Reducing bathroom water consumption: replacing 4.5 gpf toilets with high efficiency dual-flush (low flow option, 3.5/2.5 gpf) valve units on campus – A proposed case study between two similar dormitories.

Project Description

*Briefly describe your proposed project. What changes do you propose? What environmental, economic, and/or social impacts do you anticipate? How will the project reduce operating costs for the host facility?*

Overview of Project

The University of Wisconsin has made impressive efforts transitioning into a predominantly low-emission campus. However, many campus buildings are outdated, largely composed of high-emission products. Specifically, many campus dormitories and common spaces have water waste products rated to high- and standard-emission ratings, at best. Efforts to incorporate and implement efficient methods for wastewater removal should be strongly considered for use in outdated campus buildings. If implemented, results from newly installed high-efficiency water waste units can be used as a model for implementation campus-wide. Methods proposed for efficient wastewater management include the installation of highly efficiency, low flow urinals (0.25 gallon per flush (gpf)) for male bathrooms (proposal #1) and the installation of highly efficient dual-flush toilets (3.5/2.5 gpf) for bathrooms of all genders (proposal #2).

As a previous occupant of Witte Hall as a freshman undergraduate, I noticed there were no energy efficient wastewater products in the male bathrooms. Additionally, there were no urinals. As a graduate student focusing on helping the environment, I couldn’t help but notice the outdated wastewater facilities in my own office building on campus (ironically the building that houses a department dedicated to sustainability and global environment). Motivated to change my former residence hall and office building, I am driven to transition UW-Madison to become a leading university in sustainable and responsible energy practices, starting with the implementation of low carbon footprint urinals and dual-flush toilets without sacrificing hygiene (along with the added convenience of urinals for male users).

How will your proposed project save operating costs for UW-Madison on-campus facilities? How will your proposed project reduce water, gas, electricity, or solid waste consumption and/or carbon emission?

These wastewater management implementations will provide a highly efficient and hygienic alternative to the existing low and standard water efficiency rated products currently used in existing dormitories. Implementation of high efficient water waste disposal units are already being implemented on campus - current renovations at Witte Hall and new units installed near the new Ogg Hall recreational facility - the justification for these changes is strengthened.

According to the Water-Energy-Climate Calculator (WECalc, <http://www.wecalc.org>), adjusting for the zip code 53703, there is 0.0035 kWh of energy embedded in 1 gallon of cold water used indoors. Furthermore, electricity generation in Wisconsin emits 1.73 pounds of CO2-equivalent greenhouse gases per kWH generated, resulting in 0.00605 pounds of CO2-equivalent greenhouse gases for each gallons of cold water used indoors. To gather an accurate proxy for total use among outdated facilities on campus, 15-minute intervals of traffic flow into female and male restrooms. Toilet use was recorded via visual (men’s bathrooms) and auditory confirmation of flushes (female’s bathrooms) among 3 campus dormitories (Ogg Hall, 1st floor nearest new recreational facility; Chadbourne Hall, 1st floor, nearest Rheta’s Dining Hall; Phillips Hall, 1st floor, nearest main entrance). In comparison to many existing toilet flow rates (~4.5 gpf), dual flush units are highly efficient, even for full (3.5 gpf) flushes. Furthermore, the ratio of full (3.5 gpf) to reduce (2.5 gpf) flush was calculated from the 15-minute interval bathroom use observations. Total toilet flushes (for females and males) and total urinal flushes (for males) were averaged across all observed locations for one hour. The ratio of full flush (3.5 gpf) to reduced flush (2.5 gpf) rate was 0.36 to 0.64. These values were used for calculations in this proposal.

Despite proposing to replace toilet valve stems and not the physical porcelain toilet itself (keeping costs low), the volume of toilet units across UW Housing and Facilities is quite high. With a limited budget, it is not feasible to implement a proposal for a campus-wide change. Instead, in coordination with UW Housing, we identified Tripp and Adams Halls as two dormitories that will serve as excellent comparisons for a case study. These two dormitories are nearly identical in every aspect: floor plan, number of residents, bathrooms, and toilet units. We propose to replace all existing toilets (4.5 gpf) in Tripp Hall (our experimental dormitory) with Zurn dual flush (3.5/2.5 gpf) units. We will have Adams serve as our control dormitory. To provide accurate usage of flow rates to the building, UW Housing will attach flow meters to the cold water line that feeds both buildings. There will be one water meter monitoring Tripp Hall and one water meter monitoring Adams Hall. If funded, UW Housing and I have agreed to conduct a 1-year follow-up with any interested parties in the Green Fund and potentially seek to publish our findings in a relevant environmental health/conservation journal. Previous literature reviews were not successful in identifying water consumption or energy conservation findings in large public buildings, including university dormitories. This proposal provides ideal parameters to capture dual-flush toilet interventions on a large scale, providing findings that may be very useful for any organization, campus, or business looking to not only save economically, but also be environmentally conscious.

Results (for both genders combined) indicated from the 15-minute interval recordings show that Chadbourne experienced the highest toilet use with 16 flushes for 5 units (see attachment ‘data collection sheet’). Ogg Hall experienced 8 flushes with 5 units and Phillips Hall had no visitors during each respective 15-minute interval recording. Additionally, there were 25 recorded urinal flushes (out of 5 total urinals). Of the combined 53 flushes across 18 units (13 toilets and 5 urinals), there was an average of 2.94 flushes per units per 15-minute interval (or 11.78 flushes per unit for every 1 hour). We are assuming that the averages of the 15-minute recordings apply to all genders and during each hour of the day. Applying the full (3.5 gpf) to reduce (2.5 gpf) flush rate of 0.36 to 0.64 to all 67-toilet units within Tripp Hall, results in a net savings of $50,897.12 per year. We estimate that total annual utility costs for flushing the dual flush units will result in $88,759.61 for Tripp Hall (Adams would result in $139,656.73). In addition, we estimate that Tripp Hall also reduces CO2-equivalent greenhouse gas emissions by 51,485 pounds and water consumption by 8,509,943.39 gallons per year (Figure 1, calculations in “Toilet Documentation” spreadsheet”) – the equivalent of 12.9 [Olympic sized swimming pools](http://www.patagoniaalliance.org/wp-content/uploads/2014/08/How-much-water-does-an-Olympic-sized-swimming-pool-hold.pdf).

Additional Information

UW Housing is very supportive of conservation on campus, especially if it includes their buildings. They strongly support this idea and have already supported the previous similar proposal (urinal replacements), replacing outdated high-flow valves with the newly proposed 0.25 gpf units in both Witte and Ogg residence halls on campus. UW Housing is committed to this project as well, especially considering the greater conservation benefits and cost reduction for our campus. The two main contacts at UW Housing who have been primarily involved in planning this proposal with me are Mike Henry and Breana Nehls. Along with Ian Aley, we have met several times over the previous 12 months and have flushed out technical logistics for proposed implementation. UW Housing has their own maintenance employee (from UW Facilities Department) who works solely for housing-related contracts. Mike Henry has assured us that installation and labor are included in this employee’s salary and the time spent on proposal 1 and proposal 2 will be donated (The Green Fund will not incur additional costs for this project other than the cost of the units themselves (proposed replacement units will be added to this employee’s tasks as a normal work order for UW Housing). Additionally, UW Housing purchases products from preferred vendors at wholesale price. The units that will be (and have been) used for replacement are from Zurn Valves, model AquaVantage AV Z6000AV-DF 3.5/2.5 units (unit description [here](http://www.zurnproducts.com/zurn-aquavantage-av-z6000av-df-flush-valve)).

Conclusion

Overall, it is strongly recommended to implement high-efficiency dual flush (3.5/2.5 gpf) toilet flush valves in older university dormitories. Tripp and Adams Residence Halls serve as excellent comparison facilities for a case study. With the addition of cold water flow meters on each building, we plan to take advantage of our comparison sites and write a 1 year follow up report, with the end goal to publish in an environmental health and/or conservation-oriented journal.

The economic savings and contributions towards environmental conservation (and conscientious responsibility) are clear. The buyback period for the proposed units is 0.32 years, or about 117 days. From that point forward, the campus is saving thousands of dollars, but more importantly, reducing thousands of pounds of unnecessary harmful greenhouse gases into the environment each year. Additionally, since dual-flush toilets are a relatively new concept in our society, I plan to implement a brief summary of the purpose of the units as well as key education points in each stall in Tripp Hall.

If funded, this proposal provides an excellent outlook for prolonged sustainability practices on campus, leaving a significant positive impact for years to come. UW Housing has been an absolute pleasure to work with and their dedication to improving sustainability efforts on campus is refreshing. They are deeply invested in these proposals (urinal and dual flush units) and will be observing the differences that each implementation makes. Based on their high likelihood for success, UW Housing hopes to continue replacing dual-flush toilets in all housing buildings in the near future. The Green Fund is a new program that will undoubtedly benefit from vast reoccurring funds that this project generates year to year, providing financial support and paving the way for countless other sustainability projects for our campus in the future.

Student Applicant(s)

*Please include a short bio for each student applicant, including name, year in school, area of study, connection to host facility, and the skills, experience, and/or interests you bring to your project team.*

Biography

Johnny Uelmen is a Fox Cities native, hailing from Fond du Lac, Wisconsin and a proud triple-Badger! He has Master’s Degrees in both Epidemiology and Entomology, as well as a B.S. in Biology. He is in his second year of his Environment & Resources Ph.D. program through the Nelson Institute for Environmental Studies. Under the mentorship of his advisor Dr. Jonathan Patz, Johnny’s research interests revolve around the effects of climate change and human health. More specifically, Johnny is interested in understanding infectious diseases as they proliferate within changing environments, incorporating the health of humans, the environment, and wildlife (One Health triad) as equally important components of this complex cycle. Johnny is passionate about global health and believes that every single person on this earth has the right to health and happiness, no matter where they live. His current project evaluates mosquito- and tick-borne diseases in the U.S. (West Nile, Zika, and Lyme) as well as zoonotic infectious diseases abroad. He hopes to develop new and innovative predictive models for helping both public health officials and populations most susceptible to harmful infectious diseases prepare for, mitigate, and eventually eradicate, mortality and morbidity stemming from diseases. Johnny continues his public health work and advocacy at the Wisconsin Department of Health Services, interviewing patients affected by foodborne, waterborne, and vector-borne infectious diseases as well as investigating outbreaks in our state. Johnny also serves as the New York 4 & New York 6 STEM (Science, Technology, Engineering, and Mathematics) Mentor with the Posse Program. As a graduate student in a STEM field, he plans to continue his love of mentoring into his teaching and research career, especially among underrepresented and multicultural students in STEM fields.

Connection to Host Facility

UW Housing has not only been overwhelmingly positive in this proposal, they have graciously pulled resources from within and moved forward on this project. They have worked diligently with me on planning, providing the preferred maintenance employee (for installation, maintenance, and labor) as well as the preferred vendors to purchase the units from. I am very grateful to have their overwhelming support and enthusiasm in making our campus greener.

\*Note: If this proposal is funded, the requested amount (from Green Fund) will be used to reimburse UW Housing of the costs they have spent thus far on recent installations. This will only include the costs of the units (and not labor, installation, maintenance, etc., as these are covered by UW Housing).

Skills, Experience, and/or Interests

I pride myself on having a wide-variety of interests. While I am an epidemiologist and entomologist, climate change is at the core of my interests. Naturally, “practicing what I preach” comes with the territory. I truly look to explore opportunities that can better the health of people, animals, and the environment. This is not limited to my research; while working in SAGE (the Center for Sustainability and the Global Environment), I could not help but notice how wasteful my building was (from water flushes to inefficient lighting and windows) and saw an opportunity to make a difference on my own campus.

Additionally, I am very proud to mentor undergraduate STEM students. I have been doing this for the past 5 years, and this is something I want to always implement at all stages in my life.

Please see attached Curriculum Vitae for additional information.

*Are all students in your project team good academic standing as defined by your departments? [Yes or No]*

**Yes**

Host facility

*In what facility will your project be hosted?*

UW Housing has agreed to host this project. Over the past year, I have been working with Mike Henry (Buildings & Grounds Supervisor, UW Housing) and Breana Nehls (Sustainability and Communications Coordinator, UW Housing), discussing my pre-proposal for implementing new, high-efficiency urinals and dual-flush toilets on campus. With Ian Aley’s assistance, Mike and Breana have committed to this project and have already began installing new high-efficiency 0.25 gpf urinal stem valves in campus buildings. With UW Housing’s continued support, this proposal aims to make even greater strides towards sustainability, starting with the replacement of 67 toilet stem valves with high-efficiency dual-flush valves. UW Housing has a contractor from UW Facilities assigned to aid in requested maintenance. Mike has donated the toilet replacement labor, requiring no additional install or labor costs for this project.

*Is it an auxiliary facility? [Yes or No]*

*(On-campus auxiliary buildings include: residence halls, dining halls, Memorial Union, Union South, Union Theater, the Wisconsin Institute for Discovery, Eagle Heights, computer science)*

**Yes**

*If no, please explain:*

*Is this an on-campus facility? [Yes or No]*

**Yes**

*If no, please explain.*

*Please include the name and position of the host facility staff engaged in the project, including the Staff Contact who will complete the Support Letter:*

Mike Henry, Buildings & Grounds Supervisor, UW Housing (will complete the support letter)

Breana Nehls, Sustainability and Communications Coordinator, UW Housing

Work Plan and Team

*If funded, when would you anticipate implementing this project?*

If funded, this project will be scheduled to begin summer, 2018. UW Housing aims to complete the installation of all 67 units in Tripp Hall by August 2018, before residents arrive. Additionally, the newly installed cold water flow meters will essentially be set to 0 and will start at the same time.

*What roles will your student team members play in the process?*

As the sole student team member, I will continue oversight of installations by assisting Mike and Breana with any questions regarding implementation. As part of the pre-proposal and planning process over the previous 12 months, we have met several times and flushed out many logistics and technical parameters. I will continue to closely monitor and assess any unforeseen challenges with future use of these newly installed units.

While these units are being installed, I plan to begin a marketing and education campaign on campus (as well as in each stall, as stated earlier). For every unit that gets installed, I will have high-quality signs that explain what the units are, why there were replaced, and how this benefits our environment and housing budget. In addition, UW Green Fund will be displayed and described in full detail for funding and making this (and many other) project(s) happen.

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| --- | --- | --- |
| Comparison of Annual Water Consumption | | |
|  | Toilets in Tripp & Adams | |
| *Existing Units (4.5 gpf) (control units in Adams)* | *New Units (3.5/2.5 gpf) (for replacement in Tripp)* |
|
|
|
| *Water Consumption* | 23,350,454.415 gallons | 14,840,511.0282 gallons |
| reduce consumption by 8,509,943.387 gals or 63.6% | |
| *Water Utility Costs* | $139,656.73 | $88,759.61 |
| save $50,897.12 in utility costs | |
| *C02-equivalent Greenhouse Gas Emissions* | 141,270.25 CO2-equivalent greenhouse gases | 89785.09 CO2-equivalent greenhouse gases |
| reduce greenhouse gas emissions by 51,485 pounds | |
| *Buyback Period* | N/A | 0.30 years |

**Figure 1.** Summary of annual water consumption, comparing existing toilet units (Adams Hall) with proposed high efficiency 3.5/2.5 gpf units (Tripp Hall). Results based on preliminary data recording average usage (15-minute recording intervals for Ogg, Chadbourne, and Phillips residence halls each, gender pooled) with 18-hour usage periods per day (assuming resident’s sleep 8 hours each day).

Application Contact

*Please include the name, phone number, and email for one student and one staff member to be the Student Contact and Staff Contact for the project:*

Johnny Uelmen (student contact) Mike Henry (staff contact)

920-979-9888 608-890-0444

[uelmen@wisc.edu](mailto:uelmen@wisc.edu) [mike.henry@housing.wisc.edu](mailto:mike.henry@housing.wisc.edu)

Attachments

*Please upload the Budget and Impact Calculator along with this Application Form:*

# *Please request the Lead Staff Contact to upload the Letter of Support.*

Enclosure: Budget and Impact Calculator, Data Collection Sheet (restroom use), Tripp-Adams Toilet Documentation, WECalc Water Usage and Carbon Consumption Values, Curriculum Vitae

Appendix

Additional Justification/Alternative Calculations

According to the City of Madison’s Water Utility (<http://www.cityofmadison.com/water/billing-rates/water-sewer-stormwater-rates>), water usage (per billing month) over 14,000 gallons results in a cost of $5.07 per 1,000 gallons. According to the American Water Works Association, the average person (independent of gender) flushes 5 times per day. Witte Hall has ~64 residents per floor (2 towers x 9 floors (1st floor not residence) = 18; 1,150 residents/18 floors = 63.9 residents per floor), consisting of 1 bathroom per gender. In each bathroom, there are ~5 toilets (and no urinals for male bathrooms). This would result in an estimated 9,125 gallons (low water efficiency rating of 5 gallons per flush) or 6,388 gallons (standard water efficiency rater of 3.5 gallons per flush) used per person per year (<http://www.conserveh2o.org/toilet-water-use>). Furthermore, one residence floor in Witte Hall would use about 584,000 (low water efficiency rating) or 408,832 gallons of water per year. This would result in a total water utility bill of about $2,960.88 (low water efficiency rating) or $2,072.78 (standard water efficiency rating) per residence floor per year. Breaking this down further, each toilet would result in a total utility bill of $296.09 (low water efficiency rating) or $207.28 (standard water efficiency rating) per year.