	1.2	6.6
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6
Kitchen Faucet: wash hands	4	0.33	1.5	2
Kitchen Faucet: washing dishes	1	10.00	1.5	15
Cooking	---	---	---	0.5
Shower	1	15.00	2	30
			Total	61.4
				38.4

1 load of laundry per week 5.13 gal/cycle 0.73 gal/day

Student 1 Alice

Hours at Home	School Year Days	Weekends	Summer Days	Weekends
	16	13	0	0

School Days & Weekends

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5 (8 cups/day)
Toilet: dual flush	5	---	0.5	4.5
	2	---	1	
Bathroom Faucet: face washing	2	1.50	1.2	3.6
Bathroom Faucet: hand washing	11	0.25	1.2	3.3
Bathroom Faucet: brushing teeth	2	0.33	1.2	0.8
Kitchen Faucet: wash hands	4	0.25	1.5	1.5
Kitchen Faucet: washing dishes	1	10.00	1.5	15
Cooking	---	---	---	0.5
Shower	0.5	20.00	2	20
			Total	49.7
				27.7

Student 2 Alvin

Hours at Home	School Year Days	Weekends	Summer Days	Weekends
	17	19	0	0

School Days & Weekends

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	3	---	0.5	4.5
	3	---	1	
Bathroom Faucet: face washing	1	0.50	1.2	0.6
Bathroom Faucet: hand washing	8	0.42	1.2	4
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6
Kitchen Faucet: wash hands	1	0.33	1.5	0.5
Kitchen Faucet: washing dishes	2	20.00	1.5	60
Cooking	---	---	---	0.333333333
Shower	2	9.00	2	36
			Total	107.0333333
				41.2

Student 3 Kara

Hours at Home	School Year Days	Weekends	Summer Days	Weekends
	16	17	15	16

School Days

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	3	---	0.5	2.5
	1	---	1	
Bathroom Faucet: face washing	1	1.00	1.2	1.2
Bathroom Faucet: hand washing	8	0.17	1.2	1.6
Bathroom Faucet: brushing teeth	2	0.25	1.2	0.6
Kitchen Faucet: wash hands	3	0.25	1.5	1.125
Kitchen Faucet: washing dishes	1	5.00	1.5	7.5
Cooking	---	---	---	0.5
Shower	1	7.00	2	14
			Total	29.525
				17.4

Student 4 Lucas

Hours at Home	School Year Days	Weekends	Summer Days	Weekends
	16	21	17	18

School Days

Activity	Number	Minutes	gpm	gal/day
Drinking water	---	---	---	0.5
Toilet: dual flush	4	---	0.5	5
	3	---	1	
Bathroom Faucet: face washing	1	0.33	1.2	0.4
Bathroom Faucet: hand washing	8	0.17	1.2	1.6
Bathroom Faucet: brushing teeth	3	0.33	1.2	1.2
Kitchen Faucet: wash hands	1	0.30	1.5	0.45
Kitchen Faucet: washing dishes	1	1.00	1.5	1.5
Cooking	---	---	---	0.0264172
Shower	2	7.00	2	28
			Total	38.6764172
				31.2

For this data, I asked people how many times and for how long they do each of these actions per day, on a normal shcool day and on the weekend. From this, I gained that there isnt too much of a difference between water use on the weekends vs. weekdays.

Washing machine: assume each student does one load of laundry every week. For 4 people, that's 208 loads per year for the household. But for 12 weeks there are only 2 students, and for about 7 weeks, students are on holiday/break. Assuming that during the weeks students are not here, they do their laundry elsewhere. This gives a total of **~156** loads per year. From the specs, it was found that it uses 2013 gal for 392 cycles. Therefore, for the 106 cycles per year, the water use would be **544 gal/yr**

544 gal/yr

Extra People Over

3 guests per week	Number	Minutes	gpm	Total Per Week
Toilet	5	---	0.5	2.5
Bathroom: handwashing	6	0.33333	1.2	2.4
Kitchen: handwashing	3	0.33333	1.5	1.5
Cooking	---	---	---	0.5
			Total	6.9

Key		
(light blue)	Estimated value	Produces Blackwater
(grey-blue)		Produces Greywater
(light green)	Value From Credible Source	Produces Blackwater
(green-grey)		Produces Greywater

Total Water Usage

Time of Year		Days	gal/day	gal/year	Total			
School Year	Weekday	165	224.935	37114.2	47911.1	gal/year		
	Weekend	48	224.935	10796.9		gal/year	64.0478	ccf
Summer	Weekday	60	68.2014	4092.09	4910.5	gal/year		
	Weekend	12	68.2014	818.417		gal/year	6.56439	ccf
				Total	53724.4	gal/year		
					71.8191	ccf		

Greywater Usage

Time of Year		Days	gal/day	gal/year	Total			
School Year	Weekday	165	117.5	19387.5	25027.5	gal/time		
	Weekend	48	117.5	5640			33.4569	ccf
Summer	Weekday	60	48.6	2916	3499.2	gal/time		
	Weekend	12	48.6	583.2			4.67775	ccf
				Total	29195.5	gal/year		
					39.0287	ccf		

Family of Four

Husband, Wife, & 2 Children

Data Entry:					*Key*	
Age of Child 1:	15	years old	*Please enter values between 0 & 18 (numbers only, no text)*			User Imputs
Age of Child 2:	13	years old				Greywater Producing Activity

DO NOT EDIT ANYTHING BELOW THIS LINE

Ideal Indoor Personal Water Usage

Husband

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	5	---	0.5	4.5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	1.00	1.2	1.2	
Bathroom Faucet: hand washing	10	0.50	1.2	6	
Bathroom Faucet: brushing teeth	3	0.33	1.2	1.2	
Kitchen Faucet: wash hands	3	0.50	1.5	2.25	
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125	
Shower	1	8.00	2	16	
			Total Water Use Per Day	**32.775**	74% This percentage of the used water ends up as greywater!
			Total Greywater Production Per Day	**24.4**	

Wife

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	4	---	0.5	3	A half flush should be used for lighter uses (mainly liquids)
	1	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	2	1.00	1.2	2.4	
Bathroom Faucet: hand washing	8	0.50	1.2	4.8	
Bathroom Faucet: brushing teeth	3	0.33	1.2	1.2	
Kitchen Faucet: wash hands	6	0.50	1.5	4.5	
Kitchen Faucet: rinse plate	3	0.25	1.5	1.125	
Shower	1	12.00	2	24	
			Total Water Use Per Day	**41.525**	78% This percentage of the used water ends up as greywater!
			Total Greywater Production Per Day	**32.4**	

Child 1 - Teen

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	5	---	0.5	4.5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	1.5	1.2	1.8	
Bathroom Faucet: hand washing	9	0.5	1.2	5.4	
Bathroom Faucet: brushing teeth	3	0.5	1.2	1.8	
Kitchen Faucet: wash hands	3	0.5	1.5	2.25	
Kitchen Faucet: rinse plate	3	0.5	1.5	2.25	
Shower	1	15	2	30	
			Total Water Use Per Day	**48.5**	80% This percentage of the used water ends up as greywater!
			Total Greywater Production Per Day	**39**	

Child 2 - Teen

Activity	Number	Minutes	gpm	gal/day	Notes
Drinking water	---	---	---	0.5	The recommended 8 cups per day is equivalent to a half gallon per day
Toilet: dual flush	5	---	0.5	4.5	A half flush should be used for lighter uses (mainly liquids)
	2	---	1		A whole flush should be used for heavier uses (solids)
Bathroom Faucet: face washing	1	1.50	1.2	1.8	
Bathroom Faucet: hand washing	9	0.50	1.2	5.4	
Bathroom Faucet: brushing teeth	3	0.50	1.2	1.8	
Kitchen Faucet: wash hands	3	0.50	1.5	2.25	
Kitchen Faucet: rinse plate	3	0.50	1.5	2.25	
Shower	1	15.00	2	30	
			Total Water Use Per Day	**48.5**	80% This percentage of the used water ends up as greywater!
			Total Greywater Production Per Day	**39**	

Water Use Information

Total Water Use Per Day	Total Water Use Per Day (per person)	These values also include family water uses such as clothes washer, dishwasher, and cooking uses
178.9027397 gallons	**44.72568493** gallons	
Total Water Use Per Month	Total Water Use Per Month (per person)	
5367.082192 gallons	**1341.770548** gallons	
Potable Water Use Per Day	Potable Water Use Per Day (per person)	These values include all activities that use potable water (not
162.4027397 gallons	**40.60068493** gallons	

Potable Water Use Per Month	Potable Water Use Per Month (per person)	greywater). This is everything except the toilet, which uses treated greywater
4872.082192 gallons	**1218.020548** gallons	

Greywater Production Per Day	Greywater Production Per Day (per person)	These values also include greywater production from the clothes washer
140.3150685 gallons	**35.07876712** gallons	
Greywater Production Per Month	Greywater Production Per Month (per person)	
4209.452055 gallons	**1052.363014** gallons	