Student Research for Campus Water Savings

Redesign of a Campus Sustainability Course

San Francisco State Team Members:

Living Lab Champion: Caitlin Steele, Director of Sustainability & Energy

Faculty Lead: Carlos Davidson, Professor, Environmental Studies Program

Nick Kordesch, Sustainability Coordinator

Charles Meyer, Senior Director Facilities & Service Enterprises

Course to be redesigned:

The course to be redesigned is Environmental Studies 570: Campus Sustainability. This course was first taught in 2008 and has from the start worked on collaborative projects with the Facilities department at SF State including the first greenhouse gas inventory for campus.

Timeline for implementation of redesigned course:

Redesign will take place during Fall 2015 semester, with implementation in the class in Spring 2016

Goals for the course redesign:

1. Redesign of course lecture and assignments to include campus water use and efficiency. Initial new assignment would have students conduct bathroom water assessments by collecting information on number and water use of existing fixtures and bathroom use (pilot underway). Future assignments would be on water use on grounds and other water uses.

2. Develop a building water use model that will allow estimates of water use and potential retrofit costs and water savings based on bathroom use and fixture information for all bathrooms in a building. Subsequently develop a model for lawn to native plant conversions, and then other water uses.

3. Redesign of final course projects to focus on water use. Initially in bathrooms, reports would use all the individual bathroom assessment data collected by students for a single building and the building water use model to estimate current water use and potential retrofit costs and water savings. Students would conduct financial analysis to examine payback period, and cost of water savings for particular retrofits in specific bathrooms to make retrofit recommendations to Facilities.

4. Infrastructure needs funds would be used by Facilities to carry out a pilot retrofit of one mens and one womens bathroom. New high efficiency toilets and urinals would be installed allowing Facilities to assess new toilet and urinal models and the labor time and cost for retrofits. This information would then be incorporated in the building water use model and subsequently used by students in their building retrofit reports.

Student earning objectives:

- Raise awareness of how institutional decisions affect water use.
- Apply financial analysis to a sustainability retrofit decision.
- Integrate financial, use, and sustainability commitment considerations to arrive at retrofit recommendations.
- Enhance skills in quantitative assessments and professional presentation of sustainability research.

SAN FRANCISCO STATE UNIVERSITY

Environmental Studies Program
School of Public Affairs and Civic Engagement

Student Research for Campus Water Efficiency Projects

Living Lab Champion: Caitlin Steele, Director of Sustainability & Energy

Faculty Lead: Carlos Davidson, Professor, Environmental Studies

Nick Kordesch, Sustainability Coordinator

Charles Meyer, Senior Director Facilities & Service Enterprises

San Francisco State University

Course Name & Description: Applied Local Sustainability (ENVS 570) is an upper division course for Environmental Studies majors in the College of Health and Social Sciences at San Francisco State University. The course is designed to prepare students to do sustainability work at the local level in city and county government and in business, educational and non-profit organizations.

Project Abstract: Redesign of course lecture and assignments to include a major campus water use and efficiency project. New assignment would have students conduct bathroom water assessments by collecting information on number and water use of existing fixtures and bathroom use and write a report on building water use and retrofit savings and costs for an entire campus building.

GE Credit (if applicable): Yes – meets San Francisco State environmental sustainability general education requirement

Keywords/Tags: sustainability, water use, bathrooms, retrofits, water efficiency

Instructional Delivery: Currently, in-class lecture and laboratory

Pedagogical Approaches: lecture, discussion, in the field demonstrations, hands on field collection of data

Class Size: 35

About the Course Redesign

Stage 1

Background on the Redesign

Why Redesign Your Course?

- **Current Course Description:** Students will learn about current sustainability issues and efforts at universities across the country and at San Francisco State. A major component of course will be completion of a hands-on sustainability project on campus.

- What type of characteristics are you looking to change in the redesign to incorporate elements of Campus as a Living Lab?

  Three main elements of a redesign:

  1. Redesign of course lecture and assignments to include campus water use and efficiency. Initial new assignment would have students conduct bathroom water assessments by collecting information on number and water use of existing fixtures and bathroom use (pilot underway). Future assignments would be on water use on grounds and other water uses.

  2. Develop a building water use model that will allow estimates of water use and potential retrofit costs and water savings based on bathroom use and fixture information for all bathrooms in a building. Subsequently develop a model for lawn to native plant conversions, and then other water uses.

  3. Redesign of final course projects to focus on water use. Initially in bathrooms, reports would use all the individual bathroom assessment data collected by students for a single building and the building water use model to estimate current water use and potential retrofit costs and water savings. Students would conduct financial analysis to examine payback period, and cost of water savings for particular retrofits in specific bathrooms to make retrofit recommendations to Facilities.

Course History/Background

- Describe how this course maps into the selection of courses the students take before and after this particular course in your department or program. Is this course part of a larger selection of sustainability themed curriculum?

  This course is an upper division elective course that meets a number of requirements in the Environmental Studies major. Students are required to take ENVS 300 Introduction to Environmental Studies as a prerequisite.

- What is the department's historical context for student success in these courses?

Course Redesign Planning

Stage 3

Implementing the Redesigned Course

Which Aspects of Your Course Have You Redesigned?

- What are you now doing or planning to do through the redesign of your course?

  I redesigned the major final project for the course from a campus sustainability policy proposal to hands on collection of water use data in campus bathrooms and writing of a report on water use in bathrooms in a campus building with potential money and water savings through fixture retrofits. Also built a water use calculator for student use, and added a lectures on water use in bathrooms, calculating water use using the calculator, and on using water and financial metrics to evaluate retrofit options.

- How has the CALL program influenced the decisions you made in the redesign of your course?

  The CALL program encouraged me to work directly with Facilities to have students work on water projects that provided Facilities with useful data and analysis for reducing water use on campus.

What role did the CALL Champion play in the redesign of your course?

- How was the CALL Champion involved in identifying and developing course content?

  The CALL champion helped right from the start in identifying bathroom water use as an area Facilities wanted to work on and where student collected data and analysis would be helpful. The CALL champion and other facilities partners came up with the specific retrofit fixtures students used in their retrofit analyses. And the CALL champion identified the first priority buildings for data collection.

- How will the CALL Champion participate once the course is redesigned and implemented?

  The CALL champion identified priority buildings for a second semester of data collection and helped determine additional data students could collect that would be useful to Facilities.

Which Professional Development Activities Have You Participated in During Your Course Redesign?

Students have been very enthusiastic about applied courses in the major.

- What are the elements of sustainability currently in the course, if any? How is this content currently delivered?

  The entire course is focused on sustainability. Currently the course covers energy use in lighting, waste, landscaping, greenhouse gas emissions inventories and climate action planning, transportation, and more.

High Demand / Low Success Issues

- Describe the high demand/low success issues which are affecting the course you are redesigning?

There are no high demand/low success issues with this course.

Syllabus from pre-designed course is an attachment

About the Students and Instructor(s)

Stage 2

Student Characteristics

- To the best of your abilities, describe the population of students who take the course, including the range of majors, and their incoming knowledge and/or skills that they typically have coming into the class.

  Students in the course are mainly upper division Environmental Studies majors with a hand-full of majors from a scatter of other disciplines. Generally they have a strong background in environmental issues, but have few applied skills to work on sustainability issues.

- Is there an overall sustainability culture with the students at your campus?

  Yes, the campus has a fairly strong sustainability culture.

Impact of Student Learning Outcomes/Objectives (SLOs) on Course Redesign

- The outcomes of this project include:

  Raise awareness of how institutional decisions affect water use.

  Apply financial analysis to a sustainability retrofit decision.

  Integrate financial, use, and sustainability commitment considerations to arrive at retrofit recommendations.

  Enhance skills in quantitative assessments and professional presentation of sustainability research.

- Current course learning objectives:

  Give students hands on opportunities to develop skills involved in sustainability work - both technical skills such as those involved in conducting a greenhouse gas inventory as well as organizational, political, and social skills involved in carrying out a sustainability project.

Alignment of SLOs With Course Redesign

- Briefly describe how the course redesign will align with the SLOs.

  The redesign continues the courses focus on hands on learning with applied projects in which students gather their own data, analyze it and write a report.

Assessments Used to Assess Students' Achievement of SLOs

- How are you planning to assess the students' achievement regarding the SLOs?

  Students write reports which are then graded and assessed with a rubric.

Accessibility, Affordability, and Diversity Considerations

Accessibility

- Share how you have considered designing the course to serve students with varied abilities.

  All class exercises are accessible to students, even a student in a wheel chair.

Affordability

- Are the course materials and technologies used readily available and affordable for your students?

  I did not attend any professional development activities during my course redesign.

Revised syllabus is attached below. Note that since the redesign focused on the course final project, the syllabus alone, which does not have details of the final project, does not well illustrate the redesign work. I have therefore also attached below the assignment description for the water use final project.

Redesign Results

Stage 4

Course Redesign Impact on Teaching and Learning

- How has the course redesign strategies affected your instruction and your students' learning? Did your redesign strategy solve the issues that motivated you to redesign the course?

  The motivation for the redesign was to have students do more hands on sustainability work that would give them professional skills and a sense that they were contributing directly to campus sustainability. The redesign was very successful in this regard. The redesign greatly increased student learning of field quantitative data collection techniques, data storage, manipulation and analysis with Excell, assessment of financial and environmental benefits and cots of alternative retrofits, and report writing

- Describe how your students mastered the student learning outcomes. Were the students more successful in the redesigned course than in previous courses? Explain.

  Students did excellent work with the water efficiency work and met my learning goals. I think the fact that the project was connected to real sustainability work on campus addressing a pressing environmental issue made students more motivated. Because this already was a highly motivated set of students who generally did very well, I was not able to gauge whether or not the redesign led to greater success.

- Did you experience unexpected results after teaching the redesigned course? If so, what were they?

  The redesigned course required much greater use and mastery of Excell. The first time I taught it, I did not realize this, and students struggled with Excell. The second time I added a class session in the a computer lab where we could work together on an example of water use and retrofit calculations in Excell. This helped greatly.

- Sample of student work: ie capstone projects.

  Three student building water use reports are attached below.

Assessment Findings

- Compile and upload graphs/tables/charts reflecting your findings with a short description. You might include a course comparison of pre/post student achievements before redesign.

  I don't have this sort of data. I have student grades in the course pre and post redesign, and students grades on the final project pre and post-redesign. However, I do not believe either of those are informative.

Student Impact

- Comments or survey results:

  Here are two selected comments from my end of course teaching evaluations for Fall 2016. In general students expressed to me that they really appreciated the hands on nature of the final project, that they learned real professional skills such as professional report writing, working with Excell, analyzing retrofit options based on both environmental and financial criteria, and that the projects were directly connected to improving sustainability on campus and addressing a pressing environmental issue.

  "Both the lighting and water report were extremely significant because they gave students a hands on feel on what people are actually doing in sustainability work. These activities could be what we do in future jobs so it was enjoyable and beneficial to do these activities."

  "The instructor provided tons of good resources and information for students to access. He gave lots of time to finish projects and clearly laid them out for students. He had very beneficial assignments that helped students understand bigger concepts on campus such as water and light usage."

Lessons Learned & Redesign Tips

Teaching Tips

- What advice do you have for others who might want to teach with this redesigned course? (technology training and support, planning, creating learning outcomes, etc.)

  My advice:

  1. Coordinate buildings to study with your Facilities department
  2. Provide lots of Excell support to students – they will need it to do the reports, and improving their Excell skills is an important professional skill (which most students will appreciate).
  3. Provide a word template for the final reports and explain the importance of professional looking reports.

Only course expense is one small book. Rest of readings are available free on course management software. All materials are free

- **Diversity**

- Do the pedagogical strategies support students' learning with diverse backgrounds?

  Yes, the strategies support students learning with diverse backgrounds. Also I have been working on student support groups to help all students get peer support.

About the Instructor

Carlos Davidson is a Professor of Environmental Studies at San Francisco State University. He has been active in campus sustainability issues including helping found the University Sustainability Committee, co-authoring the campus' first greenhouse gas emissions inventory, leading a successful effort to get a general education sustainability requirement, working on SF State's fossil fuel divestment, and teaching a Campus Sustainability course. Davidson's research is on the causes of amphibian population declines. He is also interested in issues of environmental justice, and climate change. Davidson earned his Ph.D. in ecology at the University of California, Davis.

About the Facilities Staff Partners

Caitlin Steele is Director of Sustainability and Energy. Nick Kordesh is Sustainability Coordinator, and Charles Meyer was Senior Director Facilities & Service Enterprises (He has retired since the CALL project began).

4. Compile student data from each bathroom into a shared class spreadsheet that students can use for their full building assessments. It is more satisfying for a student to write a report on a full building than just a few bathrooms.
5. Assign multiple students to gather data each bathroom so you can check student results against each other, and still have coverage is a student fails to collect data.
6. Similarly, assign multiple students to write final reports on each building. This will allow you to pick a best report to share with Facilities.

Course Redesign Obstacles

- What challenges did you confront and how did you overcome them?

  Two main challenges

  1. Many students having only rudimentary Excell skills. Overcame by providing some online Excell training, devoting an entire class in a computer lab to hands on working with the water calculations in Excell, and ensuring teaching assistant and my office hours were welcoming to students who needed Excell help.
  2. A very few students doing poor data collection or not completing their data collection. Solved by having each bathroom assigned to two students – so I got duplicate data that I could compare and coverage if one student did not collect their data. It meant the class could cover only half as many bathrooms, but it was worth it.

Strategies I Used to Increase Engagement

- What pedagogical strategies did you use in your newly redesigned course to engage students?

  Make it fun, and emphasize that this was real work helping the campus address water use in the drought. That was very motivating.

Instructor Reflection

- Share any plans to disseminate/publish the findings of your course redesign activity.

  No plans to disseminate or publish my findings.

Attachments

1. Carlos Davidson CV
2. ENVS 570 Syllabus Spring 2015 (pre-redesign)
3. ENVS 570 Syllabus Fall 2016 (post redesign)
4. Assignment description for water use in bathrooms final project
5. Student sample work #1: Water Use in Fine Arts building by Lillebaek Anderson
6. Student sample work #2: Water Use in Student Services Building by Kelly Dodge
7. Student sample work #3: Water Use in Thorton Hall by Rebecca Standridge

CARLOS DAVIDSON
CV

EDUCATION

Ph.D., Ecology, Conservation Ecology Emphasis Area. University of California, Davis. 2000. Dissertation: Spatial Patterns of California Amphibian Declines and Ecological Limits. Advisor: H. Bradley Shaffer.

Masters degree, Economics. University of California, Berkeley. 1990.

Bachelors degree, Economics. University of California, Berkeley. 1982.

CURRENT POSITION

Professor. 2010-present. Environmental Studies Program. San Francisco State University. 1600 Holloway Ave., San Francisco CA 94132.

ACADEMIC POSITIONS

Program director/Program coordinator. 2005-2015. Environmental Studies Program. San Francisco State University. 1600 Holloway Ave., San Francisco CA 94132.

Associate Professor. 2005-2010. Environmental Studies Program. San Francisco State University. 1600 Holloway Ave., San Francisco CA 94132.

Assistant Professor. 2000 – 2005. Environmental Studies Department. California State University, Sacramento.

AWARDS AND HONORS

California State University System. Campus as a Living Laboratory grants. Course redesign: Student Research for Campus Water Efficiency Projects. $15,439. AY 15-16.

Office for Research and Sponsored Projects, SF State. Individual investigator grants. Climatic refuges for declining amphibian populations. $18,844, AY 12-13.

U.S. Fish and Wildlife Service. Impacts of a fungal pathogen, pesticides, and temperature on the cascades frog in the mountains of northern California. With Catherine Johnson, Janet Foley, Sharon Lawler, Karen Pope, Nathan Nieto, Kevin Aceituno and Jonah Piovia-Scott. $395,122. AY 10-13.

Rose Foundation for Communities and the Environment. Effects of sub-lethal pesticide exposure on frog's immune response. $20,000. 2005-2006.

State Water Quality Control Board, PRISM grant. Pesticide residues in frogs and amphibian declines in the California Cascades and Sierra Nevada. $190,000. 2004-2006.

U.S. Environmental Protection Agency. STAR grant. Airborne pesticides and disease outbreaks in Sierra Nevada frogs. Roland Knapp co-PI. $215,000. 2003-2004.

U.S. Fish and Wildlife Service. Historic pesticide use and California amphibian declines. Research grant. $29,000. 2001-2002.

Declining Amphibian Populations Task Force of The World Conservation Union (IUCN)/Species Survival Commission. Seed grant. $1,700. 2000-2001.

Declining Amphibian Populations Task Force. Special seed grant for climate change research. $4,500. 1998-2000

PUBLICATIONS

Refereed journal articles

Vincent K, and Davidson C. 2015. The toxicity of glyphosate alone and glyphosate-surfactant mixtures to western toad (*Anaxyrus boreas*) tadpoles. Environmental Toxicology and Chemistry

Boone MD, Bishop CA, Boswell LA, Brodman RD, Burger J, Davidson C, et al. 2014. Pesticide regulation amid the influence of industry. Bioscience 64:917-922.

Davidson C, Williamson C, Vincent K, Simonich S, Yip KS, Hero JM, et al. 2013. Anuran population declines occur on an elevational gradient in the Western Hemisphere. Herpetological Conservation and Biology 8:503−518.

Davidson, C., K. Stanley, and S. Simonich. 2012. Contaminant residues and declines of the Cascades frog (*Rana cascadae*) in the California Cascades, USA. Environmental Toxicology and Chemistry **31**:1895-1902

Grasso, R. L., R. M. Coleman, and C. Davidson. 2010. Palatability and antipredator response of Yosemite Toads (*Anaxyrus canorus*) to nonnative Brook Trout (*Salvelinus fontinalis*) in the Sierra Nevada mountains of California. Copeia **2010**: 457-462.

Stanley, K., S. M. Simonich, D. Bradford, C. Davidson, and N. Tallent-Halsell. 2009. Comparison of pressurized liquid extraction and matrix solid phase dispersion for the measurement of semi-volatile organic compound accumulation in tadpoles. Environmental Toxicology and Chemistry **28**: 2038-2043.

Davidson, C., M. Benard, H. B. Shaffer, J. Parker, C. O'Leary, J. M. Conlon, and L. A. Rollins-Smith. 2007. Effects of chytrid infection and carbaryl exposure on survival, growth and

antimicrobial peptide defenses in foothill yellow-legged frogs (*Rana boylii*). Environmental Science and Technology **41**:1771-1776.

Davidson, C., and R. Knapp. 2007. Multiple stressors and amphibian declines: dual impacts of pesticides and fish on yellow-legged frogs. Ecological Applications **17**:587-597.

Conlon, J. M., A. al-Dhaheri, E. al-Mutawa, R. al-Kharrge, E. Ahmed, J. Kolodziejek, N. Nowotny, P. F. Nielsen, and C. Davidson. 2007. Peptide defenses of the Cascades frog *Rana cascadae*: implications for the evolutionary history of frogs of the Amerana species group. Peptides **28**:1268-1274.

Conlon, J. M., N. Al-Ghafari, L. Coquet, J. b. Leprince, d,, T. Jouenne, H. Vaudry, and C. Davidson. 2006. Evidence from peptidomic analysis of skin secretions that the red-legged frogs, *Rana aurora draytonii* and *Rana aurora aurora*, are distinct species. Peptides **27**:1305 – 1312.

Conlon, J. M., A. Sonnevend, C. Davidson, A. Demandt and T. Jouenne. 2005. Host-defense peptides isolated from the skin secretions of the Northern red-legged frog *Rana aurora aurora*. Developmental and Comparative Immunology **29**:83-90.

Davidson, C. 2004. Declining downwind: California amphibian population declines and historic pesticide use. *Ecological Applications*. **14**:1892-1902.

Conlon, J. M., A. Sonnevend, C. Davidson, D. Smith and P. F. Nielsen. 2004. The ascaphins: a family of antimicrobial peptides from the skin secretions of the most primitive extant frog, *Ascaphus truei*. Biochemical and Biophysical Research Communications **320**:170-175.

Conlon, J. M., A. Sonnevend, M. Patel, C. Davidson, P. F. Nielsen, T. Pal and L. A. Rollins-Smith. 2003. Isolation of peptides of the bevinin-1 family with potent cadidacidal activity from the skin secretions of the frog *Rana boylii*. Journal of Peptide Research 62:207-213.

Davidson, C., H. B. Shaffer, and M. R. Jennings. 2002. Spatial tests of the pesticide drift, habitat destruction, UV-B and climate change hypotheses for California amphibian declines. Conservation Biology 16: 1588-1601.

Davidson, C., H. B. Shaffer, and M. R. Jennings. 2001. Declines of the California red-legged frog: climate, UV-B, habitat and pesticides hypotheses. Ecological Applications 11:464-479.

Davidson, C. 2000. Economic growth and the environment: Alternatives to the limits paradigm. BioScience 50:433-440.

Davidson, C. 1998. Issues in measuring landscape fragmentation. Wildlife Society Bulletin, 26:32-37.

Shaffer, H. B., R. N. Fisher, and C. Davidson. 1998. The role of natural history collections in documenting species declines. Trends and Reviews in Ecology and Evolution 13:27-30.

Books

Elliot, L., Gerhardt, C. and Davidson, C. 2008. The Frogs and Toads of North America: A comprehensive guide to their identification, behavior and calls. Houghton Mifflin, Boston

Book Chapters

Boone, M.D., C Davidson, and C.M. Bridges. 2009. Evaluating the Impact of Pesticides in Amphibian Declines. In Amphibian Biology Volume 8: Diseases, Parasites, Maladies and Pollution, Heatwole, H. and J. Wilkinson, eds.

Davidson, C. and G. M. Fellers. 2005. Species account: Bufo canorus. Pages 400-401 In Status and Conservation of United States Amphibians. M. J. Lannoo ed. University of California Press, Berkeley.

Vredenberg, V., Fellers, G.M. and C. Davidson. 2005. Species account: Rana muscosa. In Status and Conservation of United States Amphibians. M. J. Lannoo ed. University of California Press, Berkeley.

Audio Publications

Davidson, C. 1995 first edition, 2014 Second edition. Audio field guide to frog and toad calls of the Pacific Coast. CD/Cassette and booklet. Cornell Laboratory of Ornithology, Ithaca, NY.

Davidson, C. 1996. Audio field guide to the frog and toad calls of the Rocky Mountains and Southwest. CD/Cassette and booklet. Cornell Laboratory of Ornithology, Ithaca, NY.

Selected reports

C. Davidson. 2009 Greenhouse Gas Emissions Inventory for Pacifica, California for 2005.Pacifica Climate Committee. pp 11.

Fager, C. and C. Davidson. 2008 Greenhouse Gas Emissions Inventory 1990-2006 for San Francisco State University. Report prepared for the SF State Facilities Department for submission to the American University and College Presidents Climate Commitment. pp 22.

SELECTED RECENT PRESENTATIONS

Climate refuges, climate and the decline of red and yellow legged frogs. Amphibian Diseases annual meeting, Arizona State University, Tempe AZ. 2014

Anuran population declines occur on an elevational gradient in the Western Hemisphere. Amphibian Diseases annual meeting, Arizona State University, Tempe AZ. 2013

Evaluating the pesticide hypothesis for amphibian population declines: Evidence from landscapes to laboratories. Invited symposium talk. World Congress of Herpetology. Vancouver, BC. 2012.

Contaminants and the decline of Cascades Frogs**.** California Nevada Amphibian Populations Task Force, Yosemite Valley, CA 2011.

Are contaminants contributing to the declines of Cascades Frogs in California? California Nevada Amphibian Populations Task Force, Bodega Bay, CA 2009.

Agricultural pesticide drift and amphibians. Agriculture and Air Quality Conference, U.C. Davis, 2008.

Pesticide use and California amphibian declines. Invited talk. Univ. of California, Davis, CA. 2008.

Why are amphibian population declines concentrated in mountains? Invited talk. Sonoma State Univ. Rhonert Park, CA. 2008.

Pesticide use and California amphibian declines. Invited talk. Miami University, Oxford, Ohio. 2006.

Spatial associations between pesticide use and amphibian declines in California. Society for Conservation Biology. San Jose, CA 2006.

TEACHING EXPERIENCE

Professor. 2010-present. Environmental Studies Program. San Francisco State University. Teach: Senior Seminar, Internship, Research Methods, and Applied Local Sustainability courses.

Associate Professor. 2005-2010. Environmental Studies Program. San Francisco State University. Taught Environmental Problems and Solutions, Senior Seminar, Internship, and Campus Sustainability courses.

Assistant Professor. 2000 – 2005. Environmental Studies Department. California State University, Sacramento. Taught Introduction to Environmental Science, Field Methods for Environmental Science, and Senior Thesis.

Invited instructor. January 2004. Graduate short-course for students from Latin and North America titled "Advanced training in amphibian population decline research." Costa Rica.

Instructor. Environmental Analysis, Spring 2000, U.C. Davis. Designed and taught the introductory course for majors in Department of Environmental Science and Policy.

PROFESSIONAL AND CIVIC ACTIVITIES

University Service

Member CHSS elections committee, 2015 – 2018

Chair Environmental Studies faculty search committee, Fall 2015

Director/Program Coordinator Environmental Studies Program, SF State. 2005-2015

Faculty advisor to the ECO-Students student organization SFSU 2005-07; 2011- present.

Member All University Sustainability Committee Fall 2008-2012.

Member Romberg Tiburon director search committee, SF State, 2007.

Reviewer for *Conservation Biology*, *Biological Conservation*, *Ecological Applications*, *Copeia*, *Oecologia*, *Diversity and Distributions*, and *Herpetological Review*.

Community Service

Alternate Advisory Board member, San Mateo County Community Choice Energy, 2015-2016

Co-founder and member Pacifica Climate Committee, Fall 08 – present

Chair, City of Pacifica Climate Action Plan Task Force, 2010 - 2012

Board member Pacifica Land Trust, 2007-2010

SYLLABUS - ENVS 570 Campus Sustainability − Update Jan 18

Instructor:
Carlos Davidson. Office: 332 HSS.
Office Hours: Tuesday 1:30-2:30, Wednesday 10-12, Thursday 1:30-2:30. And by appointment.
Phone 405-2127
Email carlosd@sfsu.edu (put "ENVS570" at start of subject line)
Web page: http://online.sfsu.edu/carlosd

Classroom and Time: Tuesday, Thursday 11:00-12:15, HSS 102.

Final Exam: no final exam, but we will meet Tuesday May 19 10:45-1:15.

Course Description: The catalog description is: Students will learn about current sustainability issues and efforts at universities across the country and at San Francisco State. A major component of course will be completion of a hands-on sustainability project on campus.

The big projects for this section of the course will be on doing building lighting energy efficiency assessments and developing recommendations on a sustainability policy issue for the University Sustainability Committee.

Course objectives:
Give students hands on opportunities to develop skills involved in sustainability work - both technical skills such as those involved in conducting a greenhouse gas inventory as well as organizational, political, and social skills involved in carrying out a sustainability project.

Instructional methods:
A major component of student learning in this course will be student sustainability projects - individual or group - to be carried out by students during the semester. Classroom time will include standard lecture format, in addition, small group discussion, and full class discussions.

Course Materials:
Main texts: Creighton, Sara H. 1998. Greening the ivory tower: improving the environmental track record of universities, colleges and the other institutions. MIT press, Cambridge. (Hence SHC)

And readings on the class ilearn site. See the readings list for reading assignments by topic.

Attendance Policy: Attendance in class is required. Participation is part of the course grade and you can't participate if you don't attend. Furthermore substantial class time will be devoted to activities that cannot be "made up" if they are missed.

Homework assignments. All homework assignments are due at the start of class on the due date. Email submission of assignments will not be accepted. All written assignments must be typed with the exception of reading question assignments which may be handwritten if legible. Late assignments are down graded half a grade for each class period (or fraction thereof) late. The one exception is reading question assignments which are not accepted late. **Last Day to hand-in course assignments: Tuesday May 19 10:45am.**

Electronics policy: No use of electronic gadgets (phones, laptops, ipods, etc) in class. If you need to use a laptop for note taking please talk to me first.

Grading: Grades are based on the following points:

Homework 1 Reading questions (12 total)	120
Homework 2 Hope presentation	25
Homework 3 AASHE bulletin actions	25
Homework 4 Policy Op Ed	75
Homework 5 Water use in bathrooms	75
Homework 6 Lighting assessemnt raw data	50
Homework 6 Lighting assessemnt report	100
Homework 7 GHG inventory written report	75
Homework 8 GHG calculations	25
final paper proposal	50
final paper literature list	25
final paper Part II	25
final paper your review	50
final paper	100
final paper presentation	75
Participation	105
Total Points	1000

Final course grades are based on total points, with 100-90% A, 89-80% B, and 79-70% C. The percentage cutoffs may be adjusted or "curved" downward based on the difficulty of assignments, but they will not be moved upwards.

Plagiarism: Plagiarism is using someone else's work and not giving credit. Plagiarism can consist of either borrowing ideas or borrowing wording or both. If you take a sentence from a source and use it in a paper without quotation marks that is plagiarism. Depending on the seriousness of the case, plagiarism will result in failing an assignment and or being reported to Student Affairs. Please don't plagiarize.

Important Dates: CHSS Withdrawal Policy: The last day to drop a class is <u>February 6, 2015 until 11:59pm.</u> Starting <u>February 7 – April 24, 2015</u> you must submit a withdrawal petition. Withdrawal from a class starting **<u>February 7, 2015</u>** will be considered for *serious and compelling* reasons only and **must have accompanying documentation**. The following reasons are not considered *serious and compelling*: Changing your major, poor performance, class not required for graduation/major, or more time needed for other classes.

If you wish to withdraw from class due to unexpected changes in your work schedule, illness or family emergencies, **documentation will be required**, along with a copy of unofficial transcripts. Submit your petition **within a reasonable timeframe (e.g., within 2 weeks of a change in work hours.)** From **April 25 – May 15, 2015** you may not withdraw from a class or the University, except in the case of a **serious** documented illness or verified accident. Please refer to the following website for further information on withdrawal polices: https://chss.sfsu.edu/advising/

CR/NC Option: The last day to request CR/NC option is March 20, 2015 until 11:59pm. The Associate Dean will not approve requests for changes if you miss this deadline.

Late Add Policy: The period to add classes via permit numbers is January 26 – February 6, 2015. The period to add classes by Exception is February 7 – February 20, 2015. It is your responsibility to procure a late permit number from your instructor and add the class. Faculty cannot add you into a class. Starting **February 21, 2015,** a Waiver of College Regulations form must be signed by your instructor, Chair and CHSS Associate Dean to add. This will be approved only if there was an administrative error.

Check your registration through *SF State Gateway*: Sign up for CR/NC, drop and add classes by the appropriate deadline online through *SF State Gateway*. ALWAYS check your registration after making any changes and BEFORE deadlines to be sure you are registered properly for your classes. Deadlines for all registration procedures, including withdrawals and requests for credit/no credit, are listed in the class schedule and will be strictly adhered to by the instructor, the Department Chair and the Associate Dean of College of Health & Social Sciences. **It is ALWAYS the student's responsibility to ensure their schedule is correct, even if the instructor indicates they will drop you.** This can be viewed on the Registration Calendar at the following website: http://www.sfsu.edu/~admisrec/reg/regsched.html

Disability Programs and Resource Center: Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC, located in SSB 110, can be reached by telephone at 415-338-2472 (voice/TTY) or by e-mail at dprc@sfsu.edu.

ENVS 570 Campus Sustainability
Professor Carlos Davidson Spring 2015

SCHEDULE

Date	Day	Week	Who	Class Topic	Due
27-Jan	Tu	1	Davidson	Course overview, what is sustainability?	
29-Jan	Th	1	Davidson	Sustain. & social justice	
3-Feb	Tu	2	Davidson	Sustainability at SFSU I	RQ (= Reading Question)
5-Feb	Th	2	Nick Kordesch	Sustainability at SFSU II	HW AASHE bulletin
10-Feb	Tu	3	Davidson	Finances 1 - endowments	RQ
12-Feb	Th	3	Jason Schwartz	Students Organizing	HW Water use in bathrooms
17-Feb	Tu	4	Miguel Guerrero	working with ASI	
19-Feb	Th	4	Davidson	Organizing Strategies	HW Policy Op Ed
24-Feb	Tu	5	Davidson	Energy	RQ
26-Feb	Th	5	Davidson	Lighting training	RQ, HW Final paper proposal
3-Mar	Tu	6	Davidson	Sustainability Finances II	RQ
5-Mar	Th	6	Davidson	Sustainability Finances III	
7-Mar	Saturday Field trip to DeAnza college 8:30am-2pm				
10-Mar	Tu	7	Davidson	Climate change I inventories	RQ HW Lighting data
12-Mar	Th	7	Davidson	Climate I cont + GHG calcs in class	Paper literature list
17-Mar	Tu	8	Davidson	Climate action planning	RQ
19-Mar	Th	8	Davidson	Energy tour	HW Lighting report
SPRING BREAK Week of Mar 24					
31-Mar	Tu	9	No class	Cesar Chavez Day	
2-Apr	Th	9	Davidson	Grounds	HW GHG Calcs
7-Apr	Tu	10	Brian Canepa	transportation I	2RQ
9-Apr	Th	10	Jason Porth	Bicycles	HW GHG inventory
14-Apr	Tu	11	Wendy Bloom	transportation II	Paper section II
16-Apr	Th	11	TA	Topic TBA	HW Water use Extra Credit
19-Apr	Sunday Field trip to Packard Net Zero Building 12-5pm				
21-Apr	Tu	12	Davidson	Water	RQ
23-Apr	Th	12	Davidson	Food	RQ
28-Apr	Tu	13	TBA	Food tour	Final Paper (Two copies)
30-Apr	Th	13	Swinford?	SF Dept of Environ.	
5-May	Tu	14	Davidson	work on reviews	Final Paper reviews (2 copies)
7-May	Th	14	TBA	catch up day	
12-May	Tu	15	Davidson	Final presentations	Final presentations
14-May	Th	15	Davidson	Final presentations	
19-May	Tu	Finals	Exam 10:45-1:15	Final exam	10:45am last time to hand in HW

SYLLABUS - ENVS 570 APPLIED LOCAL SUSTAINABILITY

Instructor:
Carlos Davidson. Office: 332 HSS.
Office Hours: Tue 11:15-11:45. Wed 1:15-2:45. Thur 2:30-3pm. And by appointment
Phone 405-2127
Email carlosd@sfsu.edu (put "ENVS570" at start of subject line)
Web page: http://online.sfsu.edu/carlosd

Classroom and Time: Tuesday, Thursday 9:35am-10:50, HSS 102

Final Exam: no final exam, but we will meet Tuesday Dec 20th 8-10:30am.

Course Description: The catalog description is: Students will learn about current sustainability issues and efforts at universities across the country and at San Francisco State. A major component of course will be completion of a hands-on sustainability project on campus.

The big projects for this section of the course will be on building lighting energy efficiency assessments and assessing water use in bathrooms in campus building.

Course objectives:
Give students hands on opportunities to develop skills involved in sustainability work - both technical skills such as those involved in conducting a greenhouse gas inventory as well as organizational, political, and social skills involved in carrying out a sustainability project.

Course Materials:
Main texts: Creighton, Sara H. 1998. Greening the ivory tower: improving the environmental track record of universities, colleges and the other institutions. MIT press, Cambridge. (Hence SHC)

And readings on the class iLearn site. See the readings list for reading assignments by topic.

At**tendance Policy:** Attendance in class is required. A large part of your participation grade is attendance - coming to class, and coming on time. Participation is part of the course grade and you can't participate if you don't attend. Furthermore substantial class time will be devoted to activities that cannot be "made up" if they are missed. Students who miss more than 10 classes receive a zero for participation.

Homework assignments. All homework assignments are due at the start of class on the due date. Email submission of assignments will not be accepted. All written assignments must be typed with the exception of reading question assignments which may be handwritten if legible. Late assignments are down graded half a grade for each class period (or fraction thereof) late up to a maximum of half points off for lateness. Exceptions to the late policy are as follows: reading question assignments, draft water reports, and report reviews are not accepted late. **Last time to hand-in course assignments: Tuesday December 20th 10:00am.**

Weekend Field Trips: There will be one weekend field trips, dates still be arranged.

Electronics policy: No use of electronic gadgets (phones, laptops, ipods, etc) in class. If you need to use a laptop for note taking please talk to me first.

Grading: Course grades are based on the following points:

Reading questions (12 total)	180	GHG calculations exercise	70
Hope presentation	70	Water use in bathrooms raw data	50
AASHE bulletin actions	50	Water use draft report	50
Lighting assessemnt raw data	50	Water use report review	60
Lighting assessemnt report	100	Water use final report	100
GHG inventory written report	70	Participation	150
		Total Points	1000

Final course grades are based on total points, with 100-90% A, 89-80% B, and 79-70% C. The percentage cutoffs may be adjusted or "curved" downward based on the difficulty of assignments, but they will not be moved upwards.

Plagiarism: Plagiarism is using someone else's work and not giving credit. Plagiarism can consist of either borrowing ideas or borrowing wording or both. If you take a sentence from a source and use it in a paper without quotation marks that is plagiarism. Depending on the seriousness of the case, plagiarism will result in failing an assignment and or being reported to Student Affairs. Please don't plagiarize.

Campus and Living Laboratory Grant: The water use projects in the class this semester were developed with funding from the CSU Chancellor's Office Campus as a Living Laboratory grant. The water use project is a collaboration between Carlos Davidson and the SF State Facilities department. Facilities will use the information from student water research projects to aid in campus water use planning, as well as carry out two model bathroom fixture retrofits.

CHSS Withdrawal Policy: The last day to drop a class is <u>September 14, 2016 until 11:59pm.</u> Starting <u>September 15 – November 22, 2016</u> you must submit a paper withdrawal petition. Withdrawal from a class starting **<u>September 15, 2016</u>** will be considered for *serious and compelling* reasons only and **must have accompanying documentation**. The following reasons are **not** considered *serious and compelling*: Changing your major, poor performance, class not required for graduation/major, lacking the pre-requisite, instructor forgot to drop me, not attending class or more time needed for other classes. If you wish to withdraw from class due to unexpected changes in your work schedule, illness or family emergencies, **documentation will be required**, along with a copy of unofficial transcripts. Submit your petition **within a reasonable timeframe (e.g., within 2 weeks of a change in work hours.)** From **<u>November 23 – December 14, 2016</u>** you may not withdraw from a class or the University, except only in the case of a **serious** documented illness or verified accident.

Withdrawals **cannot** be initiated electronically and must be submitted using a paper application. All electronic submissions of withdrawals will be denied automatically by the Associate Dean. **You are only allowed to withdrawal from a maximum of 18 units and take a class no more than 2 times at SF**

State. Approval from the instructor and/or Chair does not constitute automatic approval from the associate dean so continue attending class until a decision is made. Please refer to the following website for further information on withdrawal polices: http://chss.sfsu.edu/src

CR/NC Option: The last day to request CR/NC option is October 19, 2016 until 11:59pm. The Associate Dean will not approve requests for changes if you miss this deadline.

Late Add Policy: The period to add classes via permission numbers is August 24 – September 14, 2016. It is your responsibility to procure a late permission number from your instructor and add the class. Faculty cannot add you into a class. Starting **September 15, 2016,** a Waiver of College Regulations form must be signed by your instructor, Chair and CHSS Associate Dean to add. This will be approved only if there was an administrative error.

Check your registration through *SF State Gateway*: Sign up for CR/NC, drop and add classes by the appropriate deadline online through *SF State Gateway.* ALWAYS check your registration after making any changes and BEFORE deadlines to be sure you are registered properly for your classes. Deadlines for all registration procedures, including withdrawals and requests for credit/no credit, are listed in the class schedule and will be strictly adhered to by the instructor, the Department Chair and the Associate Dean of College of Health & Social Sciences. **It is ALWAYS the student's responsibility to ensure their schedule is correct, even if the instructor indicates they will drop you.** This can be viewed on the Registration Calendar at the following website: http://www.sfsu.edu/~admisrec/reg/regsched2167.html

Disability Programs and Resource Center: Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC is located in the Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email (dprc@sfsu.edu).

Student Disclosures of Sexual Violence: SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the Dean of Students. To disclose any such violence confidentially, contact: **The SAFE Place** - (415) 338-2208; http://www.sfsu.edu/~safe_plc/ **Counseling and Psychological Services Center** - (415) 338-2208;http://psyservs.sfsu.edu/ For more information on your rights and available resources: http://titleix.sfsu.edu

SCHEDULE

What we are doing in class each week, what is due, and what to read

Date	Day	Week	Who	Class Topic	Assignments Due
25-Aug	Th	1	Davidson	Course overview, what is sustainability?	
30-Aug	Tu	2	Davidson	Sustain. & social justice	
1-Sep	Th	2	Davidson	Sustainability at SFSU I	RQ (= Reading Question)
6-Sep	Tu	3	Nick Kordesch	Sustainability at SFSU II	HW AASHE bulletin
8-Sep	Th	3	Davidson	Assessments and STARS	RQ
13-Sep	Tu	4	Davidson	Energy	RQ
15-Sep	Th	4	Davidson	Lighting training	RQ
20-Sep	Tu	5	Davidson	Sustainability Finances part 1	RQ
22-Sep	Th	5	Davidson	Sustainability Finances part 2	
27-Sep	Tu	6	Naftali Moed	Students Organizing 1	
29-Sep	Th	6	Celia Gonzales	Students Organizing 2	HW lighitng data
4-Oct	Tu	7	Davidson	Water	RQ
6-Oct	Th	7	Davidson	Climate change I inventories	RQ
11-Oct	Tu	8	Davidson	Climate I cont + GHG calcs in class	
13-Oct	Th	8	Davidson	Climate action planning	RQ, Lighting report
18-Oct	Tu	9	Davidson	Endowments and Investments	RQ
20-Oct	Th	9		Meet BURKE 229: water analysis	GHG calcs
25-Oct	Tu	10	Davidson	Organizing Strategies	Water data
27-Oct	Th	10	Wendy Bloom	Transportation w Wendy Bloom	RQ
1-Nov	Tu	11	Jason Porth	Trans & Bicycles w Jason Porth	RQ, GHG inventory
3-Nov	Th	11	Pete Costa	transportation w Pete Costa	
8-Nov	Tu	12	Davidson	Help with water projects	
10-Nov	Th	12	Davidson	Food	RQ
15-Nov	Tu	13	Davidson	Energy tour	Draft water reports
17-Nov	Th	13	Swinford	SF Dept of Env. w Sunshine Swinford	
	Fall Recess				
29-Nov	Tu	14	TBA	TBA	water report reviews (2 copies)
1-Dec	Th	14	Davidson	peer review meetings	
6-Dec	Tu	15	Davidson	bottled water	
8-Dec	Th	15	Davidson	Grounds	RQ
13-Dec	Tu	16	Davidson	conclusions	Final water reports
20-Dec	Tu	Finals	8-10:30am	Final meeting 8:00-10:30am	last time to hand in HW: 10am

ENVS 570 Applied Local Sustainability
SFSU, Fall 2016.
Professor Carlos Davidson
Updated Dec 2, 2016

Assignment Water Use in Bathrooms

This document has the following sections

A. Introduction
B. Bathroom water use survey
C. Full building water use reports
D. Peer review instructions – with reviewer assignments
E. Room assignments for bathroom surveys
F. Building assignments for full building water use reports
G. How to use the bathroom water use calculations
H. Instructor provided language for the methods section of full building reports.
I. Instructor provided language for Acknowledgements section

A. Introduction

This assignment is designed to give you hands-on experience working with analysis of water use in buildings. You will be trained on how to assess water use in bathrooms and then assigned two bathrooms in a campus building to assess the water use in fixtures and how many people use the bathroom. Student's assessment data will be combined and input into a water use model to calculate total water use for a number of campus buildings.

Students will be assigned a building, and based on the full building assessment data will write a professional report on water use and potential fixture retrofits. At the end of class these reports will be shared with the campus facilities department.

The assignment has four parts you hand in: raw assessment data for two bathrooms and draft full building reports, peer review of another students building report, and final full building report.

B. Bathroom Water Use Survey

Each of you will be assigned to two bathrooms (see bathroom assignment table below) to survey and gather the following information for each bathroom:

1. Building, floor, room number and gender of your bathroom.
2. Count of the number of sinks, number of toilets and for men's bathrooms number of urinals.
3. Estimates of the gpm (gallons per minute) flow of a faucet done with a flow rate bag and a timer for each faucet in your bathroom (Consider the sink on your far left to be sink number 1, sink 2 next to the right, etc). For each sink take three measurements and average them.
4. Brand of toilets (ok to enter more than one brand).
5. GPF (gallons per flush) if it is printed on the toilet – if not say "not indicated" for each toilet (As with the sinks, consider the toilet on your far left to be toilet number 1, toilet 2 next to the right, etc).

6. Time (in seconds) to flush for each toilet. Time is measured from the moment you flush to when the water in the bottom starts to come up.
7. Brand of urinals (ok to enter more than one brand).
8. GPF (gallons per flush) if it is printed on the urinal – if not say "not indicated" for each urinal (As with the sinks, consider the urinal on your far left to be urinal number 1, urinal 2 next to the right, etc).

9. Two "peak time" counts of the number of people going into your assigned bathroom for exactly five minutes. These counts should be done between classes on Monday-Thursday, between 11am and 3pm. Peak times on Monday and Wednesday are the first ten minutes after the hour - 10-10:10, 11-11:10, 12-12:10, 1:00-1:10 and 2:00-2:10. On Tuesday and Thursday peak times are 9:50-10, 10:50-11, 12:15-12:35, and 1:50-2:10. One of your peak time counts should be in the morning and one in the afternoon. Start your count at least two minutes into the peak time windows.
10. Two "non-peak time" counts of the number of people going into your assigned bathroom for exactly five minutes. These counts should be done between classes on Monday-Thursday, between 10am and 3pm. Non-peak times are any times at least five minutes after or before peak times listed above. One of your non-peak time count should be in the morning and one in the afternoon.

Submit your raw data: Enter all your data in the class water use spreadsheet available on iLearn. Due Oct 25th.

C. Whole Building Bathroom Water Use Report

Complete "Draft" due Nov 15th. Bring a paper copy to class, digital copy to turnitin. No late copies accepted.

Final version due Dec 13th (both in paper and digital via turnitin).

Each of you will be assigned to a specific building to write a professional report on total bathroom water use in the building. Like the lighting reports, these are supposed to be professional reports in terms of content and appearance, and will be shared with Facilities to aid in their water reduction work. You will be provided with a water use calculator spreadsheet for your building with estimated water use for each bathroom in the building based on student survey data.

Your report should be in eight sections: Introduction, methods, current water use, full retrofit analysis, toilets versus urinals retrofit analysis, alternative retrofit analysis, recommendations. The introduction should discuss water use in buildings and the possible benefits of doing bathroom retrofits. You should cite two journal, academic or government sources – not commercial sources (e.g. manufacturers of fixtures). Roughly a single page double spaced in length. For the methods section describe how the bathroom data was collected and how you made any additional calculations. I will provide you a paragraph you can use describing how water use in buildings was calculated and what assumptions were used.

The current water use section should report on your findings on water use in the building. In addition to total water use give breakouts (with totals and percent of building total) for water use in sinks, toilets, and urinals. And what two or four bathrooms had the greatest water use, again give a total water use and percent of building total.

The full retrofit section should present your analysis of replacing all the toilets and urinals in the building with low flow fixtures (fixture details are below). The toilets versus urinals retrofit section should present your analysis of replacing the all the toilets versus replacing all the urinals. In the alternative analysis section you analyze some other subset of bathrooms or subset of fixtures to retrofit, such as just bathrooms on certain busy floors, or just women's bathrooms, etc.

The three analysis sections should each include the following information:

a. both current and after-retrofit annual water use, with total water use and water use broken down for sinks, urinals, toilets.
b. cost calculations: annual cost of water and sewage charge with total and broken down for sinks, toilets and urinals
c. one time cost of retrofit – fixtures and labor costs.
d. retrofit savings in terms of annual water volume saved, and water and sewage costs saved, payback period and cost per 1000 gallons of water saved.

Each analysis section should have its own summary table (See Koefoed lighting report for examples of tables). Place all your tables in the appendix but reference them by number (e.g. (See Table 2) in the text. You should be able read your report and understand it without looking at the tables. Put another way, you have to tell the reader the "story," the tables do not tell the story.

The recommendations section gives your recommendations to SF State Facilities on bathroom retrofits you think the school should do in your building **and why**. Use a summary table for all your alternatives which shows for each total costs, annual water savings in gallons, annual money savings (on water plus sewage), cost per 1000 gallons of water saved, and payback period.

Final reports should be 4 to 6 pages in length (12 point type, double spaced, 1 inch margins all around), not including references cited and the tables appendix.

Part of the grading will be on appearance. Start with the word template used for the lighting assignment and make up your own style by at a minimum changing the format and graphics of the cover page, changing the format for section headings, and changing the style of the footer.

Additional information for analyzing building water use and retrofits.

1. For each building where students collect data there will be an excel water use "calculator" file posted on ilearn. The calculator gives water use in sinks, urinals, and toilets in each bathroom. You will need to add calculations for building totals for various aggregations – totals and percentages by sink, urinal, and toilet, totals and percentages of the building total for the most used bathrooms, etc.

2. Assume a cost of $5.42 per CCF for water and $8.05 per CCF (hundred cubic feet) for sewage for the assignment. So for each gallon flushed in toilet and urinals campus has to pay both the water cost and the sewage cost. This applies to water down the drain in sinks too. Note: 1 CCF = 748.051948 US gallons. Although costs are given here based on CCF, your report should report all usage and costs based on gallons.

3. Assume urinal retrofis are done with this model. There's a link to a spec sheet ($279.71 per urinal, 0.13 gpf)
http://www.faucetdepot.com/faucetdepot/ProductDetail.asp?Product=116944&AffiliateID=GoogleDirectFeed&gclid=CjwKEAiAx4anBRDz6JLYjMDxoQYSJAA4loRmHeOf6yrrA9l5tKyGjHY4HG73wyxZ4p4RF3p_sfwA7hoCfz_w_wcB
For labor: 4 hours per urinal, $40 per hour

4. The retrofit model toilet ($387 per toilet, 1.28 gpf): http://www.sustainablesupply.com/Sloan-WETS2050-1001-High-EfficiencyToilet-1-28-GP-p/w179295.htm?gclid=CjwKEAiAx4anBRDz6JLYjMDxoQYSJAA4loRmEqmDSA9pjk0CVeYS_6DqV2q4fGbssBkauSzqV_PlpRoC7zDw_wcB
For labor: 4 hours per toilet, $40 per hour

D. Peer reviews. Due Nov 29th. Bring TWO paper copies of your reviews to class.

Instructions for peer review comments on water paper drafts

The goals of peer reviews are two-fold. First, is to give useful feedback on the draft project report to the author to help them improve their final report. The second goal is to improve your own ability to evaluate a study, which hopefully you can then apply to your own work. The focus of your evaluation should be on the content of the study. Do NOT worry about grammar or spelling (and don't mark up the report with grammar errors). The questions below are to help you with the evaluation. Type up about a page to page and half of comments. Write in full sentences – not just "yes/no".

1. Introduction: Does it tell the reader fairly quickly and clearly what the study is about. Does it explain why this is something worth studying – why would we maybe want to know this. Or explain what the research is connected to – the larger context? Does the introduction xxx make use literature?

2. Methods: Could someone repeat the study based upon the information in the methods section? Does it tell the reader how water data was collected? Does it use the instructor provided paragraph to explain how water use was calculated?

3. Current water use: Does the section cover include information on water use totals and percent of building total for water use in sinks, toilets, and urinals. Does it report on what two or four bathrooms had the greatest water use?

4. Full retrofit section. Does it clearly and accurately present the costs, water savings and money savings from doing a full toilet and urinal retrofit? Does the section include a table and is the table clear and include the necessary information to understand the retrofit costs and savings? Does the text tell the full story without having to read the table? Are there any corrections you would suggest to the calculations? Does it clearly explain the make and model of the retrofit fixtures? Does it include the following information:

a. both current and after-retrofit annual water use, with total water use and water use broken down for sinks, urinals, toilets.
b. cost calculations: annual cost of water and sewage charge with total and broken down for sinks, toilets and urinals
c. one time cost of retrofit – fixtures and labor costs.
d. retrofit savings in terms of annual water volume saved, and water and sewage costs saved, payback period and cost per 1000 gallons of water saved.

5. Toilet versus urinal retrofit section: Does it clearly and accurately present the costs, water savings and money savings from doing a just toilet retrofits and just urinal retrofit? Answer all the questions for section 5 above.

6. Own retrofit section: Does it clearly and accurately present the costs, water savings and money savings from doing a some other retrofit of the authors choosing such as just toilet retrofits in the women's bathrooms or just high use bathrooms? Answer all the questions for section 5 above.

7. Recommendations. Does the section clearly give recommendations on which of retrofit the author things should be carried out at SF State and why? Does the rationale make sense? Does the section include a summary table for each retrofit option showing total costs, annual water savings in gallons, annual money savings (on water plus sewage), cost per 1000 gallons of water saved, and payback period?

8. Does the paper cite and make use of two journal, academic or government sources (not just websites)?

9. Finally, any other suggestions you might have to help the author improve their paper?

For each paper you reviewed, bring **two** copies of your answers to the questions to class on the due date – one copy for the author and one copy for the instructor.

E. Room Assignments for data collection

The table below gives the **TWO** bathrooms where you are to carry out your assessments. Please check out these rooms ASAP and let me know if there are any problems.

Name	Building	Floor	Room #	Gender
Andaluz,Al	CCSC	Terr		M
Andaluz,Al	SSB	1st	T0102	M
Anderson,Lillebaek	CCSC	Lwr Con	*drew in on floor plan*	U
Anderson,Lillebaek	HUM	5th	T0577	W
Barraza,Edgar	CCSC	Plaza	PL116	M
Barraza,Edgar	SSB	2nd	T0201	M
Bazan-Sakamoto,Nina	CCSC	Lwr Con	B0125	W
Bazan-Sakamoto,Nina	ESP	2nd	T0206A	W
Berg,Serena	CCSC	Lwr Con	B0125	W
Berg,Serena	CCSC	Terr	T135	W
Dodge,Kelly	CCSC	Plaza	PL112	W
Dodge,Kelly	CCSC	Terr	T135	W
Evans-VanHook,Imani	CCSC	Plaza	PL112	W
Evans-VanHook,Imani	CCSC	Rec/Din	SB124	W
Gordon,Sara	CCSC	Rec/Din	SB124	W
Gordon,Sara	ESP	1st	T0103	W
Greenlaw,Anjelica	CCSC	Lwr Con	*drew in on floor plan*	U
Greenlaw,Anjelica	ESP	1st	T0103	W
Hakim,Israel	CCSC	Plaza	PL116	M
Hakim,Israel	SSB	1st	T0102	M
Hanhan,Nadeen	ESP	2nd	T0206A	W
Hanhan,Nadeen	ESP	3rd	T0305	W
Ibarra,Alex	ESP	4th	T0410	W
Ibarra,Alex	SSB	3rd	T0302	W
James,Lilly	ESP	4th	T0410	W
James,Lilly	SSB	2nd	T0202	W
Knapp,Shawna	ESP	5th	T0505	W
Knapp,Shawna	SSB	1st	T0103	W
Lopez Xochi	ESP	3rd	T0305	W
Lopez Xochi	ESP	5th	T0505	W
Marasovich,Gianna	SSB	1st	T0103	W
Marasovich,Gianna	SSB	2nd	T0202	W
Rodarte,Daniel	CCSC	Rec/Din	SB125	M
Rodarte,Daniel	SSB	4th	T0401	M
Sanchez,Alejandro	CCSC	Lwr Con	B0127	M
Sanchez,Alejandro	SSB	3rd	T0301	M
Schulman, Sam	SSB	3rd	T0302	W
Schulman, Sam	SSB	4th	T0402	W
Soden I,Erin	HUM	1st	T0134	U
Soden I,Erin	SSB	4th	T0402	W
Standridge,Rebecca	BUS	3rd	T0332	W
Standridge,Rebecca	HUM	1st	T0134	U
Wong,Veronica	BUS	3rd	T0332	W
Wong,Veronica	HH	3rd	T0314	W

F. Report building assignments

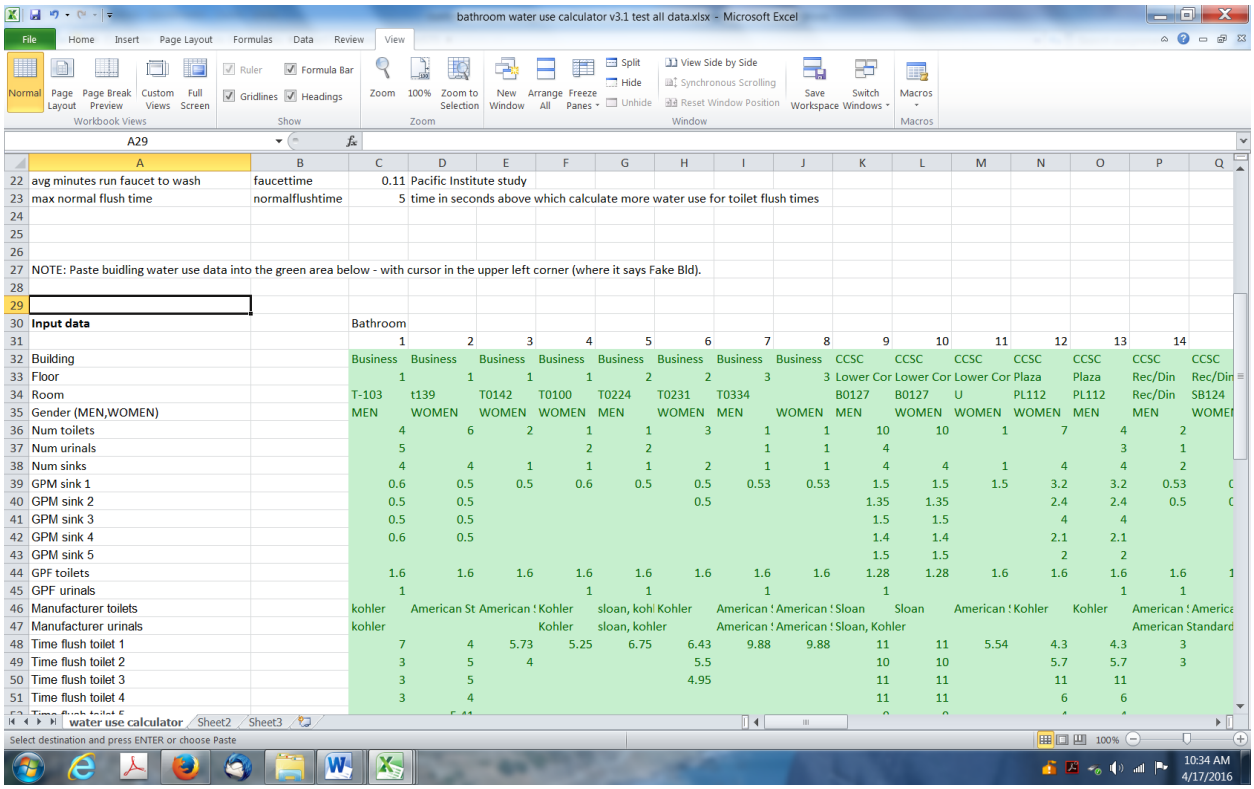
The table below gives the building for which you are to write you final report.

First	Last	Buidling Assignment
Al	Andaluz	Business
Lillebaek	Anderson	SSB
Edgar	Barraza	HSS
Nina	Bazan-Sakamoto	CSSC
Serena	Berg	Ethnic Studies/Psycology
Kelly	Dodge	SSB
Imani	Evans-VanHook	Business
Sara	Gordon	Hensil Hall
Anjelica	Greenlaw	CSSC
Israel	Hakim	Hensil Hall
Nadeen	Hanhan	SSB
Alexandra	Ibarra	CSSC
Elizabeth	James	Ethnic Studies/Psycology
Shawna	Knapp	SSB
Xochitl	Lopez-Torres	Humanities
Gianna	Marasovich	HSS
Miriam	Palma	Humanities
Daniel	Rodarte	Fine Arts
Alejandro	Sanchez	CSSC
Sam	Schulman	Humanities
Erin	Soden	Thornton Hall
Rebecca	Standridge	Thornton Hall
Veronica	Wong	Ethnic Studies/Psycology

G. **Basic steps in using the water use calculator and class survey data (May be updated for Fall 2016)**

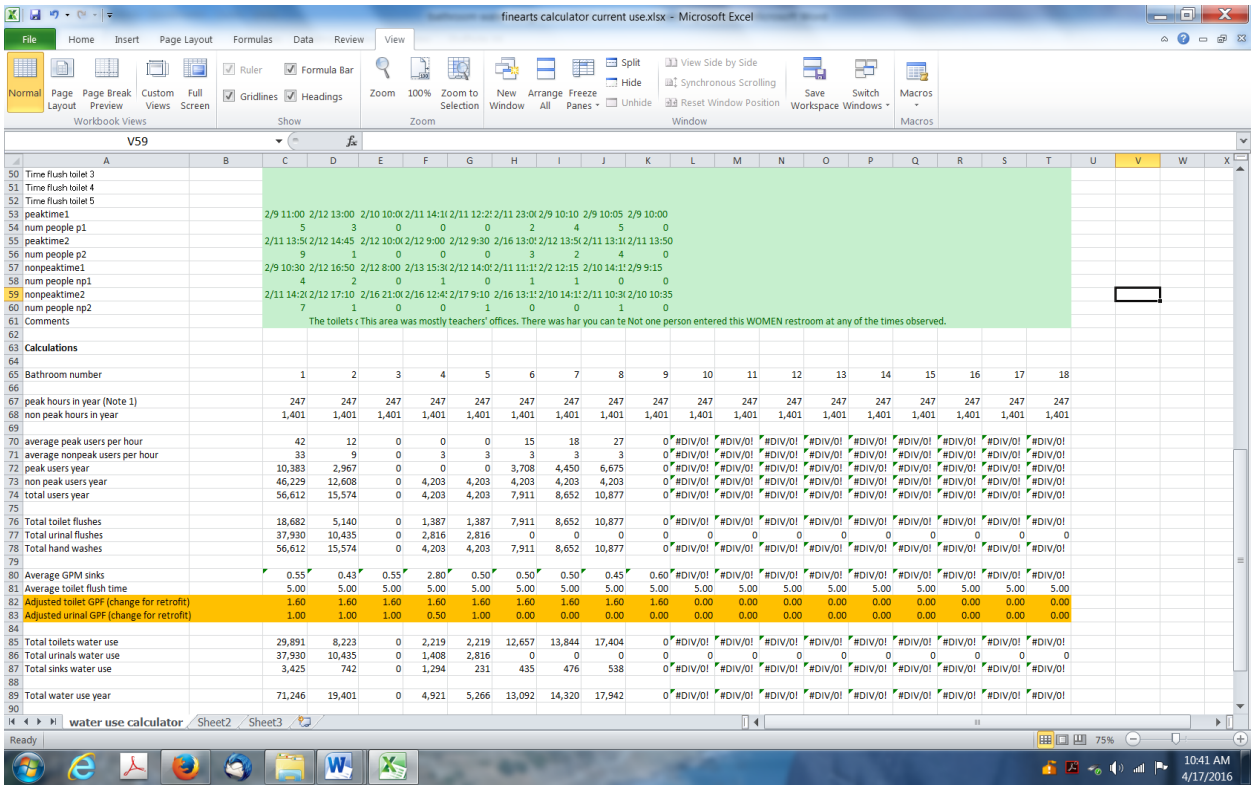
1. Download from ilearn assignment/bathroom water section two spreadsheets: bathroom water use calculator v3.3.xlxs, and the bathroom survey data sp15 f16 to students.xlxs.
2. Make a copy of the calculator spreadsheet and name it for your building and "current use". For example "finearts calculate current use.xlxs".
3. Move data for your building into your current use calculator spreadsheet as follows:

   Open your calculate current use spreadsheet and the bathroom survey data spreadsheet. Find the columns of data for your assigned building in the bathroom survey data spreadsheet (e.g. Fine Arts data in columns BO to BW, rows 4 to 33). Copy the data for your building, and paste it (use paste special and paste only values) into your calculate current use spreadsheet in the upper right corner of the light green area (cell C32).
4. Check that the data you pasted lines up correctly with the names in column A. Your spreadsheet should look like this:



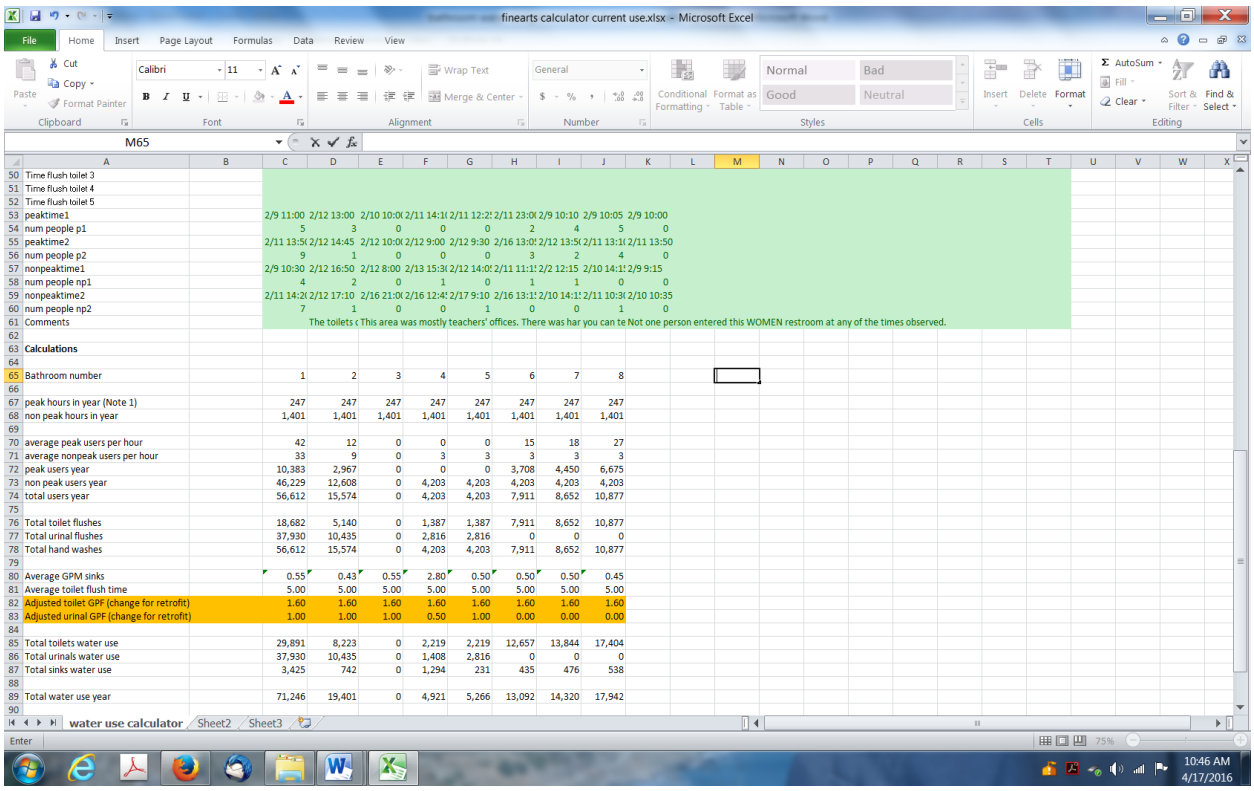
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
22	avg minutes run faucet to wash	faucettime	0.11	Pacific Institute study													
23	max normal flush time	normalflushtime	5	time in seconds above which calculate more water use for toilet flush times													
24																	
25																	
26																	
27	NOTE: Paste buidling water use data into the green area below - with cursor in the upper left corner (where it says Fake Bld).																
28																	
29																	
30	**Input data**		Bathroom														
31			1	2	3	4	5	6	7	8	9	10	11	12	13	14	
32	Building		Business	Business	Business	Business	Business	Business	Business	Business	CCSC	CCSC	CCSC	CCSC	CCSC	CCSC	CCSC
33	Floor		1	1	1	1	2	2	3	3	Lower Cor	Lower Cor	Lower Cor	Plaza	Plaza	Rec/Din	Rec/Din
34	Room		T-103	t139	T0142	T0100	T0224	T0231	T0334		B0127	B0127	U	PL112	PL112	Rec/Din	SB124
35	Gender (MEN,WOMEN)		MEN	WOMEN	WOMEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	WOMEN	WOMEN	MEN	MEN	WOMEN
36	Num toilets		4	6	2	1	1	3	1	1	10	10	1	7	4	2	
37	Num urinals		5			2	2		1	1	4				3	1	
38	Num sinks		4	4	1	1	1	2	1	1	4	4	1	4	4	2	
39	GPM sink 1		0.6	0.5	0.5	0.6	0.5	0.5	0.53	0.53	1.5	1.5	1.5	3.2	3.2	0.53	0
40	GPM sink 2		0.5	0.5				0.5			1.35	1.35		2.4	2.4	0.5	0
41	GPM sink 3		0.5	0.5							1.5	1.5		4	4		
42	GPM sink 4		0.6	0.5							1.4	1.4		2.1	2.1		
43	GPM sink 5										1.5	1.5		2	2		
44	GPF toilets		1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.28	1.28	1.6	1.6	1.6	1.6	1
45	GPF urinals		1			1	1		1		1				1	1	
46	Manufacturer toilets		kohler	American St	American !	Kohler	sloan, kohl	Kohler	American !	American !	Sloan	Sloan	American !	Kohler	Kohler	American !	America
47	Manufacturer urinals		kohler			Kohler	sloan, kohler		American !	American !	Sloan, Kohler					American Standard	
48	Time flush toilet 1		7	4	5.73	5.25	6.75	6.43	9.88	9.88	11	11	5.54	4.3	4.3	3	
49	Time flush toilet 2		3	5	4			5.5			10	10		5.7	5.7	3	
50	Time flush toilet 3		3	5				4.95			11	11		11	11		
51	Time flush toilet 4		3	4							11	11		6	6		

5. The calculator will calculate for you total water use in toilets, urinals, and sinks for each bathroom (rows 85 to 89)
6. To the right of all the bathroom by bathroom totals you can calculate building total water use. You may have to first erase formulas in the calculations row for columns that don't have bathroom data. For example the calculator has formulas built in for 18 bathrooms, if your building has only 8 bathrooms in columns C through J, then there will be a bunch of mess (zeros and #DIV/O!) in the column K through T, rows 67 to 89. You can clear this. For example here is the spreadsheet before clearing the unused formulas:



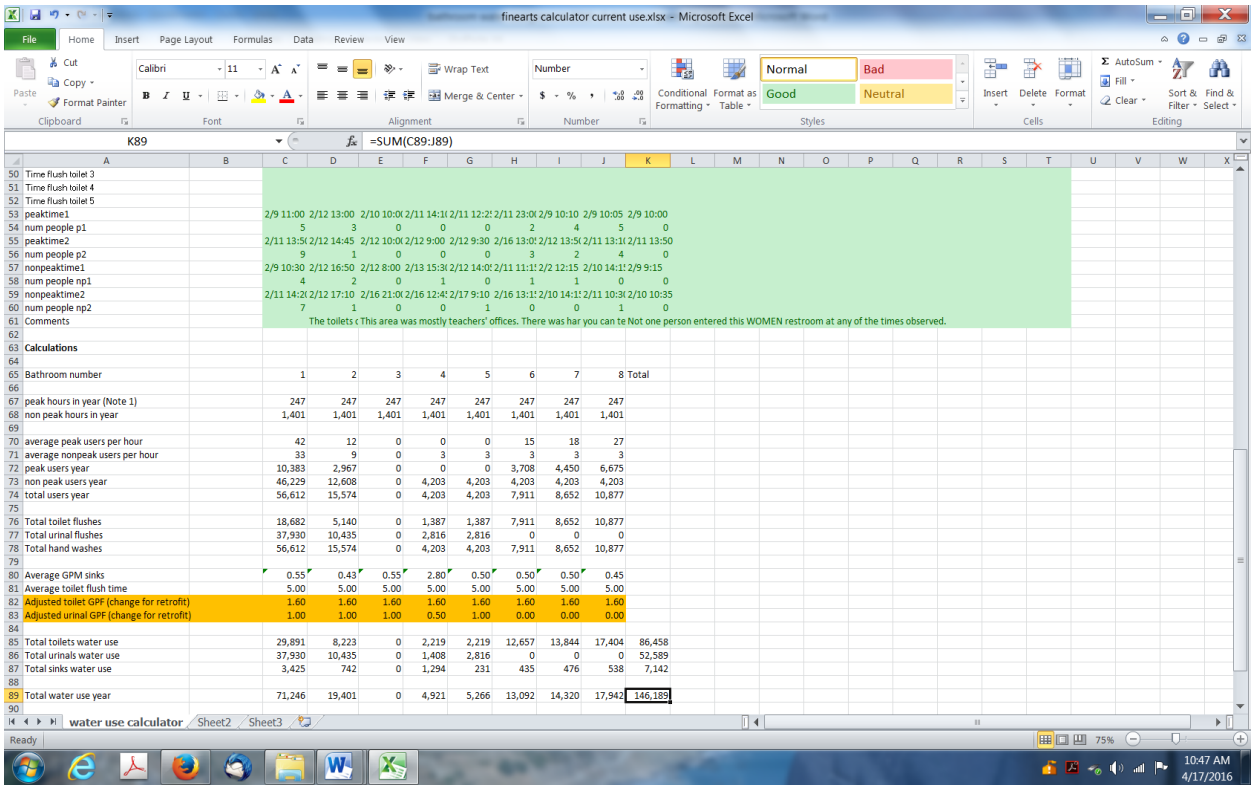
	A	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
50	Time flush toilet 3																		
51	Time flush toilet 4																		
52	Time flush toilet 5																		
53	peaktime1	2/9 11:00	2/12 13:00	2/10 10:0(	2/11 14:1(	2/11 12:2:	2/11 23:0(	2/9 10:10	2/9 10:05	2/9 10:00									
54	num people p1	5	3	0	0	0	2	4	5	0									
55	peaktime2	2/11 13:5(	2/12 14:45	2/12 10:0(	2/12 9:00	2/12 9:30	2/16 13:0:	2/12 13:5(	2/11 13:1(	2/11 13:50									
56	num people p2	9	1	0	0	0	3	2	4	0									
57	nonpeaktime1	2/9 10:30	2/12 16:50	2/12 8:00	2/13 15:3(	2/12 14:0:	2/11 11:1:	2/2 12:15	2/10 14:1:	2/9 9:15									
58	num people np1	4	2	0	1	0	1	1	0	0									
59	nonpeaktime2	2/11 14:2(	2/12 17:10	2/16 21:0(	2/16 12:4:	2/17 9:10	2/16 13:1:	2/10 14:1:	2/11 10:3(	2/10 10:35									
60	num people np2	7	1	0	0	1	0	0	1	0									
61	Comments	The toilets (This area was mostly teachers' offices. There was har you can te Not one person entered this WOMEN restroom at any of the times observed.																	
62																			
63	**Calculations**																		
64																			
65	Bathroom number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
66																			
67	peak hours in year (Note 1)	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247
68	non peak hours in year	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401
69																			
70	average peak users per hour	42	12	0	0	0	15	18	27	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
71	average nonpeak users per hour	33	9	0	3	3	3	3	3	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
72	peak users year	10,383	2,967	0	0	0	3,708	4,450	6,675	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
73	non peak users year	46,229	12,608	0	4,203	4,203	4,203	4,203	4,203	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
74	total users year	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
75																			
76	Total toilet flushes	18,682	5,140	0	1,387	1,387	7,911	8,652	10,877	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
77	Total urinal flushes	37,930	10,435	0	2,816	2,816	0	0	0	0	0	0	0	0	0	0	0	0	0
78	Total hand washes	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
79																			
80	Average GPM sinks	0.55	0.43	0.55	2.80	0.50	0.50	0.50	0.45	0.60	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
81	Average toilet flush time	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
82	Adjusted toilet GPF (change for retrofit)	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	Adjusted urinal GPF (change for retrofit)	1.00	1.00	1.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84																			
85	Total toilets water use	29,891	8,223	0	2,219	2,219	12,657	13,844	17,404	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
86	Total urinals water use	37,930	10,435	0	1,408	2,816	0	0	0	0	0	0	0	0	0	0	0	0	0
87	Total sinks water use	3,425	742	0	1,294	231	435	476	538	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
88																			
89	Total water use year	71,246	19,401	0	4,921	5,266	13,092	14,320	17,942	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
90																			

And here is the spreadsheet after clearing the unused formulas by selecting the cells M65:T89 and then using “clear/all” from the home menu:



	A	C	D	E	F	G	H	I	J	K
50	Time flush toilet 3									
51	Time flush toilet 4									
52	Time flush toilet 5									
53	peaktime1	2/9 11:00	2/12 13:00	2/10 10:0(	2/11 14:1(	2/11 12:2:	2/11 23:0(	2/9 10:10	2/9 10:05	2/9 10:00
54	num people p1	5	3	0	0	0	2	4	5	0
55	peaktime2	2/11 13:5(	2/12 14:45	2/12 10:0(	2/12 9:00	2/12 9:30	2/16 13:0:	2/12 13:5(	2/11 13:1(	2/11 13:50
56	num people p2	9	1	0	0	0	3	2	4	0
57	nonpeaktime1	2/9 10:30	2/12 16:50	2/12 8:00	2/13 15:3(	2/12 14:0:	2/11 11:1:	2/2 12:15	2/10 14:1:	2/9 9:15
58	num people np1	4	2	0	1	0	1	1	0	0
59	nonpeaktime2	2/11 14:2(	2/12 17:10	2/16 21:0(	2/16 12:4:	2/17 9:10	2/16 13:1:	2/10 14:1:	2/11 10:3(	2/10 10:35
60	num people np2	7	1	0	0	1	0	0	1	0
61	Comments	The toilets (This area was mostly teachers' offices. There was har you can te Not one person entered this WOMEN restroom at any of the times observed.								
62										
63	**Calculations**									
64										
65	Bathroom number	1	2	3	4	5	6	7	8	
66										
67	peak hours in year (Note 1)	247	247	247	247	247	247	247	247	
68	non peak hours in year	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	
69										
70	average peak users per hour	42	12	0	0	0	15	18	27	
71	average nonpeak users per hour	33	9	0	3	3	3	3	3	
72	peak users year	10,383	2,967	0	0	0	3,708	4,450	6,675	
73	non peak users year	46,229	12,608	0	4,203	4,203	4,203	4,203	4,203	
74	total users year	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	
75										
76	Total toilet flushes	18,682	5,140	0	1,387	1,387	7,911	8,652	10,877	
77	Total urinal flushes	37,930	10,435	0	2,816	2,816	0	0	0	
78	Total hand washes	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	
79										
80	Average GPM sinks	0.55	0.43	0.55	2.80	0.50	0.50	0.50	0.45	
81	Average toilet flush time	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
82	Adjusted toilet GPF (change for retrofit)	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	
83	Adjusted urinal GPF (change for retrofit)	1.00	1.00	1.00	0.50	1.00	0.00	0.00	0.00	
84										
85	Total toilets water use	29,891	8,223	0	2,219	2,219	12,657	13,844	17,404	
86	Total urinals water use	37,930	10,435	0	1,408	2,816	0	0	0	
87	Total sinks water use	3,425	742	0	1,294	231	435	476	538	
88										
89	Total water use year	71,246	19,401	0	4,921	5,266	13,092	14,320	17,942	
90										

7. To calculate total water use you can use the =Sum(range) formula in excel. For example if you building has 8 bathrooms so you are using cell k89 to calculate total building water use the formula would be =sum(c89:j89)



	A	C	D	E	F	G	H	I	J	K
50	Time flush toilet 3									
51	Time flush toilet 4									
52	Time flush toilet 5									
53	peaktime1	2/9 11:00	2/12 13:00	2/10 10:0(	2/11 14:1(	2/11 12:2:	2/11 23:0(	2/9 10:10	2/9 10:05	2/9 10:00
54	num people p1	5	3	0	0	0	2	4	5	0
55	peaktime2	2/11 13:5(	2/12 14:45	2/12 10:0(	2/12 9:00	2/12 9:30	2/16 13:0:	2/12 13:5(	2/11 13:1(	2/11 13:50
56	num people p2	9	1	0	0	0	3	2	4	0
57	nonpeaktime1	2/9 10:30	2/12 16:50	2/12 8:00	2/13 15:3(	2/12 14:0:	2/11 11:1:	2/2 12:15	2/10 14:1:	2/9 9:15
58	num people np1	4	2	0	1	0	1	1	0	0
59	nonpeaktime2	2/11 14:2(	2/12 17:10	2/16 21:0(	2/16 12:4:	2/17 9:10	2/16 13:1:	2/10 14:1:	2/11 10:3(	2/10 10:35
60	num people np2	7	1	0	0	1	0	0	1	0
61	Comments	The toilets c	This area was mostly teachers' offices. There was har					you can te	Not one person entered this WOMEN restroom at any of the times observed.	
62										
63	**Calculations**									
64										
65	Bathroom number	1	2	3	4	5	6	7	8	Total
66										
67	peak hours in year (Note 1)	247	247	247	247	247	247	247	247	
68	non peak hours in year	1,401	1,401	1,401	1,401	1,401	1,401	1,401	1,401	
69										
70	average peak users per hour	42	12	0	0	0	15	18	27	
71	average nonpeak users per hour	33	9	0	3	3	3	3	3	
72	peak users year	10,383	2,967	0	0	0	3,708	4,450	6,675	
73	non peak users year	46,229	12,608	0	4,203	4,203	4,203	4,203	4,203	
74	total users year	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	
75										
76	Total toilet flushes	18,682	5,140	0	1,387	1,387	7,911	8,652	10,877	
77	Total urinal flushes	37,930	10,435	0	2,816	2,816	0	0	0	
78	Total hand washes	56,612	15,574	0	4,203	4,203	7,911	8,652	10,877	
79										
80	Average GPM sinks	0.55	0.43	0.55	2.80	0.50	0.50	0.50	0.45	
81	Average toilet flush time	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
82	Adjusted toilet GPF (change for retrofit)	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	
83	Adjusted urinal GPF (change for retrofit)	1.00	1.00	1.00	0.50	1.00	0.00	0.00	0.00	
84										
85	Total toilets water use	29,891	8,223	0	2,219	2,219	12,657	13,844	17,404	86,458
86	Total urinals water use	37,930	10,435	0	1,408	2,816	0	0	0	52,589
87	Total sinks water use	3,425	742	0	1,294	231	435	476	538	7,142
88										
89	Total water use year	71,246	19,401	0	4,921	5,266	13,092	14,320	17,942	146,189
90										

8. Once you have calculated total building water use, and separate totals for toilets, urinals and sinks, save and close your spreadsheet.
9. Lets calculate water use for a toilets and urinals retrofit. To analyze water use after a retrofit make a copy of your calculate current use spreadsheet and call it buidlingname calculate retrofit name – for example "finearts calculate toilet urinal retrofit.xlxs"

   Open the retrofit spreadsheet. You can simulate a toilet or urinal retrofit by changing the gallons per flush values in rows 82 and 83. For example to make all the toilets 1.28 GPF just enter 1.28 in all the cells in row 82. Once you do this the calculator will recalculate all the individual bathroom water use totals and the full building totals.
10. Now you are ready to analyze water savings and the finances of a retrofit. Make a spreadsheet like you did for the lighting report but this time for water. We did this in class – see the file "Example bathroom retrofit analysis" on ilearn (assignment/bathroom water section) for a picture of an example spreadsheet. You can enter the total water use numbers for toilets, urinals and sinks from calculate current use spreadsheet, and from your calculate retrofit spreadsheet.
11. To figure out the cost of the retrofit you will need to know the total number of toilets or urinals to be replaced. You can find that in rows 36 and 37 of the calculate current use spreadsheet.

F. Instructor provided language for the methods section of building water reports

Write your own paragraph on how data on sink GPM, toilets and urinals GPF, and flush times were collected.

And use the following two paragraphs in your report:

Bathroom usage was measured as the number of people entering the bathroom in four five minute periods. Two of the periods were during "peak time" between classes on Monday-Thursday, between 11am and 3pm. Peak times on Monday and Wednesday are the first ten minutes after the hour: 10-10:10, 11-11:10, 12-12:10, 1:00-1:10 and 2:00-2:10. On Tuesday and Thursday peak times are 9:50-10, 10:50-11, 12:15-12:35, and 1:50-2:10. Two counts were in "non-peak time" Monday-Thursday, between 10am and 3pm and at any times at least five minutes after or before peak times. For each bathroom one of the peak and one of the non-peak time counts was in the morning and one in the afternoon.

Water use in bathrooms was calculated from student survey data using the ENVS 570 Bathroom water use calculator v3.2. As inputs the calculator used survey data on each bathroom's faucet gallons per minute for each faucet, toilet and urinal gallons per flush for each toilet and urinal, toilet flush times, and bathroom usage. The bathroom water use calculator estimated annual bathroom water use for each bathroom based on the following assumptions. In a day there were assumed to be 1.5 hours of peak time usage and 8.5 hours of non-peak usage. Bathrooms were assumed to be used for 160 days in the Spring and Fall semesters and 50 days in Summer. Weekend and usage between spring, fall and summer sessions was not accounted for. Summer usage was scaled to Fall and Spring semester usage based on the ratio of summer full time equivalent enrollment (2,284 FTE Summer 2015) to Fall and Spring average full time equivalent enrollment (23,746 FTE 2014-15 academic year). Men using bathrooms are assumed to use the urinal 66% of the time and the toilet 34% percent. Bathroom users were assumed to wash their hands with the water on for 0.11 minutes (this average takes account of the 45% of users who are assumed not to wash hands). Water use in toilets was calculated based on the nominal gallons per flush for the fixture (e.g., 1.6 GPF – gallons per flush) and surveyed flush time. A toilet in good working order should flush is approximately 4 seconds. For flush times greater than 5 seconds, actual toilet GPF was calculated as nominal GPF multiplied by the ratio of measured flush time to 5 seconds. For example if the nominal GPF was 1.6 and flush time was 10 seconds then actual gallons per flush was calculated as 1.6 GPF x (10 sec/5 sec) = 3.2 GPF.

I Instructor provided language for Acknowledgements section

This report was written for the course Environmental Studies 570 Applied Local Sustainability in Fall 2016 taught by Professor Carlos Davidson. Water use reports were made possible in part due to a CSU Chancellor's Office Campus as a Living Laboratory grant to Professor Carlos Davidson, Caitlin Steele, Director of Sustainability & Energy, Nick Kordesch, Sustainability Coordinator, and Charles Meyer, then Senior Director Facilities & Service Enterprises.

The report draws upon water assessment work done by the following students: Al Andaluz, Lillebaek Anderson, Edgar Barraza, Nina Bazan-Sakamoto, Serena Berg, Kelly Dodge, Israel Hakim, Alexandra Ibarra, Lily James, Shawna Knapp, Xochitl Lopez-Torres, Miriam Palma, Daniel Rodarte, Alejandro Sanchez, Sam Schulman, Erin Soden, Rebecca Standridge, Veronica Wong, Ricardo Arias, David Ayala, Darien Casimiro, Philip Chau, Steven Childs, Brandon Chiu, Ellie Chung, Rachael Costello, Monica DiLullo, Tom Evans, Devin Foster, Cory Goldstein, Amanda Jimenez, Cristal Juarez, Natalie Lazard, Hop Le, Ariana Lease, Kimberly Long, Layla Luna, Timothy Maniquis, Ariane Marshall, Chanel Nagra, Nina Omomo, Miriam Palma, Ambar Ramirez, Austin Robertson, Liz Salazar, Caryn Stark, Paige Wenzel, Michael Yang, Julia Beitel, Abigail Black, Cayley Camarillo, Dennis Chang, Rachel DeLuca, Carl Dresel, Matt Espinoza, Andrew Flohr, John Flynn, Matt Guglielmo, Ori Hartenstein, Ria Howell, Yin Htin, Kelly Jertberg, Chris Jones, Monisha Kaur, Simran Kaur, Soojin Kwon, John Malec, Audrey McNamara, Shelby Molini, Blanca Morales, Jose Negrete, Kelsey Rawlings, Nicholas Rilovich, Amir Sahit, Everett Santana, Daniel Soberanis, Tyler Struthers, Suzy Syers, Faraz Tajik, Claudia Vergara, Jamie Xiong, and Kenix Yu.

Professor Carlos Davidson wishes to acknowledge the following people who helped with the development of the class bathroom water retrofit project: Nick Kordesch, Caitlin Steele, and Sue Tensfeldt and Julie Ortiz of the San Francisco Public Utilities Commission.

San Francisco State University

2016 Bathroom Water Survey

Fine Arts Building

Drafted by Lillebaek Anderson
November 2016

Table of Contents

Introduction

In 2013-2014 San Francisco State University used around 80 million gallons of water, and a vast amount of the annual water usage is in restrooms. According to the EPA (2016) bathrooms are the largest source of the average American's water use, and in schools 45% of water use is from restrooms. This report will examine the current state of restrooms in the Fine Arts Building at SFSU and will provide several retrofit scenarios and benefits. Switching from higher volume old toilets to new 1.28 gallons per flush toilets can save a school about 15% in water use (Center for Environmental Education, 2008), which not only reduces the amount of water purchased, but reduces the amount of sewage the school has to pay for.

A case study, performed by the EPA, of the Holiday Inn San Antonio International Airport Hotel in Texas showed that after the hotel switched around 400 high-flow toilets to low-flow (1.1 GPF), they saved around $68,000 a year and 7 million gallons of water (EPA, 2014). Closer to home, in 2014 CSU East Bay published a Water Conservation plan that featured current projects taking place, one of which was retrofitting their bathrooms with 1.28 GPF toilets in five of their highest used buildings, and plan to keep replacing old toilets with low-flow (López-Muñoz, T. Evelyn et al., 2014). Additionally, CSU Channel Islands has retrofitted all their bathrooms with low-flow 1.6 GPF and 1.28 GPF toilets and 99% of their urinals are water free because they are very committed to meeting the mandated state water reduction (Barsley, Colleen et al., 2015). Retrofitting bathrooms with low-flow toilets is not a new phenomenon, all over the state and country people are replacing toilets with the lowest water use models they can find, partly to save money and partly because of our need to reduce our water use.

Methods

In the Fine Arts Building I collected my data in the Men and Women's bathrooms by first looking at the toilet and urinal fixture brands and GPF, if listed. Starting with the toilet farthest to the left, I marked this as toilet 1 and worked right, and timed how long the toilet flushed from the moment I pushed the handle to when water began to flow back into the toilet. I did this three times per toilet, recording all times and after averaging each toilet flush time. I did the same for the urinals, the farthest to the left was urinal 1 and worked right, and assumed that each urinal flushed one gallon per flush. To measure the sinks' GPM I also made the sink farthest to the left sink 1 and worked right. I had a flow rate bag that I put over the sink nozzle and for 5 seconds I turned the sink faucet on full flow speed and did this three times per sink, averaging each sink time after.

Bathroom usage was measured as the number of people entering the bathroom in four five minute periods. Two of the periods were during "peak time" between classes on Monday-Thursday, between 11am and 3pm. Peak times on Monday and Wednesday are the first ten minutes after the hour: 10-10:10, 11-11:10, 12-12:10, 1:00-1:10 and 2:00-2:10. On Tuesday and Thursday peak times are 9:50-10, 10:50-11, 12:15-12:35, and 1:50-2:10. Two counts were in "non-peak time" Monday-Thursday, between 10am and 3pm and at any times at least five minutes after or before peak times. For each bathroom one of the peak and one of the nonpeak time counts was in the morning and one in the afternoon.

Water use in bathrooms was calculated from student survey data using the ENVS 570 Bathroom water use calculator v3.2. As inputs the calculator used survey data on each bathroom's faucet gallons per minute for each faucet, toilet and urinal gallons per flush for each toilet and urinal, toilet flush times, and bathroom usage. The bathroom water use calculator

estimated annual bathroom water use for each bathroom based on the following assumptions. In a day, there were assumed to be 1.5 hours of peak time usage and 8.5 hours of non-peak usage. Bathrooms were assumed to be used for 160 days in the Spring and Fall semesters and 50 days in Summer. Weekend and usage between spring, fall and summer sessions was not accounted for. Summer usage was scaled to Fall and Spring semester usage based on the ratio of summer full time equivalent enrollment (2,284 FTE Summer 2015) to Fall and Spring average full time equivalent enrollment (23,746 FTE 2014-15 academic year). Men using bathrooms are assumed to use the urinal 66% of the time and the toilet 34% percent. Bathroom users were assumed to wash their hands with the water on for 0.11 minutes (this average takes account of the 45% of users who are assumed not to wash hands). Water use in toilets was calculated based on the nominal gallons per flush for the fixture (e.g., 1.6 GPF – gallons per flush) and surveyed flush time. A toilet in good working order should flush is approximately 4 seconds. For flush times greater than 5 seconds, actual toilet GPF was calculated as nominal GPF multiplied by the ratio of measured flush time to 5 seconds. For example, if the nominal GPF was 1.6 and flush time was 10 seconds then actual gallons per flush was calculated as 1.6 GPF x (10 sec/5 sec) = 3.2 GPF.

Current Water Use

There are currently 8 bathrooms, 2 on each floor, with one male and one female in the Fine Arts Building. The total water use for this building is around 272,664 gallons per year, 215,086 gallons from toilets (79%), 49,856 gallons from urinals (18%), and 7,722 gallons from sinks (3%). This large amount of water use is partly from most of the toilets flushing longer than normal, ranging from 7 seconds to 15 seconds. The men’s bathroom on Floor 2 is using more

water than it should for how little volume it receives because the toilet flushes for 15 seconds and could easily be adjusted. The same goes for both men and women's bathrooms on floors 3 and 4 which also receives lighter traffic but all toilets are flushing 8-9 seconds per flush. The two bathrooms that have the highest use in the building are the men and women's bathroom on Floor 1. These bathrooms have an average peak user per hour of 24 men and 30 women and non-peak user times of 18 (men) and 9 (women), using about 16% of building water use 44,490 gallons per year (men) and 15% of building water use 41,652 gallons per year (women).

Full Retrofit

A possible retrofit for this building would be to do a full fixture retrofit of all the toilets and urinals with the low-flow Sloan 1.28 GPF toilet and the Sloan .13 GPF urinal (see Table 1). Currently the building uses 272,664 gallons of water per year but a full retrofit would drop the usage down to 127,591 gallons per year, which is 47% less water used. The annual cost of the total current water use is $4,913, $1,979 for water and $2,315 for sewage and with the retrofit would decrease to $2,299 total water use cost, with $926 from water and $1,373 from sewage. The toilet water usage would decrease from 215,086 gallons to 113,388 gallons and would take the total cost of toilet water from $3,876 to $2,043, with water cost moving from $1,561 to $823 and sewage cost from $2,315 to $1,220. The urinals drastically decrease in water use and cost when doing the retrofit: currently 49,856 gallons costing $898 total, $362 water and $537 sewage, and dropping to 6,481 gallons costing only $117 total with $47 for water and $70 for sewage. The sinks would not be retrofitted and usage would remain at 7,722 gallons annually costing $139 total with $56 in water and $83 for sewage.

The one time retrofit cost would be $15,269, with $6,840 in labor cost and $8,429 in fixture cost. The retrofit would annually save 145,073 gallons of water saving $1,053 in water cost and $1,561 in sewage cost ($2,614 total). The project would take around 6 years to pay back but would have a moderate cost of $105 dollars per 1000 gallons of water saved.

Toilet vs Urinal Retrofit

Another possible retrofit would be to either replace all the toilets in the building, or replace all the urinals. Looking at replacing all the toilets first (see Table 2), we once again go back to our current total annual water use of 272,664 gallons which with the new Sloan 1.28 GPF toilets would be reduced to 170,966 gallons per year. The cost would drop from $4,961 total ($1,979 for water and $2,315 for sewage) to $3,081 total cost of water ($1,241 for water and $1,840 for sewage). The Sloan toilets would only be using 113,388 gallons of water (215,086 current) costing $2,043 total, with water cost dropping to $823 and sewage cost dropping to $1,220. The urinals would still be using the current amount of water, 49,856 gallons per year costing $898, water costing $362 and sewage costing $537. The sinks would also remain the same at 7,722 gallons annually costing $139 total with $56 in water and $83 for sewage. The one time retrofit would cost $11,752, $6,192 in fixtures and $5,560 for labor costs. It would save 101,698 gallons annually and saving a total of $1,833 in water cost, $738 in water cost and $1,094 in sewage cost. This retrofit would pay itself back in 6 years and would only cost $116 dollars per 1000 gallons of water saved annually.

The other possibility is only replacing the urinals with the Sloan .13 GPF urinals (see Table 3). Switching to this new model would reduce total water use of the building from 272,664 to 229,289 gallons annually and would cost $4,132, ($1,664 in water and $2,467 for sewage)

instead of $4,961 total ($1,979 for water and $2,315 for sewage). The Sloan urinals would be using considerably less water (6,481 gallons) than previously (49,856 gallons) and would cost $117 for total water use, $47 for water and $70 for sewage, rather than $898 total ($362 water and $537 sewage). While the Sloan urinals would be saving a large amount of water, the toilets would stay the same and would be using 215,086 gallons a year, costing $3,876 total and $1,561 for water and $2,315 for sewage. The sinks, again, would remain the same at 7,722 gallons annually costing $139 total with $56 in water and $83 for sewage. The urinal retrofit cost would be cheaper than the toilet retrofit because it would be $3,517 total with $2,237 for fixtures and $1,280 in labor costs. This makes the payback time faster, 4 years, and also decreasing the cost per 1000 gallons used to $81 but only saves 43,375 gallons of water a year.

Alternative Retrofit

An alternative retrofit to the previous possibilities would be to only retrofit the first floor bathrooms of the Fine Arts Building (see Table 4) because of the higher traffic compared with the rest of the building. These bathrooms have an average peak user per hour of 24 men and 30 women and non-peak user times of 18 (men) and 9 (women), using about 16% of building water use 44,490 gallons per year (men) and 15% of building water use 41,652 gallons per year (women). This would mean retrofitting both the men and women's bathrooms with Sloan 1.28 GPF toilets and Sloan .13 GPF urinals.

Looking at the first floor bathrooms currently, they use a total of 86,141 gallons annually ($1,552 in cost), 62,468 gallons from toilets ($1126), 20,870 gallons from urinals ($376), and 2,803 gallons from sinks ($51). Using the new models, the water use and cost would decrease by over 50% to 44,304 gallons per year, costing $798. Toilet water use would decrease to 38,788

gallons costing $699 annually ($282 for water, $417 for sewage), urinal water use would drastically decrease to 2,713 gallons costing only $49 ($20 for water, $29 for sewage), but sinks would be left the same at 2,803 gallons costing $51 ($20 for water, $30 for sewage). The total cost for retrofitting would be $2,747, $2,107 for fixtures and $640 for labor and would be paid back in 4 years. The project would save 41,837 gallons of water annually and would only cost $66 for every 1000 gallons of water saved.

Recommendations

The retrofit that I suggest for Facilities to perform on the Fine Arts Building is the Alternative Retrofit (see Table 4) with maintenance to the other toilets in the building. While a full retrofit would best, I think that because these two bathrooms receive such a higher amount of traffic than the rest that just these two should be retrofitted. The other bathrooms in the building only have high usage because their flush times are too high, and with adjustments to this I think their water use will drastically decrease and become more normal.

This retrofit option saves almost as much as replacing all the urinals in the building, 41,837 gallons for Floor 1 vs 43,375 gallons for full urinal retrofit, but is cheaper upfront ($2,474 vs $3,517) and has a lower cost per 1000 gallons of water saved. This savings of retrofitting Floor 1 also does not factor in maintenance of the rest of the building fixtures which would then make this retrofit save even more water and money annually than full urinal retrofit. Looking at the dynamics of the building use and the data gathered I believe that only a Floor 1 total bathroom retrofit would be sufficient in saving money and water, as long as other toilets are maintained properly in the rest of the Fine Arts Building.

Acknowledgements

This report was written for the course Environmental Studies 570 Applied Local Sustainability in Fall 2016 taught by Professor Carlos Davidson. Water use reports were made possible in part due to a CSU Chancellor's Office Campus as a Living Laboratory grant to Professor Carlos Davidson, Caitlin Steele, Director of Sustainability & Energy, Nick Kordesch, Sustainability Coordinator, and Charles Meyer, then Senior Director Facilities & Service Enterprises.

The report draws upon water assessment work done by the following students: Al Andaluz, Lillebaek Anderson, Edgar Barraza, Nina Bazan-Sakamoto, Serena Berg, Kelly Dodge, Israel Hakim, Alexandra Ibarra, Lily James, Shawna Knapp, Xochitl Lopez-Torres, Miriam Palma, Daniel Rodarte, Alejandro Sanchez, Sam Schulman, Erin Soden, Rebecca Standridge, Veronica Wong, Ricardo Arias, David Ayala, Darien Casimiro, Philip Chau, Steven Childs, Brandon Chiu, Ellie Chung, Rachael Costello, Monica DiLullo, Tom Evans, Devin Foster, Cory Goldstein, Amanda Jimenez, Cristal Juarez, Natalie Lazard, Hop Le, Ariana Lease, Kimberly Long, Layla Luna, Timothy Maniquis, Ariane Marshall, Chanel Nagra, Nina Omomo, Miriam Palma, Ambar Ramirez, Austin Robertson, Liz Salazar, Caryn Stark, Paige Wenzel, Michael Yang, Julia Beitel, Abigail Black, Cayley Camarillo, Dennis Chang, Rachel DeLuca, Carl Dresel, Matt Espinoza, Andrew Flohr, John Flynn, Matt Guglielmo, Ori Hartenstein, Ria Howell, Yin Htin, Kelly Jertberg, Chris Jones, Monisha Kaur, Simran Kaur, Soojin Kwon, John Malec, Audrey McNamara, Shelby Molini, Blanca Morales, Jose Negrete, Kelsey Rawlings, Nicholas Rilovich, Amir Sahit, Everett Santana, Daniel Soberanis, Tyler Struthers, Suzy Syers, Faraz Tajik, Claudia Vergara, Jamie Xiong, and Kenix Yu.

Professor Carlos Davidson wishes to acknowledge the following people who helped with the development of the class bathroom water retrofit project: Nick Kordesch, Caitlin Steele, and Sue Tensfeldt and Julie Ortiz of the San Francisco Public Utilities Commission.

Appendix

Table 1

		Summary Table of Full Retrofit				
				Current		**Retrofit**
Total Annual Cost				$4,913		$2,299
Total Toilet Cost				$3,876		$2,043
Total Urinal Cost				$898		$117
Total Sink Cost				$139		$139
Annual Water Savings (gallons)				n/a		145,073
Annual Money Savings Water				n/a		$2,614
Cost per 1000 gallons saved				n/a		$105
Payback Period (years)				n/a		6

Table 2

		Summary Table of Toilet Retrofit				
				Current		**Retrofit**
Total Annual Cost				$4,913		$3,081
Total Toilet Cost				$3,876		$2,043
Total Urinal Cost				$898		$898
Total Sink Cost				$139		$139
Annual Water Savings (gallons)				n/a		101,698
Annual Money Savings Water				n/a		$1,833
Cost per 1000 gallons saved				n/a		$116
Payback Period (years)				n/a		6

Table 3

		Summary Table of Urinal Retrofit				
				Current		**Retrofit**
Total Annual Cost				$4,913		$4,132
Total Toilet Cost				$3,876		$3,876
Total Urinal Cost				$898		$117
Total Sink Cost				$139		$139
Annual Water Savings (gallons)				n/a		43,375
Annual Money Savings Water				n/a		$782
Cost per 1000 gallons saved				n/a		$81
Payback Period (years)				n/a		4

Table 4

		Summary Table of Alternative Retrofit				
				Current		**Retrofit**
Total Annual Cost				$1,552		$789
Total Toilet Cost				$1,126		$699
Total Urinal Cost				$376		$49
Total Sink Cost				$51		$51
Annual Water Savings (gallons)				n/a		41,837
Annual Money Savings Water				n/a		$754
Cost per 1000 gallons saved				n/a		$66
Payback Period (years)				n/a		4

Complete Data Set

Water Calculations Current vs Retrofit						
Assumptions						
Descriptions	**Values**					
Number of Toilets	16					
Number of Urinals	8					
Number of Gallons per CCF	748.051948					
Price per CCF of water	$5.42					
Price per CCF of Sewage	$8.05					
Price per gallon of water	0.007258854					
Price per gallon of sewage	0.010761285					
Price per retrofit Toilet 1.28 GPM	$387					
Labor hours to install toilet	4					
Price per retrofit Urinal .13 GPM	$279.71					
Labor hours to install urinal	4					
Retrofit Calculations						
	Current use	**Retrofit 1: 1.28 GPM Toilets**	**Retrofit 2: .13 GPM Urinals**	**Retrofit 3: Urinals and Toilets**	**Current Use Floor 1 Bathrooms**	**Retrofit 4: Floor 1 Bathrooms**
Annual toilet water use (gallons)	215,086	113,388	215,086	113,388	62,468	38,788
Annual urinal water use (gallons)	49,856	49,856	6,481	6,481	20,870	2,713
Annual sink water use (gallons)	7,722	7,722	7,722	7,722	2,803	2,803
Annual total water use (gallons)	272,664	170,966	229,289	127,591	86,141	44,304
Annual Water Cost Toilets	$1,561	$823	$1,561	$823	$453	$282
Annual Sewage Cost Toilets	$2,315	$1,220	$2,315	$1,220	$672	$417
Annual Total Cost Toilets	$3,876	$2,043	$3,876	$2,043	$1,126	$699
Annual Water Cost Urinals	$362	$362	$47	$47	$151	$20
Annual Sewage Cost Urinals	$537	$537	$70	$70	$225	$29
Annual Total Cost Urinals	$898	$898	$117	$117	$376	$49
Annual Water Cost Sink	$56	$56	$56	$56	$20	$20
Annual Sewage Cost Sink	$83	$83	$83	$83	$30	$30
Annual Total Cost Sink	$139	$139	$139	$139	$51	$51
Annual Water Cost	$1,979	$1,241	$1,664	$926	$625	$322
Annual Sewage Cost	$2,934	$1,840	$2,467	$1,373	$927	$477
Annual Total Cost	$4,913	$3,081	$4,132	$2,299	$1,552	$798
Annual Toilet water Savings (gallons)	N/A	101,698	0	101,698	N/A	23,680
Annual Urinal water Savings (gallons)	N/A	0	43,375	43,375	N/A	18,157
Annual Sink water Savings (gallons)	N/A	0	0	0	N/A	0
Annual Total Water Savings	N/A	101,698	43,375	145,073	N/A	41,837
Annual Water Cost Savings	N/A	$738	$315	$1,053	N/A	$304
Annual Sewage Cost Savings	N/A	$1,094	$467	$1,561	N/A	$450
Annual Total Cost Savings	N/A	$1,833	$782	$2,614	N/A	$754
Retrofit Materials Cost	N/A	$6,192	$2,237	$8,429	N/A	$2,107
Labor Hours to Install Retrofit	N/A	64	32	96	N/A	16
Total Labor Cost	N/A	$5,560	$1,280	$6,840	N/A	$640
Total Retrofit Cost	N/A	$11,752	$3,517	$15,269	N/A	$2,747
Years to Pay Back (total retrofit cost/annual saving)	N/A	6	4	6	N/A	4
Cost Per 1000 Gallons Saved	N/A	$116	$81	$105	N/A	$66

Works Cited

Barsley, Colleen, et al. (2015). FY 14-15 Sustainability Annual Report. CSU Channel Islands. Retrieved November 12, 2016 from http://www.csuci.edu/fs/sustainability/annualreport2014-2015.pdf

Center for Environmental Education. (2008). Water. Unity College. Retrieved November 12, 2016 from http://www.ceeonline.org/greenGuide/water/WaterIntro.aspx

EPA. (2014). Hotel Installs Water-Efficient Sanitary Equipment. Water Sense. Retrieved November 12, 2016 from https://www3.epa.gov/watersense/docs/ci_casestudy_holidayinnsanantonioairport_508.pdf

EPA. (2016). Indoor Water Use in the United States. Water Sense. Retrieved November 12, 2016 from https://www3.epa.gov/watersense/pubs/indoor.html

López-Muñoz, Evelyn T, et al. (2014). Water Conservation Plan. CSU East Bay.

Student Services Building Water Report

Looking at Water Usage in Bathrooms

Kelly Dodge

Envs 570-01 Applied Local Sustainability

November 8, 2016

TABLE OF CONTENTS

INTRODUCTION

In this water report, I am going to be analyzing three different retrofit situations that could be implemented in the Student Services building and recommend which option is the best for San Francisco State considering both water saved and the finical impacts of the project. Water conservation efforts have taken place in a wide range of campuses in California. At UCSB, the graduate students have developed a water action plan, stating "Under the guidance of the plan, UCSB has already committed $48,000 to new water conservation measures including retrofits to inefficient bathroom fixtures and the installation of new water meters. These two projects alone are expected to provide water savings of 23 Mgal per year with a cost payback of less than one year." (Green Building Research Center 2013) UCSB has not only committed to replacing old fixtures but improving their metering system as well. The least San Francisco State can do is retrofit inefficient fixtures in bathrooms. Water efficiency measures are also taking place at UCSF, which mainly focused on water use in labs. The best strategy that was used at UCSF was stated as, "Team members approached the project from the standpoint of both water conservation and cost savings in order to gain broad support." (Green Building Research Center 2014) While payback period is an important factor in deciding whether SFSU moves forward with a project, we can use the water saved to rally other support such as done at UCSF. The whole goal of a retrofit should be to save water and limit our impact on the environment, especially in a state like California where drought has been so prevalent. Money saved ideally should just be a bonus to reducing San Francisco State's water footprint.

METHODS

Water usage in bathrooms was measured in toilets, urinals, and sinks. Toilets calculated gallons per flush was collected by flushing the toilet and recording how long it took the toilet bowl to fill with water. We collected the sink water data by filling up a flow rate bag for 5 seconds and recording the gallons per minute mark the water in the bag filled up to. We took three recordings

for each sink and averaged these three numbers to get an overall gallons per minute flow of the sink. As for the urinals, the gallons per flush that was printed on the urinal itself was used as the actual gallon per flush rate.

Bathroom usage was measured as the number of people entering the bathroom in four five minute periods. Two of the periods were during “peak time” between classes on Monday-Thursday, between 11am and 3pm. Peak times on Monday and Wednesday are the first ten minutes after the hour: 10-10:10, 11-11:10, 12-12:10, 1:00-1:10 and 2:00-2:10. On Tuesday and Thursday peak times are 9:50-10, 10:50-11, 12:15-12:35, and 1:50-2:10. Two counts were in “non-peak time” Monday-Thursday, between 10am and 3pm and at any times at least five minutes after or before peak times. For each bathroom one of the peak and one of the non- peak time counts was in the morning and one in the afternoon.

Water use in bathrooms was calculated from student survey data using the ENVS 570 Bathroom water use calculator v3.2. As inputs the calculator used survey data on each bathroom’s faucet gallons per minute for each faucet, toilet and urinal gallons per flush for each toilet and urinal, toilet flush times, and bathroom usage. The bathroom water use calculator estimated annual bathroom water use for each bathroom based on the following assumptions. In a day there were assumed to be 1.5 hours of peak time usage and 8.5 hours of non-peak usage. Bathrooms were assumed to be used for 160 days in the Spring and Fall semesters and 50 days in Summer. Weekend and usage between spring, fall and summer sessions was not accounted for. Summer usage was scaled to Fall and Spring semester usage based on the ratio of summer full time equivalent enrollment (2,284 FTE Summer 2015) to Fall and Spring average full time equivalent enrollment (23,746 FTE 2014-15 academic year). Men using bathrooms are assumed to use the urinal 66% of the time and the toilet 34% percent. Bathroom users were assumed to wash their hands with the water on for 0.11 minutes (this average takes account of the 45% of users who are assumed not to wash hands). Water use in toilets was calculated based on the nominal gallons per

flush for the fixture (e.g., 1.6 GPF – gallons per flush) and surveyed flush time. A toilet in good working order should flush is approximately 4 seconds. For flush times greater than 5 seconds, actual toilet GPF was calculated as nominal GPF multiplied by the ratio of measured flush time to 5 seconds. For example if the nominal GPF was 1.6 and flush time was 10 seconds then actual gallons per flush was calculated as 1.6 GPF x (10 sec/5 sec) = 3.2 GPF.

CURRENT WATER USE

In the Student Service building there was a total of eight bathrooms, one women's and one men's for each of the four floors. Overall, this building uses 272,664 gallons of water per year. The water use breaks down into 215,086 gallons per year used in toilets, which is about 79 percent of total water use in the building. The next heaviest user of water in bathrooms was urinals that used 49.856 gallons per year, or about 18 percent of total water use in the Student Services Building. Sinks used the least amount of water with only 7.772 gallons per year, or only about 3 percent of the building's total water use.

Four out of the eight bathrooms used over 40,000 gallons of water per year, while the other four bathrooms used between 20,000-30,000 gallons of water per year. However the top two bathrooms that used the most water was the men's bathroom on the first floor and the women's bathroom on the fourth floor. The men's bathroom used about 16 percent of the total water used in the building, or 44,490 gallons a year. The toilets used 21,907 gallons a year, about 10 percent of all water used in toilets. 20,870 gallons of water was used in urinals, 41 percent of all water used in urinals. Lastly, a sinks used 1,713 gallons of water, which is 22 percent of all water used in sinks. The women's fourth floor bathroom was the second highest water user in the building, consuming 42,843 gallons per year or just under 16 percent of the total water used. The toilets in that bathrooms used 41,848 gallons of water, just about 19 percent of water used in all toilets. The sinks used 994 gallons of water per year, around 13 percent of water used in sinks in

this building. There is no water used in urinals in this particular bathroom since it is a women's bathroom.

FULL RETROFIT ANALYSIS

In this section we will analyze the retrofit of all toilets and urinals in all bathrooms in the Student Services Building. Annually, this building currently uses 272,664 gallons of water with 215,086 gallons, 79 percent, used by toilets, 49,856 gallons, 18 percent, by urinals, and 7,722 gallons, 3 percent, used by sinks. Currently, the bathroom has 1.6 gallons per flush models installed, but a toilet retrofit would upgrade these models to a 1.28 gallons per flush version. Men's bathroom urinals would be retrofitted so that instead of using 1 gallon per flush, they will use .18 gallons per flush.

Annually, with the retrofit, total water use would be reduced to 186,272 gallons. With 172,069 gallons used annually by toilets, or 92 percent of the total building's use, and 6,481 total gallons used by urinals, just about 3 percent of the building's water use. The gallons of water used by sinks, 7,722 gallons, is unchanged since they were not retrofitted, however now sink use makes up 4 percent of water use in the building instead of 3 percent.

With a complete retrofit of all toilets and urinals, the total cost of water is $925, with toilets using $822 of water, urinals $47 of water, and sinks $56 of water. In terms of sewage, this retrofit would have and annual cost of $1,373. Toilets have the highest cost of sewage with $1,220 annual cost, sinks the second highest annual cost of sewage at $83, and the urinals $70 of sewage. Overall, the price of water and sewage with a retrofit of all toilets and urinals would be $2,298 annually.

The one time cost of the retrofit would be broken into two categories: labor cost and supplies cost. For the installation of a new toilet or urinal it takes approximately 4 hours each to complete, with a rate of $40 an hour, and there is 24 toilets and urinals in the Student Services

building, or 96 hours to complete. Overall, this project would have $3,840 in labor costs. For cost of supplies, there are two prices, one for urinals and one for toilets. Sixteen out of the twenty four fixtures in the Student Services buildings are toilets, to replace the old models with a 1.28 gpf Sloan model would cost $387 each or $6,192. The remaining eight urinals fixtures would be replaced by a 0.13 gpf Sloan urinals at $279.71 each, or $2,238, with a total supplies cost of $8,430. Adding together the cost of the urinals, toilets, and labor, a complete retrofit of all toilets and urinals in the building would cost $12,270.

There are a number of savings from this retrofit, first, 145,073 gallons of water would be saved from switching to more efficient toilet and urinal models. The water saved would also save money from purchasing water, $1,051, and from sewage costs, $1,561. The project costs the university approximately $85 for every 1000 gallons of water saved. Considering all the costs and

Figure 1

Water Use		Current Water Use	Retrofit Water Use
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	6,481
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	127,591

money saved from this project, it would take just 4.7 years for the money saved to pay for the initial cost of the retrofit.

Figure 1-1

Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$47.00	$70.00
	Toilets	$822.00	$1220.00
	Total	$925.00	$1373.00
Cost of Retrofit	**Fixtures**	$8430.00	
	Labor	$3840.00	
	Total Cost	$12270.00	
Retrofit Savings	**Annual Water Savings (gallons)**	145,073	
	Annual Water Cost Savings	$1051.00	
	Annual Sewage Cost Savings	$1561.00	
	Payback Period (years)	4.7	
	Cost of 1000 gallons saved	$85.00	

TOILETS VS URINALS RETROFIT ANALYSIS

Next, we will analyze only a partial retrofit of either all urinals or all toilets. Looking first at urinals, they currently use 49,856 gallons of water annually. But when retrofitted to the new 0.13 gpf Sloan model, urinals in this building would use only 6,481 gallons annually. Sink and toilet water use would remain the same, at 7,722 gallons and 215,086 respectively. Overall, prior to the retrofit this building uses 272,664 gallons of water, but after the retrofit our consumption would be cut to

229,289 gallons. As for water cost, post retrofit urinals water use would cost $47 and sewage only costing $70. Toilets' cost would remain the same with water at $1,558 and sewage at $2,315. As would sinks' cost remain the same with $56 for water and $83 in sewage. In terms of cost for the retrofit, this building only has 6 urinals to be replaced with the Sloan 0.13 model, costing $2,238 for all materials needed. Each urinal takes four hours labor, or 32 hours in total, so labor has $1,280 in costs. The total cost of just a urinal retrofit comes to $3,518. A urinal retrofit would save 43,375 gallons of water amounting to a $314 annual savings in water costs and $467 in sewage costs. With all of these annual savings, the urinal retrofit would eventually pay for itself in 4 and half years and cost $81 for every 1000 gallons of water that was saved.

Analyzing just water use in toilets, currently, they account for 215,086 gallons of water used. When all the toilets are retrofitted to the 1.28 Sloan model, toilets water use would be reduced to 113,388 gallons of water used annually. While urinal water consumption, 49,856 gallons, and sink water consumption, 7,722 gallons, would remain the same. Overall with the toilet retrofit, water consumption would be reduced from current levels of 272,664 gallons to 170,965 gallons used annually. With just a toilet retrofit, the cost of water for toilet use annually is $822 and the cost sewage is $1220. Urinal water cost would remain at $361 and sewage at $537 and sinks water cost would also remain at $56 and sewage at $83. For the cost of tis retrofit, 16 1.28 gpf Sloan toilets would have to be purchased at $387 dollars each, or a total of $6,192 for supplies. Each toilet would take four hours to replace, 64 hours total, at $40 per hour for a total of $2,560 for labor. All together, a toilet retrofit would cost $8,752 with labor and supplies. However, this retrofit would save 101,698 gallons of water annually with saving $1,239 in water costs and $1,840 in sewage costs. With these savings, the toilet retrofit would pay for itself in 4.8 years and costs $86 for every 1,000 gallons of water saved.

Figure 2

(Urinal Retrofit)

Water Use		**Current Water Use**	**Retrofit Water Use**
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	6,481
	Toilets (gallons)	215,086	215,086
	Total (gallons)	272,664	229,289
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$47.00	$70.00
	Toilets	$1558.00	$2315.00
	Total	$1661.00	$2468.00
Cost of Retrofit	Fixtures	$2238.00	
	Labor	$1280.00	
	Total Cost	$3518.00	
Retrofit Savings	Annual Water Savings (gallons)	43,375	
	Annual Water Cost Savings	$314.00	
	Annual Sewage Cost Savings	$467.00	
	Payback Period (years)	4.5	
	Cost of 1000 gallons saved	$81.00	

Figure 2-1

(Toilet Retrofit)

Water Use		**Current Water Use**	**Retrofit Water Use**
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	49,856
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	170,965
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$361.00	$537.00
	Toilets	$822.00	$1220.00
	Total	$1239.00	$1840.00
Cost of Retrofit	Fixtures	$6192.00	
	Labor	$2560.00	
	Total Cost	$8752.00	
Retrofit Savings	Annual Water Savings (gallons)	101,698	
	Annual Water Cost Savings	$737.00	
	Annual Sewage Cost Savings	$1094.00	
	Payback Period (years)	4.8	
	Cost of 1000 gallons saved	$86.00	

ALTERNATIVE RETROFITS ANALYSIS

In this section, we will analyze an alternative retrofit of replacing all toilets and urinals in the top four water use bathrooms in the Student Services building, including bathrooms T0102, T0103, T302, and T402. Three out of four of these bathrooms are women's bathrooms so there would be a total of 10 toilets for replacement and only to urinals being replaced. First analyzing current annual water use in this building, 272,664 gallons were used, but after we conduct this retrofit we would us 190,878 gallons of water annually. Post retrofit water use would be broken down into 7,722 gallons for sinks, 31,699 gallons for urinals, and 151,457 gallons for toilets. The total cost of water would be reduced to $1,383 and sewage to $2,054 for a total of $3,437 for water a sewage a year. Sinks would account for $56 in water and $83 in sewage, toilets for $1,097 in water and $1,630 in sewage, and urinals for $230 in water and $341 in sewage after the retrofit was completed.

In terms of supplies cost, we would have to purchase 10 1.28 Sloan toilets at $387 each for a total of $3,870. However this retrofit would only require two new 0.13 at $279.71 each, or $559.42 total. All together, supplies for the retrofit would cost $4,429. With 12 fixtures to replace at 4 hours each, it would take a total of 48 hours. With labor costs at $40 per hour, total labor for this project would cost $1,920. All together this retrofit project would have a one time cost of $6,349. But in terms of savings, SFSU would save 81,786 gallons of water per year. This amount of water saved would translate into $593 savings in purchased water and a $880 savings in sewage. These savings would create the shortest payback period of 4.3 years and only costs the school $76 for every 1000 gallons saved.

Figure 3

Water Use		Current Water Use	Retrofit Water Use
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	49,856
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	170,965
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$361.00	$537.00
	Toilets	$822.00	$1220.00
	Total	$1239.00	$1840.00
Cost of Retrofit	Fixtures	$6192.00	
	Labor	$2560.00	
	Total Cost	$8752.00	
Retrofit Savings	Annual Water Savings (gallons)	81,786	
	Annual Water Cost Savings	$1,383	
	Annual Sewage Cost Savings	$2054	
	Payback Period (years)	4.3	
	Cost of 1000 gallons saved	$78	

RECOMMENDATIONS

Taking into account all the different options of possible retrofits that could be completed in the Student Services building, I recommend that SFSU moves forward with a complete retrofit of all toilets and urinals. Payback period was not a heavily weighed factor in my decision process because all three of the retrofit projects analyzed above were only months apart. As for the cost of 1,000 gallons saved, a full retrofit had the second highest dollar amount at $85 (figure 1-1), with just a toilet retrofit being the most expensive per 1,000 gallons saved at $86 (figure 2-1). In my opinion, a urinal and toilet is the best retrofit option because saves the most water, 145,073 gallons according to figure 1-1. Completing urinal and toilet retrofits in the Student Services building can become much more costly, and least effective in saving water, if done in steps. A retrofit of urinals and toilets will result in the most water saved and cost of sewage and water saved resulting in the highest amount of money saved when completed together, simultaneously.

Figure 4

Water Use	Toilet and Urinal Retrofit	Urinal Retrofit	Toilet Retrofit	Alternative Retrofit
Total Cost	$12270.00	$3518.00	$8752.00	$6349.00
Annual Water Savings	$1051.00	$314.00	$737.00	$593.00
Annual Sewage Savings	$1561.00	$467.00	$1094.00	$880.00
Total Annual Savings	$2612.00	$781.00	$1831.00	$1473.00
Cost per 1000 gallons saved	$85.00	$81.00	$86.00	$76.00
Payback Period	4.7	4.5	4.8	4.3

ACKNOWLEDGEMENTS

This report was written for the course Environmental Studies 570 Applied Local Sustainability in Fall 2016 taught by Professor Carlos Davidson. Water use reports were made possible in part due to a CSU Chancellor's Office Campus as a Living Laboratory grant to Professor Carlos Davidson, Caitlin Steele, Director of Sustainability & Energy, Nick Kordesch, Sustainability Coordinator, and Charles Meyer, then Senior Director Facilities & Service Enterprises.

The report draws upon water assessment work done by the following students: Al Andaluz, Lillebaek Anderson, Edgar Barraza, Nina Bazan-Sakamoto, Serena Berg, Kelly Dodge, Israel Hakim, Alexandra Ibarra, Lily James, Shawna Knapp, Xochitl Lopez-Torres, Miriam Palma, Daniel Rodarte, Alejandro Sanchez, Sam Schulman, Erin Soden, Rebecca Standridge, Veronica Wong, Ricardo Arias, David Ayala, Darien Casimiro, Philip Chau, Steven Childs, Brandon Chiu, Ellie Chung, Rachael Costello, Monica DiLullo, Tom Evans, Devin Foster, Cory Goldstein, Amanda Jimenez, Cristal Juarez, Natalie Lazard, Hop Le, Ariana Lease, Kimberly Long, Layla Luna, Timothy Maniquis, Ariane Marshall, Chanel Nagra, Nina Omomo, Miriam Palma, Ambar Ramirez, Austin Robertson, Liz Salazar, Caryn Stark, Paige Wenzel, Michael Yang, Julia Beitel, Abigail Black, Cayley Camarillo, Dennis Chang, Rachel DeLuca, Carl Dresel, Matt Espinoza, Andrew Flohr, John Flynn, Matt Guglielmo, Ori Hartenstein, Ria Howell, Yin Htin, Kelly Jertberg, Chris Jones, Monisha Kaur, Simran Kaur, Soojin Kwon, John Malec, Audrey McNamara, Shelby Molini, Blanca Morales, Jose Negrete, Kelsey Rawlings, Nicholas Rilovich, Amir Sahit, Everett Santana, Daniel Soberanis, Tyler Struthers, Suzy Syers, Faraz Tajik, Claudia Vergara, Jamie Xiong, and Kenix Yu.

Professor Carlos Davidson wishes to acknowledge the following people who helped with the development of the class bathroom water retrofit project: Nick Kordesch, Caitlin Steele, and Sue Tensfeldt and Julie Ortiz of the San Francisco Public Utilities Commission.

CITATIONS

"UCSF Research Laboratories Water Efficiency Program." Best Practices. Green Building Research Center, 2014. http://greenbuildings.berkeley.edu/pdfs/bp2014-water-ucsf.pdf. Web.

"University of California Santa Barbara Water Action Plan." Best Practices. Green Building Research Center, 2013. http://greenbuildings.berkeley.edu/pdfs/bp2013-water-ucsb.pdf. Web.

APPENDIX

Figure 1

Water Use		Current Water Use	Retrofit Water Use
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	6,481
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	127,591

Figure 1-1

Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$47.00	$70.00
	Toilets	$822.00	$1220.00
	Total	$925.00	$1373.00
Cost of Retrofit	**Fixtures**	$8430.00	
	Labor	$3840.00	
	Total Cost	$12270.00	
Retrofit Savings	**Annual Water Savings (gallons)**	145,073	
	Annual Water Cost Savings	$1051.00	
	Annual Sewage Cost Savings	$1561.00	
	Payback Period (years)	4.7	
	Cost of 1000 gallons saved	$85.00	

Figure 2

(Urinal Retrofit)

Water Use		**Current Water Use**	**Retrofit Water Use**
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	6,481
	Toilets (gallons)	215,086	215,086
	Total (gallons)	272,664	229,289
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$47.00	$70.00
	Toilets	$1558.00	$2315.00
	Total	$1661.00	$2468.00
Cost of Retrofit	Fixtures	$2238.00	
	Labor	$1280.00	
	Total Cost	$3518.00	
Retrofit Savings	Annual Water Savings (gallons)	43,375	
	Annual Water Cost Savings	$314.00	
	Annual Sewage Cost Savings	$467.00	
	Payback Period (years)	4.5	
	Cost of 1000 gallons saved	$81.00	

Figure 2-1

(Toilet Retrofit)

Water Use		**Current Water Use**	**Retrofit Water Use**
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	49,856
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	170,965
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$361.00	$537.00
	Toilets	$822.00	$1220.00
	Total	$1239.00	$1840.00
Cost of Retrofit	Fixtures	$6192.00	
	Labor	$2560.00	
	Total Cost	$8752.00	
Retrofit Savings	Annual Water Savings (gallons)	101,698	
	Annual Water Cost Savings	$737.00	
	Annual Sewage Cost Savings	$1094.00	
	Payback Period (years)	4.8	
	Cost of 1000 gallons saved	$86.00	

Figure 3

Water Use		Current Water Use	Retrofit Water Use
	Sinks (gallons)	7,722	7,722
	Urinals (gallons)	49,856	49,856
	Toilets (gallons)	215,086	113,388
	Total (gallons)	272,664	170,965
Cost of Water and Sewage With Retrofit		Cost of Water	Cost of Sewage
	Sinks	$56.00	$83.00
	Urinals	$361.00	$537.00
	Toilets	$822.00	$1220.00
	Total	$1239.00	$1840.00
Cost of Retrofit	Fixtures	$6192.00	
	Labor	$2560.00	
	Total Cost	$8752.00	
Retrofit Savings	Annual Water Savings (gallons)	81,786	
	Annual Water Cost Savings	$1,383	
	Annual Sewage Cost Savings	$2054	
	Payback Period (years)	4.3	
	Cost of 1000 gallons saved	$78	

Figure 4

Water Use	Toilet and Urinal Retrofit	Urinal Retrofit	Toilet Retrofit	Alternative Retrofit
Total Cost	$12270.00	$3518.00	$8752.00	$6349.00
Annual Water Savings	$1051.00	$314.00	$737.00	$593.00
Annual Sewage Savings	$1561.00	$467.00	$1094.00	$880.00
Total Annual Savings	$2612.00	$781.00	$1831.00	$1473.00
Cost per 1000 gallons saved	$85.00	$81.00	$86.00	$76.00
Payback Period	4.7	4.5	4.8	4.3

Thornton Hall Bathroom Retrofits Report

SAN FRANCISCO STATE UNIVERSITY

Rebecca Standridge

November 12, 2016


Thornton Hall Bathroom Retrofits

Index

Rebecca Standridge

November 12, 2016

Introduction

Currently, efficiency and retrofits in buildings are a popular topic. Building owners and establishments are realizing that plumbing and appliances are old and outdated. Today, people want efficiency, sustainability, and to not waste money when it could be prevented. A study was done here at San Francisco State University's Thornton Hall to identify if retrofitting bathroom appliances could save the university money. The study was conducted over several semesters by students in the Applied Local Sustainability class taught by Carlos Davidson. The results could potentially lead the school towards being more sustainable and save the school money in the process, if it chose to act on retrofitting. This study's goal is to show that by increasing efficiency in toilets and urinals, SFSU will save a notable amount of money from decreased costs with maintenance and water use.

Many buildings have success stories when it comes to retrofits, for instance the Holiday Inn in at San Antonio International Airport in Texas joined the WaterSaver Hotel Program and saves 35% on their water bill now after retrofitting their bathrooms (Penny, 17). The study of Thornton Hall will show that SFSU can save that amount too on its annual water bill, by switching the old fixtures to the new ones in several retrofit possibilities. Another example of bathroom retrofit success is at University of Hawaii. They conducted a pilot study in 2008 for part of their new policy, Sustainable Saunders Initiative, in the Saunders Building. Interestingly, several companies donated high efficiency toilets and faucets to the school for the study to be conducted. The school concluded that if 21 urinals and 42 toilets were to be replaced with high efficiency models in the building; they would save 662,813 gallons per year and $4,309 per year. If SFSU made the decision to do a full retrofit, the school could potentially save that much money in Thornton Hall, as well. There are many more bathroom retrofit success stories, let's make SFSU a success as well.

Methods

1. <u>Bathroom Usage</u>

Bathroom usage was measured as the number of people entering the bathroom in four five minute periods. Two of the periods were during "peak time" between classes on Monday-Thursday, between 11am and 3pm. Peak times on Monday and Wednesday are the first ten minutes after the hour: 10-10:10, 11-11:10, 12-12:10, 1:00-1:10 and 2:00-2:10. On Tuesday and Thursday peak times are 9:50-10, 10:50-11, 12:15-12:35, and 1:50-2:10. Two counts were in "non-peak time" Monday-Thursday, between 10am and 3pm and at any times at least five minutes after or before peak times. For each bathroom one of the peak and one of the non-peak time counts was in the morning and one in the afternoon.

2. Water Use in Bathrooms

To measure the amount of water from the sink, a plastic bag with gallon measurements on the bag was used. The bag was held under the faucet for 5 seconds while the water was on. That process was repeated three times and then the mean was taken in gallons. Then at each urinal and toilet, they were flushed and the amount of time the flush lasted, was measured with a timer. This process was done once.

Water use in bathrooms was calculated from student survey data using the ENVS 570 Bathroom water use calculator v3.2. As inputs the calculator used survey data on each bathroom's faucet gallons per minute for each faucet, toilet and urinal gallons per flush for each toilet and urinal, toilet flush times, and bathroom usage. The bathroom water use calculator estimated annual bathroom water use for each bathroom based on the following assumptions. In a day, there were assumed to be 1.5 hours of peak time usage and 8.5 hours of non-peak usage. Bathrooms were assumed to be used for 160 days in the Spring and Fall semesters and 50 days in Summer. Weekend and usage between spring, fall and summer sessions was not accounted for. Summer usage was scaled to Fall and Spring semester usage based on the ratio of summer full time equivalent enrollment (2,284 FTE Summer 2015) to Fall and Spring average full time equivalent enrollment (23,746 FTE 2014-15 academic year). Men using bathrooms are assumed to use the urinal 66% of the time and the toilet 34% percent. Bathroom users

were assumed to wash their hands with the water on for 0.11 minutes (this average takes account of the 45% of users who are assumed not to wash hands). Water use in toilets was calculated based on the nominal gallons per flush for the fixture (e.g., 1.6 GPF – gallons per flush) and surveyed flush time. A toilet in good working order should flush for approximately 4 seconds. For flush times greater than 5 seconds, actual toilet GPF was calculated as nominal GPF multiplied by the ratio of measured flush time to 5 seconds. For example, if the nominal GPF was 1.6 and flush time was 10 seconds then actual gallons per flush was calculated as 1.6 GPF x (10 sec/5 sec) = 3.2 GPF.

Current Water Use

In Thornton Hall, there are 20 sinks, 16 toilets and 9 urinals. Currently, the annual sink use is 9,039 gallons per year and counts for 2.6% of the total bathroom water use. The annual toilet water use in Thornton Hall is 284,336 gallons per year and counts for 81.4% of total bathroom water use. The annual toilet water use for urinals is 55,984 gallons and counts for 16% total bathroom water use. Added together, the annual bathroom water use is 349,359 gallons. The three fourth floor bathrooms had the most usage in the building and room T337 on the third floor.

Full Retrofit Analysis

In this analysis, the cost of water and sewage was calculated. The price of water per gallon is $0.007258854 and the price of sewage per gallon is $0.010761285 and was then multiplied by the current use of water in gallons and multiplied by the number of gallons that will be used after retrofits. The current annual cost of water is $2,536 and the annual sewage cost is $3,760. Added together, the current total water annual use cost is $6,295. Respectively, the annual total cost for toilets are $5,124, for urinals are $1,009, and for sinks are $163. Additionally, the current annual sewage cost for toilets is $3,060, for urinals $602, and for sinks $97. After a full retrofit of urinals and toilets the annual water cost will be $2,287. The annual cost of sewage for toilets will be $1,190,

urinals $78, and sinks will still be $97. The annual water use cost for toilets will be $803, for urinals will be $53, and for sinks will remain $97. This gives SFSU a savings of $4,008 per year. Also, with the toilet and urinal retrofits, the annual water usage will go from 349,359 gallons to 126,923 gallons. That is a savings of 222,436 gallons per year. The calculations of the retrofits were done with specific toilet models.

For the toilets, the Sloan WETS 2050.1001-1.28 gallons per flush (GPF) model was chosen and for the urinals, the Sloan WEUS-1000.1001 model was chosen, which is 0.13 GPF. With 16 toilets multiplied by the cost of a new toilet $387, the cost of materials will $6192. With 9 urinals multiplied by the cost of a new urinal $279.71, the cost of materials will be $2517. The total cost of materials will be $8,709. The cost of labor was determined by multiplying 4 hours of time it takes to install each retrofit by $40/hr. The total cost of labor is $4000. The total cost of the retrofit with labor and materials combined is $12,709. The total amount of time to payback the costs will be 3.2 years and the cost per 1000 gallons saved will be $73.15.

*Refer to table 1 on page 5

Toilet Vs. Urinal Retrofit Analysis

With just doing the toilet retrofits, the total annual water use will be 175,629 gallons. With just the urinal retrofits, the total annual water use will be 300,653. The total annual cost for just having the toilet retrofits done would be $3,164; which is $3,131 in annual savings. The total annual cost for just having the urinal retrofits done would be $5,418; which is $877 in annual savings. That is a substantial difference. Respectively, the total annual costs of water, $803, plus sewage, $1,190, for toilets is $1,993. The total annual costs of water, $53, plus sewage, $97, for urinals is $131.

The total cost of materials for just doing the retrofitted toilets is $6,192 and the cost of materials for just doing the retrofitted urinals is $2,517. Total labor cost for toilets is $2,560 and the total labor cost for urinals is $1,440. The total cost of the retrofit for toilets, labor plus materials is $8752. The total cost of the retrofits for urinals, labor plus materials is $3,957. The Payback period for just doing toilets is 2.8 years and the payback period for just doing urinals is 4.5 years. The cost per 1000 gallons saved for doing only the toilet retrofits is $50.38 and the cost per 1000 gallons saved for doing only the urinal retrofits is $22.78.

Alternative Retrofit Analysis

The alternative retrofit analysis is replacing only the women's toilets. This is a viable option because more water is used in women's bathrooms in general than men's bathrooms. By doing this alternative retrofit, the current annual toilet water use will go from 284,336 gallons to 165,931 gallons and the current total annual water use will go from 349,359 gallons to 230,954 gallons. In total, this saves 118,405 gallons per year. The current annual water cost for toilets is $5,124 and after the retrofit, it is $2,990. The current total cost of water and sewage is $6,295 and after the retrofit, it is $4,161. The annual total costs savings will be $2,134. The total cost of the retrofit is $6,017 and the payback period will be 2.8 years. The cost per 1000 gallons saved is $50.82.

Recommendations

After considering the four retrofit options, the best choice is doing retrofit 3, the full retrofit of all the toilets and urinals in Thornton Hall. This is the best choice because not only does it produce the most savings ($4,008/year), monetarily, but it also saves the most water (222,436gallons/year). In the year 2016, we are learning that every drop of water counts, especially in California. This is not a finite world and every person's actions, count and has a positive or negative effect on the planet. So, saving the most water from being wasted as possible, is the responsible decision. The payback period is reasonable as well, in only 4.5 years the school will start receiving a return on its investment. Saving $4,008 per year is a lot, just think about how much money could be saved if every building was retrofitted. That money could be used towards more sustainable retrofits and renovations on campus.

Acknowledgments

This report was written for the course Environmental Studies 570 Applied Local Sustainability in Fall 2016 taught by Professor Carlos Davidson. Water use reports were made possible in part due to a CSU Chancellor's Office Campus as a Living Laboratory grant to Professor Carlos Davidson, Caitlin Steele, Director of Sustainability & Energy, Nick Kordesch, Sustainability Coordinator, and Charles Meyer, then Senior Director Facilities & Service Enterprises.

The report draws upon water assessment work done by the following students: Al Andaluz, Lillebaek Anderson, Edgar Barraza, Nina Bazan-Sakamoto, Serena Berg, Kelly Dodge, Israel Hakim, Alexandra Ibarra, Lily James, Shawna Knapp, Xochitl Lopez-Torres, Miriam Palma, Daniel Rodarte, Alejandro Sanchez, Sam Schulman, Erin Soden, Rebecca Standridge, Veronica Wong, Ricardo Arias, David Ayala, Darien Casimiro, Philip Chau, Steven Childs, Brandon Chiu, Ellie Chung, Rachael Costello, Monica DiLullo, Tom Evans, Devin Foster, Cory Goldstein, Amanda Jimenez, Cristal Juarez, Natalie Lazard, Hop Le, Ariana Lease, Kimberly Long, Layla Luna, Timothy Maniquis, Ariane Marshall, Chanel Nagra, Nina Omomo, Miriam Palma, Ambar Ramirez, Austin Robertson, Liz Salazar, Caryn Stark, Paige Wenzel, Michael Yang, Julia Beitel, Abigail Black, Cayley Camarillo, Dennis Chang, Rachel DeLuca, Carl Dresel, Matt Espinoza, Andrew Flohr, John Flynn, Matt Guglielmo, Ori Hartenstein, Ria Howell, Yin Htin, Kelly Jertberg, Chris Jones, Monisha Kaur, Simran Kaur, Soojin Kwon, John Malec, Audrey McNamara, Shelby Molini, Blanca Morales, Jose Negrete, Kelsey Rawlings, Nicholas Rilovich, Amir Sahit, Everett Santana, Daniel Soberanis, Tyler Struthers, Suzy Syers, Faraz Tajik, Claudia Vergara, Jamie Xiong, and Kenix Yu.

Professor Carlos Davidson wishes to acknowledge the following people who helped with the development of the class bathroom water retrofit project: Nick Kordesch, Caitlin Steele, and Sue Tensfeldt and Julie Ortiz of the San Francisco Public Utilities Commission.

Appendix

TABLE 1.

	Current use	Retrofit 1 1.28 GPF toilets
Annual toilet water use (gallons)	284,336	110,606
Annual total water use (gallons)	349,359	175,629
Annual total cost toilets	$5,124	$1,993
Annual total cost water and sewage	$6,295	$3,164
Annual total water savings (gallons)	na	173,730
Total annual cost savings	na	$3,131
Total cost of retrofit	na	$8,752
years to payback (total cost/annual sav)	na	2.8
Cost per 1000 gallons saved	na	$50.38

TABLE 2.

	Current use	Retrofit 2 0.13 GPF urinals
Annual urinal water use (gallons)	55,984	7,278
Annual total water use (gallons)	349,359	300,653
Annual total cost urinals	$1,009	$131
Annual total cost water and sewage	$6,295	$3,164
Annual total water savings (gallons)	na	48,706
Total annual cost savings	na	$878
Total cost of retrofit	na	$3,957
years to payback (total cost/annual sav)	na	$5
Cost per 1000 gallons saved	na	$81.24

TABLE 3.

	Current use	Retrofit 3 urinals and toilets
Annual urinal + toilet water use (gallons)	340,320	117,884
Annual total water use (gallons)	349,359	126,923
Annual total cost toilets	$5,124	$1,993
Annual total cost urinals	$1,009	$131
Annual total cost water and sewage	$6,295	$2,287
Annual total water savings (gallons)	na	222,436
Total annual cost savings	na	$4,008
Total cost of retrofit	na	$12,709
years to payback (total cost/annual sav)	na	3.2
Cost per 1000 gallons saved	na	$57.14

TABLE 4.

	Current use	Retrofit 4 womens toilets
Annual toilet water use (gallons)	284,336	165,931
Annual total water use (gallons)	349,359	230,954
Annual total cost toilets	$5,124	$2,990
Annual total cost water and sewage	$6,295	$4,161
Annual total water savings (gallons)	na	118,405
Total annual cost savings	na	$2,134
Total cost of retrofit	na	$6,017
years to payback (total cost/annual sav)	na	2.8
Cost per 1000 gallons saved	na	$50.82

TABLE 5.

Retrofit Calculations					
	Current	Retrofit 1	Retrofit 2	Retrofit 3	retrofit 4
	use	1.28 GPF	0.13 GPF	urinals and	Womens
		toilets	urinals	toilets	toilets
Annual toilet water use (gallons)	284,336	110,606	284,336	110,606	165,931
Annual urinal water use (gallons)	55,984	55,984	7,278	7,278	55,984
Annual sink water use (gallons)	9,039	9,039	9,039	9,039	9,039
Annual total water use (gallons)	349,359	175,629	300,653	126,923	230,954
Annual water cost toilets	$2,064	$803	$2,064	$803	$1,204
Annual sewage cost toilets	$3,060	$1,190	$3,060	$1,190	$1,786
Annual total cost toilets	$5,124	$1,993	$5,124	$1,993	$2,990
Annual water cost urinals	$406	$406	$53	$53	$406
Annual sewage cost urinals	$602	$602	$78	$78	$602
Annual total cost urinals	$1,009	$1,009	$131	$131	$1,009
Annual water cost sinks	$66	$66	$66	$66	$66
Annual sewage cost sinks	$97	$97	$97	$97	$97
Annual total cost sinks	$163	$163	$163	$163	$163
Annual water cost	$2,536	$1,275	$2,183	$922	$1,676
Annual sewage cost	$3,760	$1,889	$3,235	$1,365	$2,485
Annual total cost	$6,295	$3,164	$5,418	$2,287	$4,161
Annual toilet water savings (gallons)	na	173,730	0	173,730	118,405
Annual urinal water savings (gallons)	na	0	48,706	48,706	0
Annual sink water savings (gallons)	na	0	0	0	0
Annual total water savings (gallons)	na	173,730	48,706	222,436	118,405
Annual water cost savings	na	$1,261	$354	$1,615	$859
Annual sewage cost savings	na	$1,870	$524	$2,394	$1,274
total annual cost savings	na	$3,131	$878	$4,008	$2,134
Retrofit material cost	na	$6,192	$2,517	$8,709	$4,257
labor hours to install	na	64	36	100	44
total labor cost	na	$2,560	$1,440	$4,000	$1,760
total cost of retrofit	na	$8,752	$3,957	$12,709	$6,017
years to payback (total cost/annual sav)	na	2.8	4.5	3.2	2.8
cost per 1000 gallons saved		$50.38	$81.24	$57.14	$50.82

Work Cited

Penny, Janelle. "The Low-Down on Low-Flows." *Buildings*, vol. 108, no. 7, 2014., pp. 17 *ABI/INFORM Collection*.

Trevenna, Shanah. *College of Social Science Public Policy Center*. Vol. 05. N.p.: University of Hawai'i at Manoa, Feb. 2009. Web. 01 Nov. 2016. Rpt. of *Water-Saving Bathroom Retrofits*.