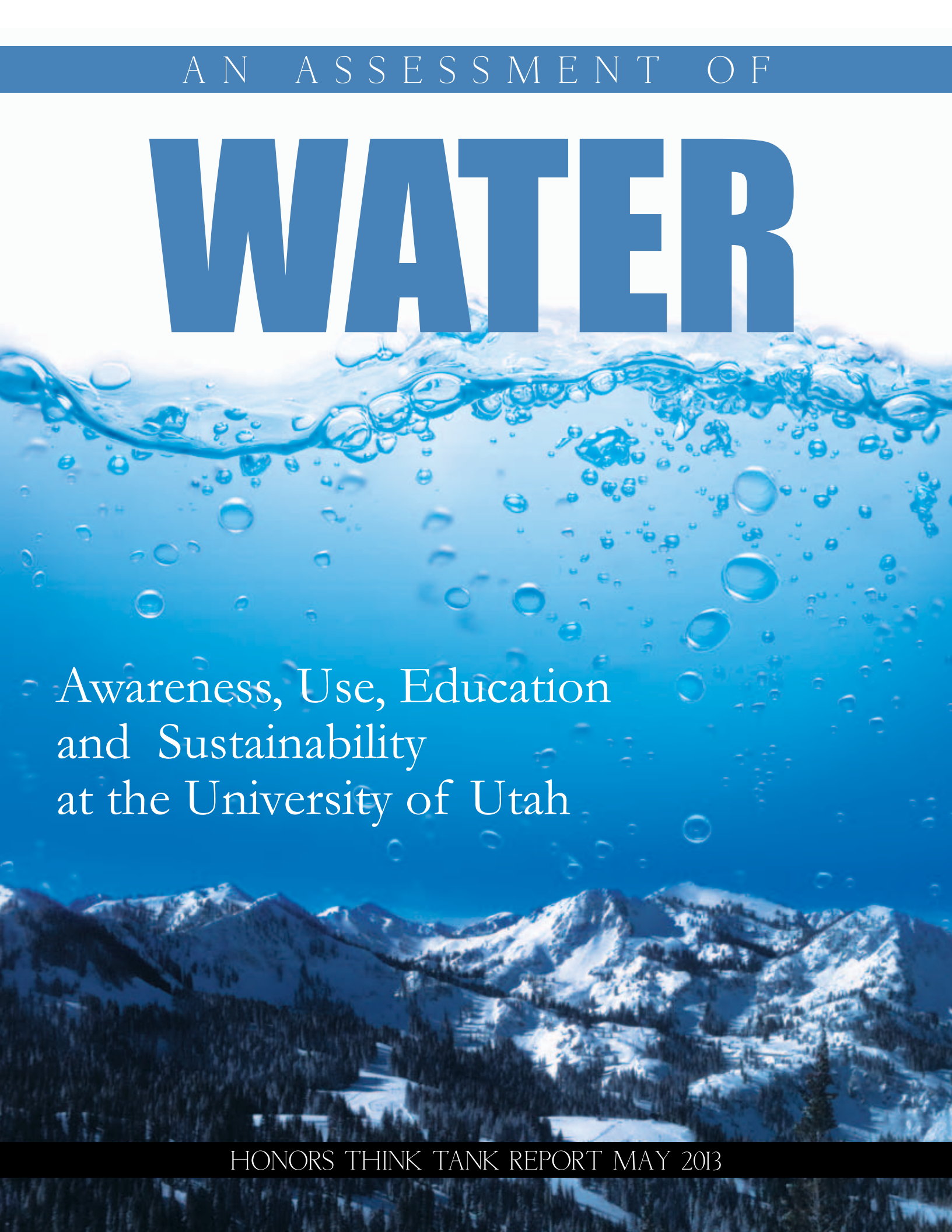
AN ASSESSMENT OF

WATER



Awareness, Use, Education and Sustainability at the University of Utah

HONORS THINK TANK REPORT MAY 2013

An Assessment of Water:

Awareness, Use, Education, and Sustainability at the University of Utah

Wasatch Waters Think Tank
Honors College
May 2013

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Acknowledgments

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The following people visited our class during the Fall 2012 semester and shared their expertise on a range of Wasatch Water issues. Their presentations and insights not only enriched us academically, but helped shape the concept and approach for our final project:

Hilary Arens – Water Protection Specialist, Utah Department of Environmental Quality
Genevieve Atwood – Geologist, Great Salt Lake Specialist, Friends of the Great Salt Lake
Michelle Baker – Professor, Department of Biology, Utah State University
Laura Briefer – Water Resources Manager, Salt Lake City Public Utilities
Steve Burian – Professor, Department of Civil and Environmental Engineering, University of Utah
Gale Dick – Founder, Save Our Canyons
Nan Ellin – Chair and Professor, Department of City and Metropolitan Planning, University of Utah
Jake Garn – Former SLC Water Commissioner, Former SLC Mayor, Former Senator of Utah, Astronaut
Laura Hanson – Executive Director, Jordan River Commission
Marian Hubbard – Watershed Scientist and Planner, Salt Lake County Watershed Planning and Restoration Project
Cathy Kahlow – District Ranger, Salt Lake Ranger District, U.S. Forest Service
Olivia Miller – Graduate Assistant, Department of Geology and Geophysics, University of Utah
Jeff Niermeyer – Director, Salt Lake City Public Utilities
Brad Stewart – Manager, Development Review Team, Salt Lake City Public Utilities
Michelle Straube – Director, Wallace Stegner Center Environmental Dispute Resolution Program, University of Utah
Thomas Walsh – Graduate Research Assistant, Department of Civil and Environmental Engineering, University of Utah
Onno Wieringa – General Manager, Alta Ski Area
Myron Willson – Director, Office of Sustainability, University of Utah
Ted Wilson – Director of Government Affairs, Talisker/Canyons Resort; Former SLC Mayor; Former Executive Director, Utah Rivers Council

Acknowledgments

As our assessment got underway, we reached out to other professionals at the University and beyond. We thank them for giving their time and sharing their varied perspectives and visions for a better water future at the University of Utah. These individuals include:

Ed Barbanell – Associate Dean, Undergraduate Studies, University of Utah
Allison Boyer – Director, Associated Students of the University of Utah Sustainability Board
Steve Burian – Professor, Department of Civil and Environmental Engineering, University of Utah
Katharine Coles – 2009 Poet Laureate of Utah; Professor, Department of English, University of Utah
Stephanie Duer – Water Conservation Coordinator, Salt Lake City Public Utilities
Russell Thomas Jacobsen – Irrigation Technology Specialist, University of Utah
Gregory Lee – Executive Director, Red Butte Gardens
Jack Newell – President Emeritus, Deep Springs College; Professor Emeritus, University of Utah
Jeff Niermeyer – Director, Salt Lake City Public Utilities
Diane Pataki – Associate Professor, Department of Biology, University of Utah
Mike Perez – Vice President, Facilities Management, University of Utah
Susan Pope – Grounds Supervisor, University of Utah
Kip Solomon – Chair and Professor, Department of Geology and Geophysics, University of Utah
Thomas Walsh – Graduate Research Assistant, Department of Civil and Environmental Engineering, University of Utah
Mercedes Ward – Graduate Teaching Assistant, Department of Anthropology, University of Utah
Myron Willson – Director, Office of Sustainability, University of Utah
Jeff Wrigley – Manager, Energy Management, University of Utah

A special thanks to Jeff Niermeyer, SLC Public Utilities Director, who visited our class to give compelling presentations about past and present management of our Wasatch water, participated in the assessment interview, and led awesome tours of the award-winning Salt Lake City Wastewater Treatment Facility and the Water Treatment Plant at the mouth of Big Cottonwood Canyon.

We are grateful to the Marriott Library, to Tom Hurtado of the Associated Students of the University of Utah, and the other faculty members who helped us design and distribute our surveys to students across campus. Thank you, also, to everyone who took time to participate in our surveys.

Also, we would like to acknowledge our instructors, James Ehleringer and Kate Kopischke, who designed a truly spectacular class for us, and who helped us tremendously throughout our assessment.

Finally, we thank the University of Utah Honors College for the generous support they provided throughout our yearlong Think Tank experience.

Table of Contents

Executive Summary

The 2012-2013 Wasatch Waters Think Tank conducted this assessment to provide an overview of water use, management, education, and opportunities at the University of Utah. The assessment seeks to characterize the water environment on campus from the perspective of students, faculty, staff, guest speakers with expertise in Wasatch water, and our own research. We also provide recommendations to strengthen good practice and additional classroom education around this precious resource.

Water is a resource that we tend to take for granted. Demand for high quality water will continue to increase, forcing us to think about its sustainability. Given the high water requirements of the University of Utah—for indoor use, for irrigation of green space, and for research—we believe our campus has potential to lead the Wasatch Front in wise, innovative, and sustainable use of water. We hope this assessment will be a useful resource for University of Utah administrators, policymakers, water managers, faculty members, and student groups when planning and executing future programs that involve water use and management on campus.

The assessment is divided into three primary sections: (1) who we are and the methodology we used to gather information and conduct our assessment; (2) the status of water management on the University of Utah campus, including considerations of changing practices and perceptions; and (3) the role of water awareness and integrated water education as a critical

part of a student's undergraduate experience here at the University of Utah.

We begin our report by introducing the students and instructors who comprise our Think Tank class. We all came to the class from different backgrounds, are following different career paths with different majors, and had different perspectives and awareness of water at the time the course began.

The methodology section summarizes how our class went about assembling this project, from lectures and field trips to meetings with community leaders, to administering surveys and conducting research. We worked in large and small working groups, and engaged in collaborative learning and information sharing to decide on the best approach for this project.

In the background section, we discuss the history of water both in the Salt Lake Valley and at the University of Utah. This informs our analysis of factors affecting water; namely climate change, population growth, ecosystem health, hardscaping, and the cost of water.

The next section reveals results of a campus-wide survey we conducted that captures undergraduate students' understanding and awareness of water use at the university, and student attitudes about water conservation and cost.

The assessment then focuses on current water projects and water-wise practices already taking place at the university. The Grounds Department has been actively re-landscaping our campus in an effort to be more water-efficient and water-conscious. We describe the Campus Master Plan, which catalogs these efforts, and the Climate Action Plan, which introduces the notion of "water neutrality" and its implementation. In addition to describing current water-focused activities, we list several activities that are currently being planned, and suggest some areas for improvement.

An assessment of water at any university would be incomplete without considering education. A number of classes at the University of Utah already pertain to water, but we found there is interest in and potential for more classes of this nature. Because our campus is adjacent to the Red Butte Canyon Research Natural Area and is situated on the banks of Red Butte Creek, students and faculty here have a unique opportunity to engage in research and learning in this remarkable outdoor 'watershed classroom.'

The assessment also revealed the university's less-than-perfect sustainability ranking among other PAC-12 schools, and only average performance when compared to other colleges and universities in Utah.

Our assessment concludes with several recommendations for improving the way we use, manage, and educate students about water at the University of Utah. In particular, we urge the university to increase collaboration and communication among stakeholders across campus, and to undertake additional educational programs, including offering a "water minor." With administrative, faculty, and student support, implementation of these ideas may have far-reaching results, which is what this assessment aims to achieve.

Our Think Tank Experience

A foreword by Kelton Johnston

When we first walked into our Think Tank class, none of us imagined what we were about to learn or accomplish. We gathered around a table and discussed the instructors' vision and format for a class about Wasatch Water—which had been initially described as a course on Ecosystem Services and the American Dream. We shared our definitions of those concepts, how they fit with the topic of water, and our expectations for the class. From there, the class evolved.

During the first semester, speakers from government, academia, non-profit organizations, and the private sector came to our class and presented on a range of topics related to Wasatch Water. During the first half of the semester, the speakers focused on water in the natural environment (i.e., where our water comes from, the characteristics of a watershed, ownership and protection of water and watersheds, how water is delivered to the city, etc.). These classes gave us a good understanding of the challenges of acquiring and protecting high-quality water for all Utahns and of how population growth, climate change, and habitat fragmentation within our watersheds can jeopardize the availability of high-quality water supplies.

Wasatch Water Think Tank at Red Butte Canyon, Fall 2012. Photo by Jay Ellwinger.

In the second part of the semester, speakers focused on water in an urban environment (i.e., how it is cleaned, distributed, managed; and where it goes next). Water has the capacity to bring vitality to a city, but also serves a role in conveyance of our waste. The life of an urban stream and of how citizens view water flowing through a city can be quite different from our perceptions of water in the mountains.

After every speaker, we wrote one-page summaries of what we learned from the presentation, and a half-page summary of possible project ideas stemming from the presentations. These assignments were intended to organize our ideas and begin to narrow our focus for a second-semester final project.

Water has the capacity to bring vitality to a city

The things we learned in the classroom were interesting and educational, as many of us did not appreciate the magnificence of our Wasatch Mountain watershed or the extent of the "real-world" challenges until we took our first field trip to Red Butte Canyon—a Research Natural Area immediately adjacent to the University of Utah campus. To preserve this pristine watershed, so near to a large metropolitan region, public access to the watershed is restricted. As a result, the area offers an unparalleled opportunity to see a watershed that has had minimal human impact, and an opportunity for comparative research and learning. Upstream of the locked gate, the vegetation along the creek was denser and there were no signs of human impact. However, as we traveled back to campus and downstream of the locked gate, it was immediately apparent how much human activity has changed the landscape. Grasses and shrubs are trampled or nonexistent, and the ground is often bare. Some litter was apparent and hiking and bike trails crisscrossed the area, making it difficult to identify the actual riparian zone.

While exploring Red Butte Canyon, we saw first-hand how humans impact a landscape, how landscapes change through time and impact water levels, and how water quality and quantity are measured and monitored in the canyon. We discussed the trade-offs of preserving these kinds of places for research, education, and conservation purposes, versus opening them for the public to enjoy. And we marveled at this incredible resource so close to our growing urban area.

The Red Butte Canyon trip helped illustrate, in practical terms, some of the concepts, challenges, and opportunities that the speakers described in their presentations, and that we all face as residents of the Wasatch Front. It also opened our eyes and minds to water issues in our own back yard, and ultimately steered us toward this final project focusing on water use and management at the University of Utah.

Introduction

Water has been integral to development of the western United States. From the time the first pioneers settled along the Wasatch Front, methods were developed for harnessing the area's water resources to serve a growing population.

Utah today is the second driest state in the U.S. Projections for the effect of climate change, economic growth, and a surging population suggest water will become even more scarce and precious in the coming decades (Garfin et al. 2013).

This campus-wide assessment of water use, management, and education at the University of Utah includes results of student and faculty surveys, numerous interviews, in-depth research, and recommendations for improvement. We believe our efforts show that the University of Utah has an opportunity to be a leader in efficient and sustainable water management, interdisciplinary water research and education, stewardship of our natural resources, and the inspiration for a conservationist ethic.

Why we care about WATER

Water is an essential and universal aspect of the human experience. Yet many of us are unaware where our water comes from, year-to-year variations in nature's capacity to provide this valuable resource, how it is managed, and what happens after water leaves our city.

We believe it is essential for students to understand the nature of our watersheds, how they are managed, and the benefits we derive from them in order to protect our way of life. Our Wasatch Water Think Tank project was motivated by our desire to protect and sustain this critical resource for future generations.

Think Tank Students:

KETI AMIRKHANASHVILI

Keti is a sophomore majoring in biology and minoring in chemistry. She is interested in neuroscience and oncology. In the future she hopes to attend medical school. As a physician, she would like to be a pediatric oncologist and also do research with cancer growth and development. She is also interested in learning how the environment impacts human health and well-being. During her free time, Keti enjoys painting, training for triathlons, and learning about the human mind.

KYLE BLASE

Kyle is a junior working on a double major in environmental and sustainability studies and parks, recreation, and tourism. He hopes to attend an environmental studies graduate program in the future. His goal is to show the intimate connection between environmentalism and outdoor recreation. Kyle works as an ice and rock-climbing instructor for Mountain Education and Development. In his spare time he enjoys climbing, backcountry skiing, mountain biking, and music.

ISA HANSWILLE

Isa is a sophomore majoring in sociology, which she hopes will serve her well in the creation of her own non-profit organization to help Salt Lake City's homeless population. Her interests include hiking and yoga, and she has a particular passion for event and wedding planning.

Who We Are

JENNIFER HANDEL

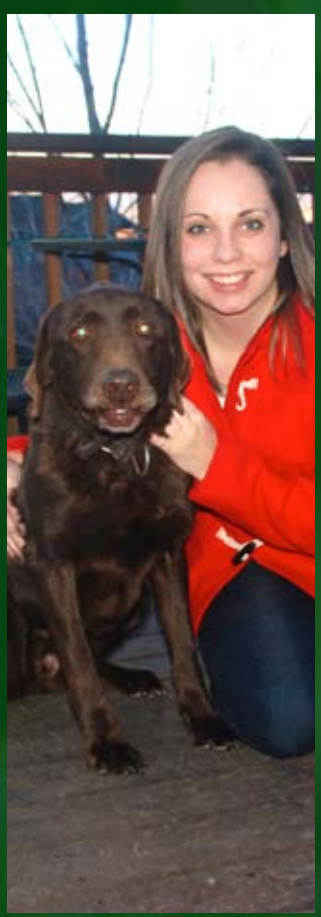
Jennifer is a junior studying environmental and sustainability studies as well as parks, recreation and tourism. She hopes to pursue a career in which recreation helps give people a deeper understanding of and connection to the natural environment. Jennifer also works as a rock and ice-climbing instructor. Her hobbies include art, climbing, yoga, mountain biking, and backcountry skiing and snowboarding.

KELTON JOHNSTON

Kelton is a sophomore double majoring in speech communications and sociology. He hopes to attain a juris doctorate at the S. J. Quinney College of Law. His goal in life is to become an adoption attorney. He wants to give kids the same chance to be adopted that he was given at the age of 8. During his spare time he enjoys hiking, swimming, and anything to do with college athletics.

CAITLIN GARN

Caitlin is a sophomore pursuing a bachelor of arts in linguistics and a bachelor of arts in music with an emphasis in violin performance. She plans to obtain a master's degree in speech-language pathology and is currently taking prerequisites for the program. The connection between music and children's language disorders is of particular interest to her. In her spare time, Caitlin loves to do anything outdoors, especially hiking with her dogs, Koda and Jill.



MATT KIRKEGAARD

Matt is a sophomore studying environmental and sustainability studies and political science. He plans to pursue a graduate degree in environmental policy and management and hopes to work later in life in the formulation of environmental policy. Climate action, biodiversity conservation, and protected area designation are of particular interest to him. His goal is to better align policy with science in regard to these critical issues of our time. He likes to drink coffee, read, hike, and travel in his spare time.

MALLORIE OWENS

Mallorie is a junior studying anthropology and integrative human biology. After graduation she plans to attend medical school. She is particularly interested in different aspects of medical anthropology, and how our culture affects our health. Born and raised in Riverton, UT, she has a love of traveling and enjoys spending time with her family, reading, cooking, and anything outdoors.

SENA BELGARD

Sena is a junior studying human development and family studies with a minor in leadership studies. She has not decided if she will pursue a master's degree, but knows she ultimately wants to work for Disney. Sena is also involved in various activities on campus. She works for the Honors College, is a program director for the Bennion Center, and an associate director for the student government's diversity board. In her spare time, she likes to sleep, watch movies and read.

Our Instructors:

JIM EHLERINGER

Jim is a Distinguished Professor of Biology. His career at the University of Utah has spanned 36 years, during which he has developed a multi-disciplinary research and teaching program with a broad focus on ecology, sustainability, and the environment. As a scholar and instructor, Jim has published over 400 articles and books and served as the teacher, mentor, and advisor to several thousand undergraduate students and to more than 50 graduate students and postdoctoral associates. His research spans from global change impacts on both natural and urban ecosystems through forensic science.

KATE KOPISCHKE

Kate is an independent mediator who specializes in stakeholder engagement, and dispute prevention and resolution in the natural resources sectors. Her work involves neutral situation assessments and facilitated dialogue to help communities, companies and the public sector address concerns stemming from impacts of large-scale development projects. She moved to Utah in 2010 from Washington, DC, where she worked as a mediator for the Compliance Advisor Ombudsman, an independent accountability mechanism of the World Bank Group. In that role, she mediated and facilitated numerous cases involving complaints from communities around the world about the social and environmental impacts of the World Bank's private sector projects.

Methodology: A Think Tank Built Around Field Trips, Learning Experiences, and Research

Project Organization

Our Think Tank course consisted of three distinct, yet integrated components—field trips, learning experiences, and a collaborative research and assessment experience.

Field trips

For all of us, water is an essential element of life that we take for granted. We turn on the faucet and water comes out. When we shower, bathe, flush, and wash our clothes, our wastewater disappears. To more fully understand water and the water cycle, we needed to get outside of the classroom to see and experience our water environment.

Our first field trip was to the Red Butte Canyon Research Natural Area, immediately behind our campus. Ten minutes and yet a world away, we were able to see the natural mountain ecosystems that are the source of our drinking waters.

Our second field experience was to the Salt Lake City Water Treatment Facility near the mouth of Big Cottonwood Canyon. Here we saw how high-quality and good-tasting water, fresh from

Red Butte Reservoir. Photo by Kate Kopischke, Fall 2012

Think Tank Field Trip 2013: SLC Public Utilities Director Jeff Niermeyer and Think Tank students at the Salt Lake Sewage Treatment Plant. Photo by Jim Ehleringer

our mountains, is made safe, further purified, and delivered through our faucets at home and at our university.

Our final field trip was to the Salt Lake City Sewage Treatment Facility near the Great Salt Lake. Here we learned of the challenge of converting everything we put into our sewer system into a safe water source that can be released back to the natural environment.

Matt Kirkegaard at the Salt Lake Sewage Treatment Plant . Photo by Kate Kopischke

Learning Experiences

In the 2012 fall semester, we met and learned from community leaders, government officials,

Genevieve Atwood, geologist and water expert, presents to Think Tank students, October 2012. Photo by Jim Ehleringer

and campus faculty and staff with strong interest and expertise in our Wasatch water. The presentations spanned a broad range of topics—from our drinking water sources to water management, watershed conservation to economic development, climate change to sustainability, and public awareness to educational needs. Details of these lectures and discussions shaped our thinking and deliberating, and ultimately resulted in this assessment (See Appendix A.) Our focus in the fall semester centered on understanding the issues related to water use, impacts, and sustainability in both natural mountain regions, where our water originates, and in the urban valley regions where most of our water is consumed.

Collaborative Research and Assessment Experience

In the 2013 spring semester, we conducted an assessment based on issues we believe are central to students at the University of Utah. The spring semester was divided into two phases. Phase one (January 2013), focused on assessing water use and management issues across campus. Phase two (February 2013) focused on education and the extent to which people are learning and

teaching key aspects of water use and management. During the interval between March and May 2013, we worked collaboratively to write, edit, and complete this assessment.

To obtain information for our assessment, we divided into three teams—a survey team, an interview team, and a data collection team. Throughout the semester, these teams collaborated to share information, exchange ideas, and address questions and challenges. Below are descriptions of the processes each team went through to compile information for the assessment.

Survey Team

Kyle Blase, Keti Amirkhanashvili, Isa Hanswille

The goal of the Survey Team was to understand the extent to which undergraduate students at the University of Utah understand water use and management. We also wanted to explore the role of water education in the U of U curriculum, and learn how faculty members feel about water conservation and education.

To achieve these goals, the Survey Team designed and distributed two surveys aimed at these different interest groups.

PLANNING THE SURVEYS—To write effective questions for a survey of undergraduate students, we developed a framework focused specifically on use and management of water on campus. Using this framework, we divided the questions into three categories: (1) how much students know about water and water-related activities on campus, (2) how much students care about water on campus, and (3) what students would like to see changed on campus in terms of water use.

For the faculty survey, we sought to understand faculty members' personal and professional thoughts about water and sustainability in undergraduate education. We wanted to understand participants' background and interest in water, as well as their suggestions and ideas on improvements to campus curricula.

WRITING AND DISTRIBUTING THE SURVEYS—In forming our initial questions for the student survey, each team member was assigned to write questions pertaining to one of the three categories. After drafting questions individually, we met in person to refine the way questions were framed. As a team we checked the premise behind each question and its potential to prompt action. We then presented our draft survey questions to the rest of the class and solicited their input.

As a class we discussed and revised the student survey many times before finalizing it. We then used an online survey generator and distributed it to undergraduate students through various student organizations, including the Associated Students of the University of Utah (ASUU) and the Bennion Center. The final survey, composed of 19 questions, was distributed to 5,200 students.

Over a period of several weeks, 951 students responded to the survey. These student responses came from every college on campus. (See Appendix B for the survey questions and results.)

The faculty survey, with a smaller sample size than the student survey, also was discussed and refined by the entire class. Once we had agreed on the final questions, we then contacted 80 faculty mem-

bers from across campus via email or personal contact, and received responses from 31 of those individuals. (See Appendix C for survey questions and a sample of responses.)

Electronic copies of all survey data have been provided to the Honors College Think Tank Archives.

Interview Team

Caitlin Garn, Matthew Kirkegaard, Mallorie Owens

In January and February 2013, the Interview Team identified key individuals and experts in water use, management, and education and contacted them by email. Those who were available to speak with us were interviewed in person or via email. General questions touched on the theme of campus water use, management, and education, and specific questions were based on the knowledge and areas of interest of the interviewee.

Below is a list of the individuals we interviewed for this assessment. (Appendix D lists the common questions we asked of them).

Ed Barbanell – Associate Dean, Undergraduate Studies; Professor, Department of Philosophy
Allison Boyer – Director, Associated Students of the University of Utah Sustainability Board
Steve Burian – Professor, Department of Civil and Environmental Engineering
Stephanie Duer – Water Conservation Coordinator, Salt Lake City Public Utilities
Russell Thomas Jacobsen – Irrigation Technology Specialist, University of Utah
Gregory Lee – Executive Director, Red Butte Gardens
Jeff Niermeyer – Director, Salt Lake City Public Utilities
Diane Pataki – Associate Professor, Department of Biology
Mike Perez – Vice President, Facilities Management, University of Utah
Susan Pope – Grounds Supervisor, University of Utah
Kip Solomon – Chair, Department of Geology and Geophysics
Thomas Walsh – Graduate Research Assistant, Department of Civil and Environmental Engineering
Mercedes Ward – Graduate Teaching Assistant, Department of Anthropology
Myron Willson – Director, Office of Sustainability, University of Utah
Jeff Wrigley – Manager, Energy Management, University of Utah

The goal of the interviews was to better understand the viewpoints of water experts on various key topics. Each interviewee is intimately involved with water in some way and through our conversations we gained knowledge and confidence in our understanding of the underlying issues surrounding water at the University of Utah. Every opinion brought different points of view that informed the assessment. Besides helping us understand water from several different perspectives, the interviews also provided us with invaluable information and statistics in the form of documents, emails, and verbal commentary.

Data Collection Team

Jennifer Handel, Sena Belgard, Kelton Johnston

PHASE 1—We began by compiling a list of people we believed would have valuable information about water that would inform our assessment. These individuals included:

Amy Brunvand – Associate Librarian, Marriot Library, University of Utah
Steve Burian – Professor, Department of Civil and Environmental Engineering
Tami Cleveland – Planner and Architect Manager, Facilities Management, University of Utah
Jen Colby – Sustainability Coordinator, Office of Sustainability, University of Utah
Cory Higgins – Director, Plant Operations, University of Utah
Diane Pataki – Associate Professor, Department of Biology
Susan Pope – Grounds Supervisor, University of Utah
Myron Willson – Director, Office of Sustainability, University of Utah

We sent an email informing them about our project and what we hoped to accomplish, and asking them to share any relevant studies and information about water use and management on our campus and elsewhere. As part of this process, we learned how to use EndNote, a reference database program, and each student was provided with a copy of this software. Throughout the class, we kept track of references, publications, and figures using a common EndNote file.

We also learned how to use the library databases and we began to research various keywords pertaining to water use in general, in our area, and on campus. Once we learned these tools, information began to flow more rapidly. Although our topic was quite broad, we determined ways to narrow our searches and become more efficient. We began brainstorming and researching different topics we thought would be interesting and pertinent.

Our findings were categorized into five main groups: (1) water efficiency on campus, (2) water conservation and efficiency on other campuses, (3) water-related education, (4) vegetation in relation to water, and (5) general water conservation topics. Although these categories were useful initially, we later altered the categorizations to better align with the work and findings of the other teams, and to the overall assessment framework.

PHASE 2—Our main goal for phase two was to refine the organizational framework that we developed as a class. The framework was useful because it provided clear direction and a definitive goal for the assessment. We began by dividing our tasks into different categories as outlined in the framework, so each of us had a specific area of focus. This process included analyzing a range of articles we had reviewed, and categorizing them by topic. We also summarized the contents or key theme of each article. We were then able to determine which categories required more research and which categories were not important to the assessment. Our final step was to collect more specific data on topics identified in the framework and/or requested by other teams.

Electronic copies of all publications and reports, as well as the EndNote database containing all referenced information and figure-citation sources, have been provided to the Honors College Think Tank Archives.

Background

Utah is the second driest state in the country, with an extremely varied topography. Our mountainous areas are the primary sources of our water, most of which comes in the form of winter snow (Ashcroft et al. 1992). For citizens living along the Wasatch Front, the Wasatch Mountains and Uinta Mountains are the two primary montane water sources. Here we see that the mountains experience long, cold winters with relatively short summers. In contrast, the lower valleys, where most citizens live, have a more moderate range of temperatures and are considered an arid, high desert climate (Baskin et al. 2002, Utah Division of Water Resources 2012). On average, Utah receives 13 inches of precipitation per year. However, in the mountainous areas this can be as high as 60 inches annually, yet in other areas as low as 5 inches.

The challenge we face in Utah is that our annual precipitation rates vary from year to year, with some years producing ample rain and snowfall, while others plunge us into drought. As a consequence, maintaining a consistent supply of water is mandatory. The solution is reservoirs, such as Jordanelle, Pineview, and Strawberry, to catch and store the snow as it melts each spring. As part of this reservoir system, a portion of the water supplied to the Wasatch Front is governed by the Colorado River Compact of 1922. Today, we intercept water leaving the Uinta Mountains before it enters into the rest of the Colorado River Basin. That water is transferred from the Colorado River basin into the Wasatch Front through tunnels, and is stored in reservoirs along the way (Starvation, Strawberry, Jordanelle, and Deercreek).

Jordanelle Reservoir, photo by Jennifer Handel

A Brief History of Water in the Salt Lake Valley

When the Mormon Pioneers arrived in Utah in 1847, they soon began to settle the Salt Lake Valley and built an irrigation system to distribute water from mountain-sourced streams to their farmlands. By the 1860s, many farming communities were established near the Wasatch Front and Jordan River (Thiros 2010). However, with a growing population and finite water resources, water quantity and management quickly became an issue (Thiros 2010, Niermeyer 2012).

Originally, the population of the Salt Lake Valley relied on City Creek as its primary water source. However, as the city grew the demand for irrigation water by farmers and other citizens also grew. Consequently, water was brought in by canals from other sources, including Big Cottonwood Canyon, Little Cottonwood Canyon, and the Jordan River (Thiros 2010, Niermeyer 2012). Before the 1950s, drinking water came straight from the mountains into our homes with little or no treatment. For this reason, residents were conscientious about maintaining good water quality and keeping their rivers and streams clean. Today the Wasatch Mountains still provide the majority of the high quality drinking water for citizens throughout the Salt Lake Valley. However, we tend not to give much thought to how important it is to maintain this water supply, especially in the face of threats to the watershed from potential development and of increased recreational activities (Niermeyer 2012). There is sufficient water today, but it is tomorrow that we must think about. Keeping a sustainable water supply now and for future generations should be a priority for everyone.

Water History at the University of Utah

In 1850, soon after the Mormon Pioneers had settled in the Salt Lake Valley, the University of Utah was founded. At first the campus consisted of a few buildings surrounded by farmland and natural vegetation, but over the years its landscape transformed to accommodate the growing student population and to make it a more attractive campus. During this expansion, the University of Utah was not always water conscious when it came to outdoor landscaping and domestic use; for many years we even maintained our own golf

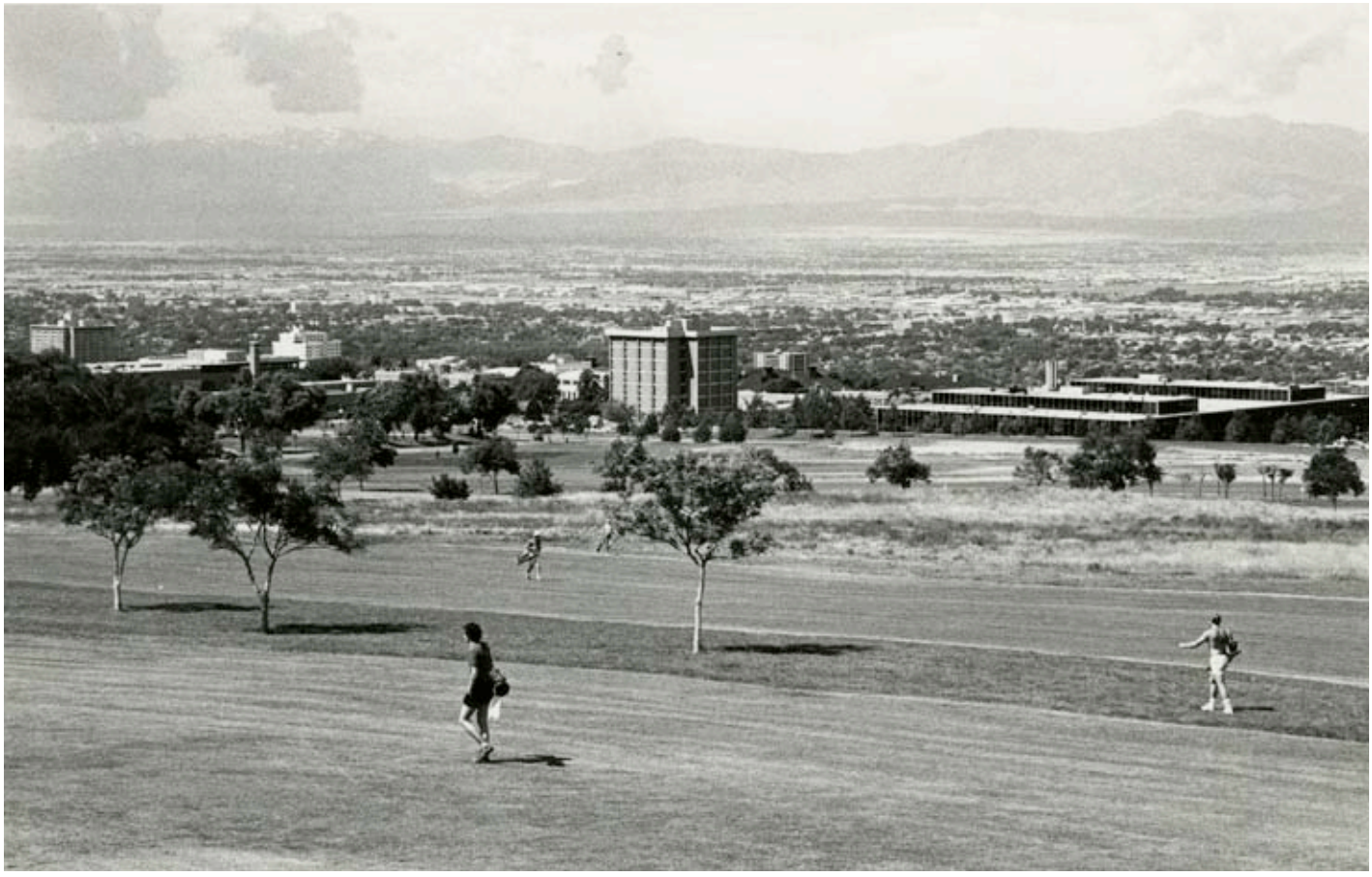
Aerial view of lower campus, April 2012

Aerial view of University of Utah campus ~1920s. Photos Special Collections Department – J. Willard Marriott Library

course. However, as space became more valuable for buildings and as the university became more conscious of its water use, it has made efforts to become more sustainable.

As the university has grown, the campus landscape has transformed. New buildings have been constructed and the facilities and landscape features have changed along with students' priorities. One example of the changing landscape is the University Golf Course. From the early 1920s through 1948, Fort Douglas maintained an 18-hole golf course on what is now University campus. In 1948, the golf course was given to the university (Webb 2009). By 1961 with the construction of Van Cott Hall and the Sill Home Living Center, the university reduced the golf course from an 18- to a 9-hole golf course. This golf course separated main campus from upper campus. As health care demands, research needs, student housing needs, and the student population grew further, the golf course continued to shrink; in 2009 it closed to create more room for buildings and a changing campus landscape (Webb 2009). With this change came a large reduction in the University's outdoor irrigation needs.

As the university's landscape has changed over the years, so have its water sources. Historically, the university obtained most of its water from Red Butte Creek, City Creek, and a campus well that fed into an underground aquifer (Azbill 2012). The



University of Utah Golf Course, 1982. Photos Special Collections Department – J. Willard Marriott Library

water from City Creek was supplied by Salt Lake City Public Utilities. By 1926 the university was independent of the city's water source and was drawing from a large well known as "The Fountain of Ute," which supplied water to most of campus. In 2005 the Fountain of Ute was closed because of new water management regulations, and the university turned once again to Salt Lake City for its water supply (Azbill 2012).

In 2010, the Facilities Management department once again reopened the Fountain of Ute to help in the university's efforts to make landscape irrigation self-sustaining. To comply with new water management regulations, water from the well is only used for irrigation and non-consumption purposes. By using the Fountain of Ute for irrigation, the university has saved more than $100,000 in water costs over the past several years. In addition to using the Fountain of Ute, the university is continuing to look at other ways to become self-sustaining and water conscientious (Azbill 2012). (See the "Water Use and Management on Campus" section.)

The Fountain of Ute, near Rice Eccles Stadium
Photo by Isa Hansville

Emerging Issues

Climate Change

Noticeable climate changes are already occurring throughout the southwestern United States (Garfin et al. 2013). Climate and water availability are inextricably linked to each other here in Utah. Due to a warming climate, the frequency of dramatic weather events such as flooding and drought are expected to increase (Blue Ribbon Advisory Council 2007, Metz et al. 2007, Parry et al. 2007, Solomon et al. 2007, Stern 2007, Karl et al. 2009). This warming trend directly affects Utah's water cycle (Blue Ribbon Advisory Council 2007).

A warming climate in an already arid landscape should concern everyone along the Wasatch Front, including the University of Utah. Our water derives from the mountains; nearly 60% of it comes as snowmelt runoff from the Wasatch Mountains. The remaining 40% is transported from the Uinta Mountains (Niermeyer 2012). Because snow melts and runs down the mountain at a slower rate than rain, it acts as a water retention feature similar to a reservoir. Snow remains in the mountains during winter months and begins to melt as the dry season approaches. With a warming climate, more winter precipitation is falling as rain rather than snow, altering the mountains' capacity to store water (Blue Ribbon Advisory Council 2007, Garfin et al. 2013).

Population Growth

The world is getting more crowded. Utah is getting more crowded. Our valleys along the Wasatch Front are getting much more crowded. In Utah, population and demand for water are increasing as our state gets hotter and summer droughts grow longer (Blue Ribbon Advisory Council 2007). Even before calculating population growth from immigration, the population along the Wasatch Front is expected to double over the next 30 years because of higher-than-average intrinsic growth rate in our state (Governor's Office of Planning and Budget 2001). Population growth will impact the price of water. When a constant or diminishing water supply is combined with ever increasing demand for water, the price of water is much more likely to increase than it is to decrease. Through pricing, regulation, and/or behavior change, Utahans will necessarily adjust to a new water environment in the future.

Ecosystem Health

As water levels in our aquifers and reservoirs continue to decrease, demand for water retention and diversion structures increases. We look for more places to build dams and pipes so we can more easily collect and divert water where it is needed. However, although we rely heavily

Wasatch Mountains: Backcountry Skiing, 2012. Photo by Jennifer Handel

Wasatch Mountains, 2012. Photo by Jennifer Handel

on important infrastructure projects, the need for more dams, pipes, and other water retention structures creates stress on the water cycle and the natural functioning of our ecosystem. Eighty percent of Utah's wildlife depends on riparian habitats for at least a portion of its life cycle.

Hardscaping

Continued 'hardscaping' (the process of building surfaces such as rooftops, cement walkways and parking lots) has detrimental impacts to nearby rivers and streams. Rather than allowing water to be absorbed into the ground, hard, impervious surfaces force water into nearby rivers, streams, or storm drains (Pomeroy 2012). As water travels along these

Developments that capture and divert water regulate the flow of streams in an unnatural way, which causes erosion of stream banks and destruction of native vegetation.

Water retention and diversion structures are not the only factors affecting our ecosystem. Other watershed concerns exist as well, especially in the Wasatch Range—the primary source of water for the Salt Lake Valley. More than 85% of Utah's total population lives along the western edge of the Wasatch Mountains. That means more than 2 million people live within a few miles of our precious watersheds (Governor's Office of Planning and Budget 2001, Niermeyer 2012). With this many people so close to the watershed, upstream contamination of the water treatment plants is a great concern. Easy access to recreation in Big and Little Cottonwood Canyons continually threatens water quality in these canyons.

An additional threat to our watersheds is urban development. With population growth and more demand for housing, retail and commercial development, recreational use of the canyons is increasing. On-going and proposed expansion of ski and summer resorts is further impacting our watershed, and this issue pits development interests against those of conservationists and watershed managers—heightening conflict and increasing the need for costly mitigation efforts.

A rainy day at the University of Utah; Marriott Library Plaza, 2012
Photograph by Jennifer Handel

hard surfaces, it collects sediment and pollutants, depositing these into our waterways. Among the most common pollutants collected on hard surfaces are nitrogen, phosphorus, heavy metals, hydrocarbons, sediments, pathogens, chloride salts, other particulates and debris. These pollutants come from sources such as fertilizers, pesticides, automobile fluids, pet feces, livestock, wildlife, sand and salt from snow removal operations, sediment from construction sites, and litter. In addition to depositing these pollutants, hardscape runoff floods waterways and increases erosion of the natural environment.

Because of the extensive hardscaping and the lack of proper stormwater controls on our campus, the riparian ecosystem surrounding Red Butte Creek is being disrupted. Like any creek impacted by nearby hardscaping, Red Butte Creek has been experiencing changes since urban development began in the valley. Stormwater delivers increased levels of sediment into the creek, burying materials that many species rely on for their survival. Toxic pollutants are being deposited into Red Butte Creek from sources such as runoff from our streets that enters the storm water system, construction sites, snow removal operations, fertilizers and pesticides. Water from irrigation creates another source of runoff, and increases the base flow of the creek (Pomeroy 2012).

Together, these factors alter the riparian area of Red Butte Creek, making it harder for native species to survive, and disrupting the diversity, productivity, and dynamic tolerance ranges of the creek's ecosystem. Altered regimes such as this create an environment where, if anything, invasive species thrive, while native species suffer. This is because invasive species can often tolerate a wider range of variability and reproductive strategies (Pomeroy 2012).

With proper stormwater controls, such as bioretention features, many of the problems caused by extensive hardscaping can be reduced and even eliminated (Pomeroy 2012). Reduction of stormwater runoff could reduce erosion, sediment buildup, and deposition of toxic substances. Incorporating stormwater controls on campus will help restore Red Butte Creek to its natural state.

Cost of Water

The cost of water depends on a number of factors. Climate, geography, water quality, type of water delivery system, energy costs, and funding from federal, state, and private sources all play a role in determining the price of water.

The cost of water in Utah per 1,000 gallons is 43% below the national average, and 45% below the average of all western states (Utah Division of Water Resources 2012). The use of gravity for transport to urban areas, low energy costs, property taxes, and water impact and connection fees all help to keep down the cost of water in Utah. However, these low prices lead to overuse of water.

For example, St. George, UT—one of the driest cities in the west—uses among the highest amounts of water per capita but pays among the lowest price (Utah Rivers Council 2012). Such low prices do not promote the idea of water conservation in arid landscapes where conservation practices are needed the most. This point was underscored during an interview with Jeff Wrigley, Program Manager for Energy Management at the University of Utah, who said:

"The major downside to water conservation efforts is cost. Water conservation efforts are primarily limited by payback due to the low cost

of water ($0.0033/gallon). As long as water costs are extremely low, there are other higher priorities for sustainability (including reducing energy consumption and greenhouse gas emissions) that provide better business cases for investment. Water is a precious commodity and as demand continues to increase costs will continue to rise, creating more opportunities for attractive investments. Without a greater benefit/cost ratio, water issues will not be able to effectively compete for the limited funding that's available for improvements."

Photo courtesy of and copyright Free Range Stock, www.freerangestock.com

Sustainability: Changing Attitudes and Expectations

Student Perspectives and Awareness

Some of the greatest movements in history were initiated by students and young adults who saw a need for change and chose to act. Guided by this assumption, we decided to measure the attitudes and opinions of undergraduate students at the University of Utah. Do individuals on campus see a need for sustainability? Are they interested in an expansion of water management practices? How much do they care?

To answer these questions, we conducted a student survey in which 951 participants answered questions pertaining to water conservation. (See the Methodology section for detail on design and distribution of the survey.) Survey results showed strong support for increased water conservation measures, as well as a lack of knowledge of specific water issues on campus.

When asked how important it is for the University of Utah to conserve water, on a scale of 1-5 (1 being "not important" and 5 being "very important"), 69% responded that water issues were important. Furthermore, 75% of students said they conserve water because it is "better for the environment", while only 2% of students said they do not bother conserving water.

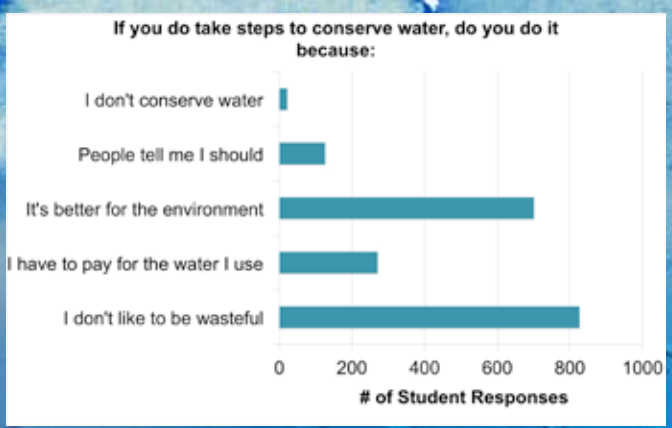
Photo by Kristi Kirshberg Harmon

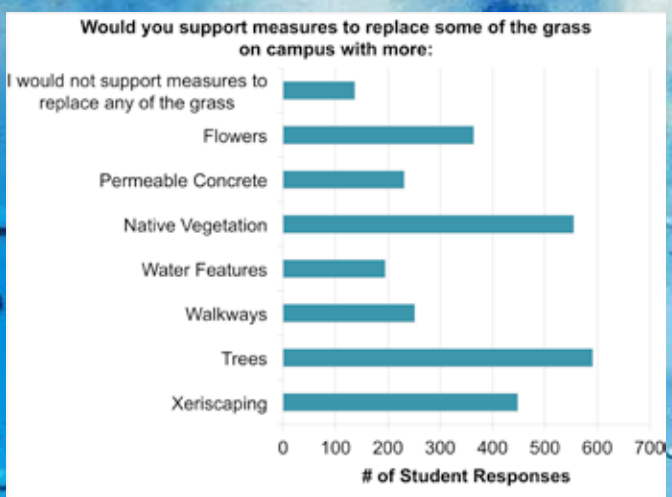
As an indication of student willingness to address water issues, 75% said water conservation on campus is important enough that they would support a new water conservation fee attached to their tuition. Additionally, 85% percent of students support measures to replace some of the grass on campus with less water-intensive landscaping.

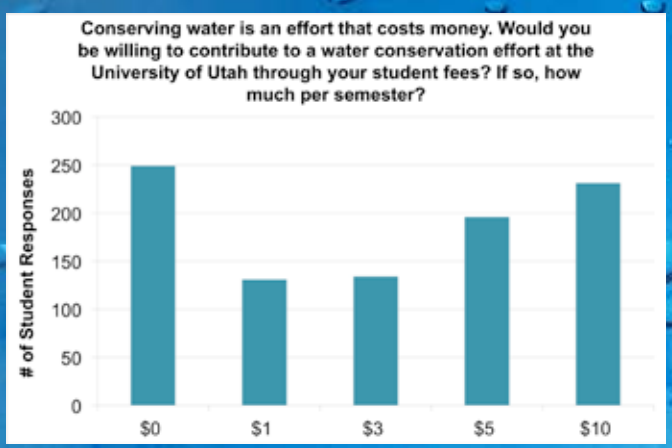
Although strong student support exists for conservation efforts, many students remain uninformed about water issues on campus. Among the students surveyed, 45% do not know Red Butte Creek runs through the university, and 71% do not know that stormwater drains into Red Butte Creek or into the stormwater system once it falls on campus.

Despite the lack of knowledge pertaining to specific water issues, there is strong student desire for increased water education; only 33% of students were not interested in increased water education.

As the survey results indicate, there is desire to improve water awareness and water sustainability on campus, and the general lack of knowledge pertaining to water on campus implies an opportunity for more education on this topic.



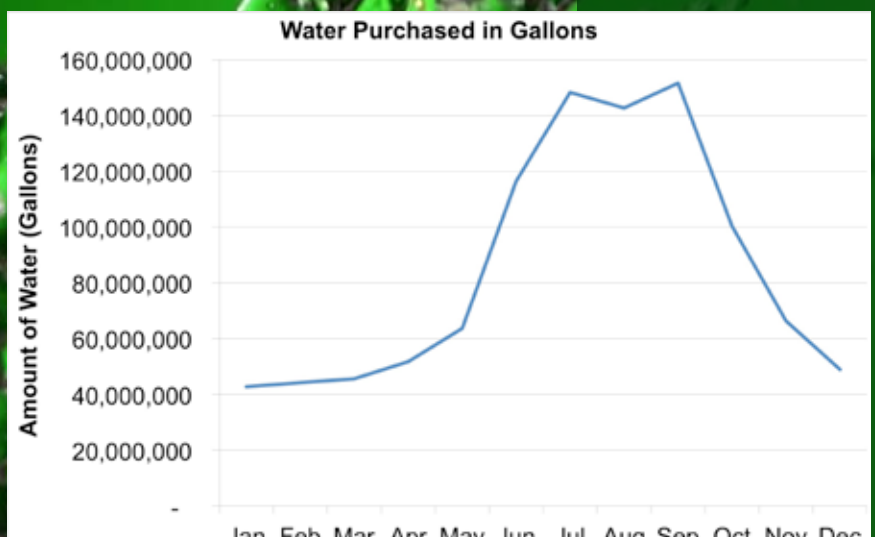




PROJECT PHASE 1: Water Use and Management on Campus

How Much Water Do We Use?

The Energy Management Department at the University of Utah tracks and manages water use on campus. Program Manager Jeff Wrigley provided our class with data on purchased water. Data on secondary water use (any water used that is not purchased) were not available. Wrigley said the University of Utah used 1,022,897,526 gallons of water in 2012. As expected, water use for landscaping dramatically increases in the summer months. Below are some measurements of campus water use provided by Wrigley (2013):



Number of gallons of water purchased monthly by the U of U in 2012
Data provided by Jeff Wrigley, 2013

Building/Indoor usage per month = 45,694,812 gallons
Annual Building/indoor usage = 544,694,812 gallons
Outdoor usage = 478,202,714 gallons

Photo by Natalia Demkina

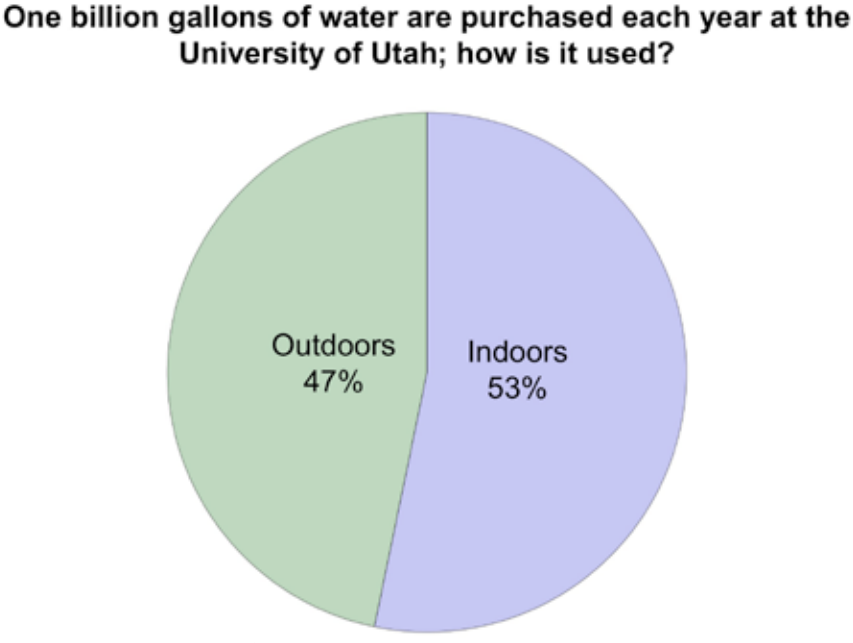
Based on these figures, we calculated that the university's outdoor water use was 47% of the one billion gallons purchased. Thus, of the approximately one billion gallons purchased, outdoor use of water comprises about 47% while indoor use comprises about 53%.

Of the 478,202,714 gallons used outdoors, the Energy Management Department purchases 300-400 million gallons each year specifically for campus landscaping. Total landscaping material includes 26 million square feet of grass and 460,000 square feet of shrubs (Wrigley 2013).

By taking the average of 350 million gallons (Wrigley's estimate of water purchased for landscaping), and dividing it by total square footage of calculated landscaped space (26,460,000 square feet), we calculated the amount of water used for grass and shrubs per year is about 13.23 gallons/ft^2 ((350,000,000 gallons)/(26,460,000 ft^2)= 13.23 gallons/ft^2).

Overall, the University of Utah campus spans approximately 1,535 acres, or 66,864,600 square feet. We estimated that approximately 15.29 gallons of water is applied annually to each square foot of landscaped campus. We arrived at this figure by dividing the total amount of water purchased by university-square-footage (1,022,897,526 gallons) / (66,864,600 ft^2) = 15.29 gallons/ft^2). However, this figure does not include the amount of secondary water used, which the lack of adequate monitoring and metering prohibits inclusion in our calculations.

In summary, while the university is making an important transition to a more conservative water-use landscape, the university today still uses an appreciable amount of water to maintain its facilities and landscape architecture. In addition to the billion gallons purchased annually, water also is extracted from wells and other secondary resources. We were able to use the data provided by Wrigley to compare the university's water consumption to the university's sustainability goals and initiatives. Currently, while we are on our way to more sustainable water use, the University community has not achieved its goal to become water neutral. (This topic is explored further in the "Water Planning" section under "Climate Action Plan.")



Estimated proportion of purchased water for indoor use vs. outdoor use by the U of U
Data Provided by Jeff Wrigley, 2013

Sustainable Water Management Practices

Several methods of water management have been shown to reduce water use in our dry, semi-arid climate. These include xeriscaping, green infrastructure practices, rainwater harvesting, and low-flow fixtures. Our assessment revealed that each of these practices exists on campus today, and that more are planned for the future.

Xeriscaping is a landscaping method where plants with reduced water requirement are selected (Fross et al. 2011, Ogden and Ogden 2011). Drought-tolerant plants can be attractive and colorful, yet conservative in their water requirements and capable of withstanding periods of drought. Plants used in xeriscaped gardens are typically native and better adapted to arid or semi-arid climates than traditional plants, which often are derived from much wetter climates.

Xeriscaping is gaining popularity for both its environmental and aesthetic values. At the University of Utah, the amount of green space that is xeriscaped has increased noticeably in recent years, with drought-tolerant plants slowly replacing lawns across campus.

Xeriscaped bed at the J. Willard Marriott Library
Photograph by Isa Hanswille

Rain garden at the Frederick Albert Sutton Geology Building
Photo by Isa Hanswille

Green infrastructure projects are engineered plant communities (Farr 2008, Pazwash 2011) used as an urban planning approach aimed at safeguarding important natural areas and promoting sustainability. Green infrastructure projects include such features as bioswales, rain gardens, bioretention systems, and pervious pavement.

A bioswale is a shallow linear depression that captures storm water runoff and allows water to penetrate into the soil. The natural microbial soil processes in a bioswale have the capacity to capture, retain, and decompose contaminants. Rainwater that collects in a bioswale infiltrates into the ground after being cleansed. Bioswales currently exist in several locations at the University of Utah, including a site near the Carolyn Tanner Irish Humanities Building, and the Frederick Albert Sutton Geology Building.

Bioswale near the Carolyn Tanner Irish Humanities Building
Photo by Isa Hanswille

A rain garden has the same function as a bioswale, but is planted on flat ground. It is designed with similarly water-efficient vegetation, so rainwater is all that is required to sustain the landscaping (Pomeroy 2012).

Bioretention is a system whereby pollution and sediments are captured from stormwater runoff. The Urban Water Research Group in the Department of Civil and Materials Engineering has several projects that model and monitor these systems on campus, including one adjacent to its own building.

Pervious pavement is porous pavement that allows stormwater to penetrate the surface and reach the soil below. This water can then supply trees and shrubs with water that would otherwise be lost into the stormwater system. Impervious concrete and asphalt surfaces do not allow such penetration. Instead, water falling on those surfaces drains into adjacent storm water systems. Pervious pavement is an alternative that allows precipitation to percolate into the soil and water adjacent trees and shrubs, reduce runoff, and potentially recharge groundwater (Strom et al. 2013). Pervious pavement is being incorporated into some of the new parking lots on campus. For example, the Natural History Museum's new 26,240-square-foot parking lot is paved entirely with pervious concrete (Astle 2013).

Pervious Pavement at the Natural History Museum of Utah
Photo by Jennifer Handel

Rainwater harvesting captures, diverts, and stores rainwater for later use. It is beneficial because it reduces pressure on existing water supplies, and reduces run-off, erosion, and pollution of surface water. It also can be purified and used as a source

of water in homes and buildings. It is important to note that different cities have varying policies on the legality of rainwater collection. Capturing rain means less water will flow to aquifers and creeks. If enough people capture rainwater, it could impact more distant users who may have legal rights to the water. Increasingly, however, restrictions on rainwater harvesting are being relaxed. As of May 2010, rainwater harvesting is now legal in the state of Utah.

The Natural History Museum of Utah has catchment cisterns located beneath the grassy areas on the south side of the building.

There are practices underway now that will reduce water needs within buildings. Low-flow fixtures enable indoor water use to be reduced. According to the U.S. Environmental Protection Agency, low-flow faucets can reduce the number of gallons used per minute from 2.2 gallons to 1.5 gallons, representing a 30% reduction of water use per minute. Low-flow toilets can reduce the standard use from 1.6 gallons per flush to 1.28 gallons, a 20% reduction. Across campus, low-flow fixtures are being installed in new buildings and are replacing older, more water-intensive fixtures.

Part of a rainwater collection system at the Natural History Museum
Photo by Isa Hanswille

Tap water at the U of U is Wasatch Water!
Photo by Keti Amirkhanashvili

Water Planning

Campus Master Plan

The University of Utah Master Plan contains a number of strategies and approaches to make campus more sustainable. Many of these are directed toward water wise planting and reduction of water use and runoff. The plans include incorporation of stormwater capture and reuse, pervious pavement, xeriscape planting, bioswales, usable green roof space, and rainwater harvesting into new developments.

Each new development in the Campus Master Plan contains sustainability efforts where water use is being taken into account. For example:

- The new Student Life Center plan includes usable green roof space and rainwater harvesting.

- Plans for the new South Campus Walk include permeable or locally sourced concrete with all drought resistant plantings.
- Sustainable design for the South Campus Housing Projects focuses on stormwater capture and reuse.
- The Stadium TRAX Link plan includes some xeriscaping and permeable paving.
- The HPER Mall restoration project includes provisions for the creation of bioswales

All new buildings and developments on campus are encouraged to incorporate sustainable designs. However, there is no comprehensive set of sustainability principles guiding water use on campus.

Grass and pavement, Health, Physical Education and Recreation (HPER). Photo by Isa Hanswille

Climate Action Plan

The University of Utah 2010 Climate Action Plan (CAP) states: "By 2020, the University of Utah seeks to achieve water neutrality"—a scenario where "campus would consume on an annual basis the equivalent of the average rainfall volume estimated to fall on campus."

According to Myron Willson, Director of the Office of Sustainability, "consume" refers to the total amount of water purchased from Salt Lake City in addition to the water pumped from campus wells.

The CAP's goal of achieving water neutrality was established for a number of reasons, including addressing indirect greenhouse gas emissions, the emerging trend of water scarcity due to climate change, and general sustainability.

Given the limited annual rainfall that reaches campus, "the University of Utah must be conscious of and responsible for use of this limited resource," Willson said. "In addition, water processing and transportation is tremendously energy intensive. While the carbon footprint from water use is not included in our greenhouse gas inventory, we still must be conscious of the impact. In light of an ever-increasing population demanding more resources, increased urbanization pressures, and increased trends of drought due to climate change, our limited water sources have the potential to become severely stressed, demanding more sustainable water conservation measures."

With approximately 16.5 inches of rainfall per year on campus, or 1.38 feet, and a total campus area of 66,864,600 square feet (National Oceanic and Atmospheric Administration 2013, Sustainability Tracking Assessment & Rating System 2013), we calculated that approximately 91,938,825 cubic feet—or 687,750,171 gallons of rain—falls on campus each year:

$$(1.38 \text{ ft})(66{,}864{,}600 \text{ ft}^2) = 91{,}938{,}825 \text{ ft}^3 = 687{,}750{,}171 \text{ gallons}$$

While we were unable to quantify the amount of water pumped from university wells, we do know from information provided by Energy Management Program Manager Jeff Wrigley that the university purchased and used 1,022,897,526 gallons in 2012. Based on this number, the university would need to cut its water use by 335,147,355 gallons, or about 33%, to achieve "water neutrality" and reduce its purchased water consumption to the "equivalent of the average rainfall volume estimated to fall on campus" (687,750,171 gallons). However, additional conservation would need to occur to account for the additional water pumped from campus wells.

Thus, to reach water neutrality by 2020, as the CAP prescribes, the university would need to decrease its water use by approximately 33% in fewer than seven years.

It is important to note that water neutrality is a somewhat arbitrary goal for water conservation. By the university's definition, this does not mean all the water falling on campus will actually be used on campus. Instead it sets a water use target at the equivalent amount of annual rainfall on campus, perhaps under the reasoning that if the university had the capability to capture and store all the rain that landed within its boundaries, it could supply itself through one year.

The CAP has identified specific strategies for improving "policy/purchasing", "systems/infrastructure", and "education/awareness" with regard to water on campus. From a policy/purchasing perspective, the suggested approach is to revise the university's purchasing policy to support water-efficient appliances. For systems/infrastructure, in the near term, the CAP suggests developing a plan to "reduce the volume of annual stormwater runoff

beyond campus boundaries by 50 percent within five years, and by more than 75 percent within 10 years," and a "10-year plan for enhanced water conservation efforts" in the mid-term.

Finally, in the category of education/awareness, the CAP advocates for establishment of "an administrative structure to facilitate campus-wide water-conservation and reuse," "a general education campaign for water-conservation," and the eventual integration of water-efficient technology into course work to provide opportunities for students, faculty, and staff.

Based on our assessment, there is significant variation in implementation of approaches to meet these CAP goals. The university has been successful achieving some of them—by supporting the purchase of water-efficient appliances and offering resources to help facilitate implementation of this approach (University of Utah 2013). Also, initiatives are underway that incorporate technology for reducing stormwater runoff through the use of bioretention systems such as bioswales (Burian 2013).

Our assessment also revealed that there are no administrative structures to facilitate improvement of water conservation and reuse, no general education campaigns for water conservation, and no 10-year plan focused on water conservation efforts. Integration of water efficient technology into course work appears to be minimal. We could not identify a campus-wide working group for outdoor landscape and irrigation practices that included staff, faculty, and students.

The CAP includes numerous goals for improving water use, management and education on campus. However, additional actions may be necessary for these goals to be achieved. Based on our understanding of the Campus Master Plan and the Climate Action Plan, and on our assessment findings, we offer several recommendations for improvement (see 'Room for Improvement' below) for consideration by the Facilities Management Department.

Grounds Department Initiatives

Water efficiency efforts that fulfill the goals of the University of Utah's Master Plan and Climate Action Plan are underway in the Grounds Department. The information presented here was obtained from communications with Sue Pope, Landscape Supervisor in the Facilities Management Department.

The University is adding low water-use plants and updating the campus irrigation system as money becomes available. When possible, drought-tolerant turf is installed where it can be separated from existing bluegrass and operated on its own irrigation valve.

Generally, when there is new construction, the Grounds Department looks for ways to improve the existing site to a water wise landscape.

In the fall of 2012, the Social and Behavioral Science Building upgraded its patio and gardens with water-wise plantings. Additional money was allocated for drought-tolerant landscape improvements. Also in 2012, turf around the Aline Wilmot Skaggs Biology Building and Intermountain Network Scientific Computation Center was updated with low-water use plants.

Xeriscaping at the Social and Behavioral Science Building
Photo by Isa Hanswille

Near the Jon M. Huntsman Center, turf was removed and trees, plants, shrubs and an irrigation system were installed. In spring 2013, the Huntsman Cancer Institute parking lot and the parking lot east of Rice Eccles Stadium will be updated. Plans are also underway to complete an irrigation system upgrade on President's Circle. Before the upgrade, according to Pope, walkways were being watered and sprinkler heads did not have matched precipitation rates.

A centralized computer system monitors landscaping water on campus. It cycles and soaks turf according to soil conditions, sun exposure, slope angle, and plant types. A weather station enables watering rates to align with precipitation rates. During rainfall, irrigation clocks are shut down as long as the precipitation is measurable.

To reduce runoff, watering times are continually adjusted. Also, when new shrub areas are installed, sprinkler heads are removed from the edge of the walks or street so water stays in the planting bed rather than flowing into storm drains.

Other Departments' Initiatives

S.J. Quinney College of Law

A new, LEED certified building for the S.J. Quinney College of Law at the University of Utah is planned for construction in the near future, and will include a range of efficiency features that promote sustainability, save energy, and conserve water.

A stormwater retention system will consist of rain gardens and underground retention tanks that will store all water from the building's hardscaped areas and roof. The tanks will slowly release water into the ground. Landscaping adjacent to the hard-

scaped areas will be designed to receive the storm-water runoff. Plants will be native and adapted vegetation that require significantly less water than traditional landscaping, adapted to thrive in warm, dry climates and survive cold, snowy winters. A rooftop rainwater capture system will direct all rainwater into the holding tanks to be used for landscaping and irrigation. The low-water use drip irrigation system will respond to specific weather conditions. It will feature efficient sprinkler heads and be tied into the campus irrigation system.

The new building also will have high efficiency plumbing fixtures, with 1.28 gallon-per-flush toilets, one-pint flush urinals, low-flow faucets, and low-flow showerheads. These features are expected to lower water consumption between 30% and 40% compared to using standard fixtures.

The College of Law also hopes to raise enough money to install a grey water treatment system. Grey water is generated from activities such as laundry and dishwashing, and a treatment system is required in order to treat that water (VCBO Architects 2013). For this to happen, dual supply plumbing for the toilets will need to be installed. This will allow for potable water to be used in case of a lack of grey water, or if there is a failure in the system. Sinks, showers and drinking fountains also would need a dual waste piping.

Frederick Albert Sutton Building

Faculty members in the Department of Geology and Geophysics have been advocates for xeriscaping and more logical uses of water across campus, and were instrumental in promoting a sustainable, water-wise building during a recent renovation. In an assessment interview, Department Chairman Kip Solomon described some of the features of the Frederick Albert Sutton Building—a LEED certified building that features xeriscaping, pervious concrete, an on-site stormwater capture and recharge system, a roof garden, and an energy and water metering system.

According to Solomon, the most significant water saver in the Sutton Building is the cooling water system. Instead of water running through the building to collect heat (a process that uses a massive amount of water), a coolant fluid circulates throughout the building. Solomon said the university would like to see this system installed everywhere on campus.

Rock garden, Frederick Albert Sutton Geology Building
Photo by Kate Kopischke

Xeriscaping at the Frederick Albert Sutton Geology Building
Photo by Kate Kopischke

Future Initiatives

The Grounds staff is actively engaged in designing and implementing water sustaining landscapes. For this assessment, Grounds Director Susan Pope and Technology Specialist Russ Jacobsen took time to prepare the following list of campus water-wise irrigation and landscaping projects they are proposing for the near future:

- Add second controllers to multiple athletic fields on campus to allow non-athletic zones to be controlled by irrigation central control system and weather station.
- Convert weather station to permanent power and communication.
- Add communication and or radio equipment to University Hospital controllers #119, 120, 140, 150 and to connect to central control system and weather station.
- Install hydrometers on systems missing them.
- Landscape improvements along Mall Way, such as incorporating a dry river bed and adding large trees and plantings
- Remove park strips from parking lots and place trees in raised planters to produce cooling green space with drip systems
- Replace planters that are currently running off old irrigation systems to drip systems
- Convert the north road Merrill steep grass slope into terraced planting areas with more drought tolerant trees and shrubs.

These are encouraging initiatives that are consistent with the university's climate planning and master plan goals, and with the strong support among students for less water-intensive landscaping on campus (see 'Student Perspectives and Awareness' section).

Recommendations for Improving Water Use and Management on Campus

1. Basic Monitoring

As our research revealed, the University of Utah does not have a mainstream water monitoring system on campus. Without one, it is not possible to calculate secondary water use or how water is disbursed among buildings and turf area. Such a system would provide insight into where water use can be reduced, or should be increased. It is encouraging that Energy Management is working on improving its metering system to better manage water in the future (Wrigley 2013).

2. Coordination and Communication

Our assessment indicates a general lack of coordination, knowledge, and communication with regard to water use and management on campus. It was difficult for our assessment team to find out exactly how much water the university uses, or where this use occurs.

Across campus, individual faculty members, students, Facilities Management staff, and some independent centers (such as Red Butte Garden), are all working to improve water use and management on campus. From conservation to decreasing the volume of runoff to storm drains to creating aesthetically pleasing low-water landscaping, there is extraordinary work occurring at the university. Yet there is a notable absence of collaboration or a university-wide dialogue about broad solutions to water issues, and no clear initiatives or avenues for cross-disciplinary communication and coordination on water issues.

There appears to be high demand and opportunity for more collaborative efforts around water. Virtually everyone we spoke with during this assessment expressed a desire for more accessible information pertaining to water at the university, expanded learning opportunities, and concrete action on water issues.

As our survey results show, 41% of undergraduate students believe water conservation at the University of Utah is "very important," and 27% believe it is "important." On average, students surveyed said they would be willing to pay an additional $4.06 per semester for water conservation efforts at the University of Utah.

Similarly, there is widespread recognition of the importance of improved water management among members of the administration, faculty, and staff. As Mike Perez, Associate Vice President for Facilities Management, notes: "[Water conservation] fits within the broad definition of sustainability—exercising actions and decision-making today that will impact, and hopefully leave a quality environment for, generations to come."

Myron Willson, Director of the Office of Sustainability, went a step further, expressing hope for water conservation to be a means of achieving greater understanding of and engagement with sustainability in general by the University community. "For example, a lot of people engage [with sustainability] because of food," he said, "They want it local, they get involved in gardening and then they start to realize about food systems... transportation costs, and the climate impacts of food. I think water is kind of the same thing."

As Jeff Wrigley, a manager on the Facilities Management team, noted: "Water management is an important issue [that] will most likely only increase in its importance over time."

PROJECT PHASE 2: Preparing the Next Generation—Engaging Students through Education and Research

One of the best ways to facilitate change is through education

In our view, the best place to begin stimulating further student awareness about watersheds and the effects of climate on water systems and conservation is in the classroom. Here, instructors can encourage and direct their students not only to be mindful of water and its many uses, but also to learn what it means to be environmental stewards and understand the critical role of watersheds. Living in an age of global population growth, climate change, and rapidly evolving societies, understanding and embracing sustainability is increasingly pertinent. Future generations must be inspired to take action on behalf of our changing world. Water, given its essential role in human life and society, needs to be protected.

Classes with a Water Focus

The University of Utah offers several classes that incorporate water into their curriculum. However, as a subject matter, water is not currently integrated directly, or indirectly, into the undergraduate curriculum, a perspective backed up by responses of faculty members interviewed for this assessment. Of the 31 faculty members who participated in our survey, 76% said water-focused coursework would be beneficial and that some courses exist, but more are needed.

Of existing classes with a specific water focus, most are in geology and civil and environmental engineering departments. For example, GEO 3300, titled "The Water Planet," deals with the physical and chemical properties of water, water politics, hydrology, water use, and water as a global resource. Another geology class, "Solute Transport and Subsurface Remediation" (GEO 5390), designs solutions to the problem of organic contaminants in groundwater aquifers. A Civil and Environmental Engineering course (CVEEN 3610), "Introduction to Environmental Engineering," is an overview of the profession and includes a focus on water quality.

Several classes focus specifically on water conservation. "Hydrotopia" (cross-listed in CVEEN and philosophy) is a course taught by Steve Burian and Ed Barbanell, who participated in this assessment, that examines the aridity of the west and the region's changing socio-political climate. The class looks at the historical evolution of our area, from one where inhabitants had a vision of a hydraulic society to the present day, where due to population explosions and higher demand, water is gradually becoming a scarcity. The curriculum aims to prepare students as the next generation of engineers and social scientists who will shape the future of water in the west.

A somewhat similar class is found in GEOG 3290, "Water in Utah." Here, students learn about where water is found in the state, how it is used, and ways it can be conserved.

Classes in biochemistry, molecular biophysics, pharmaceutics, geochemistry, hydraulics and biology are also taught with an emphasis on water, but these mainly consider its physical properties and not methods of conservation. Naturally, the classes discussed above do not comprise an exhaustive list of classes that deal with water conservation. Still, by perusing the Sustainability Certificate Course List, it appears as though water-focused classes are lacking (EPA 2013). These insights into the curriculum at the university lead an observer to consider that, possibly, more can be done in order for students to learn about conservation. As such, the potential for new classes and programs is great.

Potential for New Classes and Programs

Our assessment indicates that people generally assume water is a discipline of science or environmentalism. However, based on our research and input from participants in surveys and interviews, we believe water can and should be considered from a wider array of perspectives and disciplines.

For example, poetry and literature often contemplate the crucial role of water. English professor and 2009 Utah poet laureate Katharine Coles noted that while literature courses would not typically be structured around "water conservation" or "water awareness", students could nonetheless "take away some deeper connection to water, both as a literary figure and as an actual thing in the world, [as] this is how poems make us better people."

Political Science, public policy, and law curricula also offer courses that incorporate or focus on water (i.e., Policy Analysis [POLS 5323], Water Law [LAW 723], etc.). While these courses train smaller groups of graduate or law or students, rather than a broad section of undergraduates, there is general agreement among participants in the assessment that water is a topic with relevance to many departments and disciplines.

Some suggested that the Block U Program (an initiative that bundles general education, support for student success, and integrated learning) could be a logical place to integrate a water-based curriculum. The Block U program involves problem-based learning and research, and is organized around

University of Utah . Photo by Isa Hanswille

Marriott Library Plaza. Photo by Keti Amirkhanashvili

specific themes, such as global citizenship, sustainability or creativity and community.

Steve Burian, Professor of Civil and Environmental Engineering, offered a different perspective regarding development of new, water-focused coursework—either in the form of Block U or an integrated minor. In his view, most majors that focus on the water profession already have the basis of a water minor in their curriculum. He acknowledged that the addition of water-focused educational programs focused would be feasible, but questioned its practical value, particularly among engineering students. Nonetheless, Burian said if a water-related Block U or integrated minor program were to be created, it should be useful, attractive to a diversity of majors, and should prepare students for work beyond college.

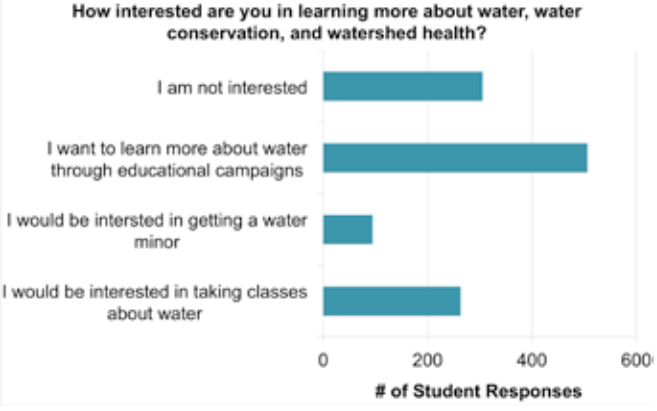
Student interest is another method of focusing more coursework on water. Jack Newell, former President of Deep Springs College in California, and former Dean of the Liberal Education Program at the University of Utah, suggested a model used at Deep Springs, where students are encouraged to define a topic of interest to learn more about. After selecting their topic, they then approach a faculty member with expertise on the subject, and the faculty member crafts several course options around the students' desire to learn.

For example, if a group of students is interested in watershed health, a faculty member would craft two different classes according to his or her expertise in the area. He or she would then give the two different syllabi to the prospective students to assess which class best fits their interest.

While initiating this kind of a program may prove challenging at a larger school like the University of Utah, it may be worth considering at the departmental level. Indeed, our Honors Think Tank on Wasatch Water was created by the Honors College in response to the desire of a previous class of about 25 students who were interested in sustainability and the environment.

Student and Faculty Interest

A majority of respondents to our undergraduate survey expressed support for the addition of water-focused education at the University of Utah. Twenty-eight percent said they would be interested in taking classes about water at the university that would fulfill some of their undergraduate requirements, while another 40% said they would like to learn more about water through websites with useful information or flyers and placards posted around campus. Only 32% said they would not be interested in such classes or information.



According to fall 2012 enrollment statistics, 24,840 undergraduates are enrolled at the University of Utah. Assuming our survey results are representative of those undergraduates, there are nearly 7,000 students who expressed interest in enrolling in classes dealing with water. Increased education around campus in the form of flyers or websites may translate into even greater numbers expressing an interest in specific coursework focused on water.

As previously noted, 76% of faculty agree that there needs to be more water-focused coursework on campus. When asked, "In what ways do you think the University of Utah can improve undergraduate education efforts on water related subjects?" faculty responses fell into two general categories: (1) The U has to set an example of conservation, and more courses are needed; (2) more courses are not necessarily needed, but an interdisciplinary approach to water education would be beneficial.

According to Jack Newell (former Dean of Liberal Education), one way the university can improve is to "find 10 faculty willing to team up and create courses across departmental and college lines." In this way, conservation could be promoted via collaborative and integrated approaches.

Ten of the 13 faculty members interviewed responded positively to the idea of introducing an integrated water minor or similar program that would satisfy general education requirements around water—including the study of water in nature, urban areas, and water sustainability.

Most interviewees also offered perspectives on why a water education program was important. For example, Gregory Lee, Executive Director of Red Butte Garden, said a liberal education on water would be beneficial because "it teaches students to think rather than learn a certain set of skills. Most skills become outdated." He also said that as water becomes scarcer, a liberal understanding of water will be increasingly valuable. It is interesting to note that Red Butte Garden is an extremely valuable resource that should be incorporated more into the undergraduate academic setting. In particular, the new Water Sustainability Garden

being developed at Red Butte Garden is very appropriate to the curriculum that students expressed an interest in seeing developed.

Ed Barbanell, Associate Dean of Undergraduate Studies, said the addition of "water" to that list of themes would be both appropriate and valuable for students. Creating such an educational program for water would be "exciting and multifaceted," he said, adding: "There are so many contexts/ conversations in which water is central. Given that we live in the arid west, in which the scarcity of water is the prevailing environmental reality, our students (and our community) need to know much more than they do now about water in the west and along the Wasatch Front. It would benefit them tremendously." He sees the potential for many different educational contexts and conversations about water, including scientific, political, economic, environmental, technical, and global interests.

There was general agreement that water courses should be taught by people with expertise on the topic. One interviewee observed that in some Utah universities, people who are uninformed about water are teaching classes in the water conservation major program. This interviewee suggested that if the University of Utah were to implement a similar program, it should establish strong partnerships with entities on and off campus.

Graduate student Thomas Walsh also stressed the importance of partnerships. "Greater interaction of university in education and outreach is where I would put greater efforts," he said.

Geology and Geophysics Professor Kip Solomon, whose "Water Planet" course is open to all students and satisfies a general education requirement, said additional courses of this nature would be beneficial, but they must include education on the science and mechanics of water by informed instructors.

In the Grounds Department, Susan Pope and Russell Jacobson suggested that classes should include material on indoor efficiency, irrigation techniques (such as water harvesting), and water-efficient turf. Sources such as EPA Water Sense and the Irrigation Association could be used to communicate this information, they said.

How We Stack Up: Pac-12 & Other Utah Universities

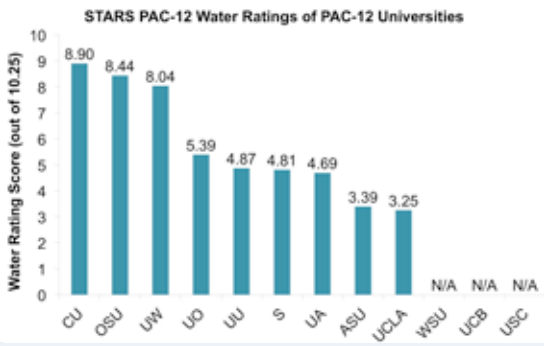
During the 2012-2013 academic year the Environmental Protection Agency tracked green power usage for collegiate athletic conferences (Environmental Protection Agency 2013). The University of Utah ranked first place in the Pac 12 for green power purchased; it bought more than 95 million kilowatt-hours (kWh) of wind power, minimizing its purchase of fossil fuels. In total, 31% of the university's energy is green (Environmental Protection Agency 2013). This is a notable accomplishment that reflects the increasing support among students, faculty, and administrators for preservation and sustainability.

In a separate report, however, the university fell short. This deficiency seems to be reflected in water-related programs, and a lack of accessibility to information about such programs.

The Sustainability Tracking, Assessment & Rating System (STARS) is a self-reporting framework for colleges and universities to measure their sustainability performance. When comparing the sustainability records of nine of the Pac-12 schools, the University of Utah is the only school with a bronze rating—compared to eight other Pac-12 schools that earned gold and silver rankings. (The University of California-Berkeley, USC, and Washington State did not participate in the survey.)

The University of Oregon and University of California at Los Angeles were the only two schools to receive a silver award, while the other six reporting schools received gold awards.

In analyzing these schools, we found that universities with a higher rating tend to offer more programs involving water, and publicly available information about water at these schools is easier to locate than at those with a lower ranking.



STARS Pac-12 Water Ratings

The Sustainability Tracking, Assessment & Rating System (STARS) is a self-reporting sustainability framework for colleges and universities. There are three overall sustainability ratings: gold, silver and bronze. A gold rating represents the most sustainable schools while bronze represents the least.

Of nine Pac-12 schools that reported, the University of Utah is the only school to receive a bronze sustainability rating.

The figure above is a comparison of all Pac-12 schools and where they stand in regard to water sustainability on the STARS website. There are seven categories that make up the water rating: water consumption, stormwater management, waterless urinals, building water metering, non-potable water usage, xeriscaping, and weather-informed irrigation (Sustainability Tracking Assessment & Rating System 2012).

For example, Oregon State University, which received a gold ranking, offers a degree program in Water Resources Science for graduate and undergraduate students, and has an institute for water and watersheds. The school also provides opportunities to complete "integrative water research for a changing world." The University of Utah has no comparable program. Rather, it offers a handful of courses that cover or focus on water, and some opportunities for research, but offers far fewer opportunities to work in the area of water compared to schools who received a gold STARS ranking. Silver ranked schools also appear to offer a larger range of opportunities for water and education.

Our assessment also compared the University of Utah to other universities in the state.

Utah State University (USU) has a number of water-focused educational initiatives. In addition, USU's sustainability policy lists three sustainable goal areas: environment, economic, and social. It also includes an explicit water draft policy comprised of a sustainability council and water committee that recommends, develops, and implements sustainability programs (Utah State University Sustainability Council 2008)

USU also offers Master's and PhD programs in watershed science, and an undergraduate minor in watershed science. Information related to sustainability is easily accessible and located in one place on USU's website.

The only other school with a water-focused degree program is Utah Valley University, which offers a certificate in water and wastewater operations.

Although the University of Utah, along with Weber State University and Brigham Young University, are making significant strides toward water conservation on their campuses, these institutions do not yet offer degree or certificate programs focused on water issues.

Opportunities for Research: Red Butte Creek and Red Butte Canyon

The University of Utah is located in a geographically unique area. It sits at the base of pristine Red Butte Canyon and has an abundance of research opportunities related to water in a natural setting (Ehleringer et al. 1992). Furthermore, given that Utah is the second driest state in the nation, innovative water conservation techniques in urban settings are even more important. The unique water features of the University of Utah campus make it a prime opportunity to develop outdoor laboratory experiences for students.

Based on our research and assessment interviews, we believe opportunities exist for nearly all disciplines at the University to utilize these resources and integrate physical water systems into their curriculum. The University has an opportunity to facilitate accessibility to these unique resources, for research, aesthetics, and as a social gathering place.

Red Butte Creek as it runs through Fort Douglas and Research Park. Google Earth photo

Red Butte Creek is an unique water system for research and education. Its upper section in Red Butte Canyon is closed to the general public to keep it pristine and available for research. This canyon is home to extraordinary biodiversity and is an undervalued asset to the university. Although it is used for research by a select few, opportunities exist for a variety of disciplines to access this canyon. The impact of humans on the landscape here is immediately apparent when you reach the gate at the entrance of the canyon. The lower side of the gate is heavily impacted by humans and therefore is heavily eroded. A few feet away, on the upper side of the gate, there is a vast increase in biodiversity and a notable reduction in erosion. Upon entering the canyon, one is immediately taken back by its beauty and the abundance of wildlife.

Where Red Butte Creek exits Red Butte Canyon, it enters the University of Utah campus and flows through Fort Douglas and Research Park. Here, the banks of the creek are being eroded at a high rate due to human use and heavy stormwater runoff. Currently, there are a myriad of ill-defined trails in this area and the negative impacts due to this are easily visible.

Recommendations for Educational Opportunities

1. Increase the Number of Water-Focused Courses

The Hydrotopia class (cross-listed in civil and environmental engineering and philosophy) is a course taught by Steve Burian and Ed Barbanell. In our view, this type of class is the direction the University should be taking in regards to education: it creates awareness in students of their surroundings, invokes a desire for improvement, and educates future leaders on the importance of water. Classes like this should be tailored for undergraduates as well as graduate students.

There is much to learn about water not only from textbooks, but also from the natural environment in our own back yard. The University of Utah is fortunate to be situated at the crossroads between an urban and ecological setting, offering potential to go beyond the typical classroom experience and to facilitate a holistic approach to water-focused coursework. Therefore, we suggest additional courses be offered that could include, among other things:

- Learning excursions into the nearby canyons
- Research opportunities focused on Red Butte Creek, the Great Salt Lake, or other features of the watersheds entering the Salt Lake Valley
- Humanities or literature classes that emphasize the importance of water and its application across many disciplines.

2. Expand Collaborative/Interdisciplinary Working Groups and Research:

Our assessment reveals a general eagerness among students, faculty, staff, administrators, and off-campus groups to work on water issues at the University of Utah. However, there appears to be little or no on-going dialogue between these groups, and no campus wide conversation about water management or water education. Therefore, we recommend the university explore a collaborative, interdisciplinary process to link the engaged, but disconnected, groups who are working on water issues at the university. This could mean formation of collaborative working groups, or creating an online forum through the university's website, where different groups can interact and share ideas for progress.

Opportunities for collaboration are many, and they could yield significant results. For example,

we believe urban planning students could learn much from the innovative landscaping designs of the new Red Butte Water Conservation Garden. Marketing or communications students could assist engineers developing revolutionary water retention techniques to increase public awareness of their projects. Biologists could work with Facilities Management staff to determine the effects of university policies on water quality, etc. In essence, the idea of collaborative approaches and information sharing is to get those already working on water to work together.

Water can be explored academically from nearly any academic discipline, and given its universal, eternal importance in the human experience, we recommend the university expanded its interdisciplinary research in this subject. We believe interdisciplinary research/projects could allow for tremendous opportunities to advance knowledge, including but not limited to place-based research on our campus. Considering that such place-based research is still in its infancy on our campus, a greater understanding of water resource management, water sustainability in urban settings, and alternative water use practices could be implemented to help improve student awareness, education, and research opportunities.

3. Incorporate Red Butte Creek Into the Campus Master Plan as an Asset for Research, Education, and Relaxation

The section of Red Butte Creek that runs through campus is in need of restoration and long-term riparian corridor conservation plans. A plan for a trail system that includes designated gathering areas should accompany restoration and conservation efforts. There is already a large amount of erosion due to human impact and a designated trail system would mitigate this erosion, as well as provide a relaxing place for students. This could be coupled with signs that explain the importance of protecting the riparian corridor.

Red Butte Creek and Red Butte Canyon have a plethora of possible research opportunities for a wide variety of students. This could include anything from analyzing water quality to studying the biodiversity of the system. Sections of the river designated for research could be incorporated into the trail system as to mitigate the impacts of human traffic.

In addition to using these resources for research in the sciences, they could also be a source of inspiration for the arts and humanities—for writers, painters, musicians, and philosophers. The pristine nature of Red Butte Canyon can compel academic work and provide an opportunity that sets the university apart from other schools. If the canyon is to be used as a place for increased academic learning, however, great care must be taken to preserve it. Users should clearly understand the value of this resource, and designated research or 'classroom' areas should be established. The process of conducting human impact studies and conservation plans could be an academic experience in itself.

4. Institute a "Water Conservation Fund"

Nearly 60% of students who responded to our survey said they would be willing to pay at least $3 in additional student fees per semester to contribute to water conservation efforts on campus.

In fact, the total average amount students say they are willing to contribute through student fees is $4.06 per semester. Given there were more than 32,000 students who attended the university in the 2012 semester, such a fund could yield nearly $100,000 per semester, depending on the amount of fee increases (Office of Budget and Institutional Analysis 2013).

Whether student fees are ultimately used as a vehicle to fund water conservation efforts, it is clear students desire greater investment in water conservation and management on campus, and students are even willing to pay more fees to fund such efforts. These funds could support projects such as improved water monitoring and management systems, native landscaping, installation of water efficient devices (i.e. toilets, faucets, urinals, sprinklers, etc.), bioretention projects, and education campaigns dedicated to awareness and further use of such projects.

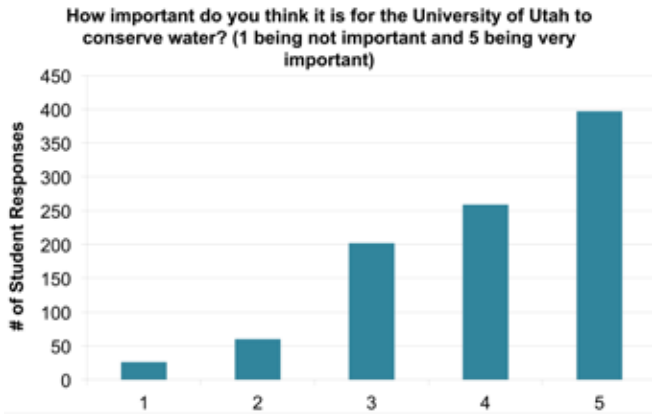
We believe the university could establish a fund to fast-track water conservation efforts by Facilities Management, students, and others on campus. Facilities Management is currently hindered in completing irrigation and landscaping water conservation projects due to a lack of funds. The department's backlogged water conservation projects include installation of controllers, hydrometers, drip irrigation, drought tolerant plants, and more.

Although there are numerous ways in which such a fund could be instituted and managed, it is imperative to recognize and respond to the willingness of students to invest in water conservation and new management systems.

Such a fund has the potential to position the university as a regional, if not national, role model for sustainable water use, move our institution closer to its goal of water neutrality, meet student demand, better prepare the university for probable water price increases in the future, and likely save the university money in the long-term. It also could facilitate development of tangible solutions to water issues, providing visible examples of the university's commitments to sustainability and innovation.

5. Explore Student Interest in and Support for Water-Efficient Landscaping

Through our interviews and surveys, we observed a desire from all facets of the university for greater water conservation on campus. When asked about the importance of water conservation at the University of Utah, on a scale of 1 to 5, 41% of students said it was very important, and another 27% said it was important. In other words, 68% of students—or more than two-thirds of students, consider water conservation at the University of Utah as an important priority.



There are many ways water conservation can be implemented, from indoor solutions such as changing fixtures, to outdoor solutions like watering landscaping more efficiently. We recommend that the University pursue water conservation through continued reduction of grass on campus, which our data suggests students support.

Although most students said they enjoy the grassy areas of campus, 85% also say they favor replacing some existing grass with other landscaping. It seems that while students do appreciate grassy areas, they also feel there is too much grass on campus. When given multiple options, students said some of the grass should be replaced on campus by trees (63%), native vegetation (59%) or xeriscaping (48%), flowers (39%), walkways (27%), permeable concrete (25%), or water features (21%). Only 15% said they would not support measures to replace any of the grass.

While water conservation benefits of replacing grass would vary with different landscaping alternatives, the second and third most supported options (native vegetation and xeriscaping) are known for their water efficiency. Additional scoping is needed to determine where exactly students would support reducing grassy area, but based on our findings, it seems students support diverse campus landscaping and less grass.

These survey results indicate student opinion is consistent with the university's goals to decrease water use and achieve water neutrality by 2020. With extensive construction occurring across campus, we believe there are ample opportunities to replace some grassy areas that will be disturbed by construction in any case with native vegetation or other lower water-use alternatives. As Landscape Supervisor Sue Pope noted: "Whenever new construction occurs [Facilities Management looks] at ways of improving the existing site to water wise landscape."

We recommend the university explore options for reducing water use on campus through changes to campus landscaping and expediting installations of water-efficient landscaping when possible.

6. Consider New Undergraduate Programs Centered on Water

According to Associate Vice President Mike Perez, "Water may be the most precious and limited commodity" in our region. It is an extraordinary compound, universal to the human experience, the bedrock of civilization, and a critical component of many academic disciplines. Water can be explored from chemical, biological, recreational, technical, legal, literary, medical, cultural, artistic, political, historical, environmental, and international perspectives, among others. The educational opportunities in any of these contexts are nearly endless."

In the words of Myron Willson, Director of the Office of Sustainability: "[Water is] wonderful because of the [interdisciplinary nature] of it; there's

political scientists and lawyers and civil engineers and planners and biologists. It's pretty amazing."

We support these sentiments, and recommend that the university strengthen and develop additional educational programs—in the form of a Block U Program, integrated minor, or other approach—around the topic of water.

We acknowledge concerns about the practicality of such a program, and agree that care must be taken to ensure any new educational programs add real value to undergraduate education—as Professor Burian and others caution. In our view, these concerns can be addressed via collaborative planning and decision-making. Given the regional importance—and indeed urgency—of water, along with its inherent applicability across disciplines, we believe it is a topic around which students could fulfill general education requirements, and gain the skills and competencies required to manage and conserve this precious resource.

7. Prioritize Action in the Climate Action Plan

While action has begun on several of the CAP water goals, we believe much work is left to be done. The university should begin immediately reducing water use if it is to meet its goal of a 40% reduction before 2020, as the CAP outlines. Timely establishment of "an administrative structure to facilitate campus-wide water-conservation and reuse," could be the logical first step to reaching the other CAP goals. Such a structure could assist in achieving the CAP's other goals, developing and implementing a "plan for enhanced water conservation efforts," a plan to substantially reduce stormwater runoff, and a general water conservation education campaign.

We believe the Office of Sustainability would be the appropriate place to house the "administrative structure to facilitate campus-wide water-conservation and reuse." However, if placed within the Office of Sustainability, this administrative structure should serve to reinforce other sustainability efforts, including the university's climate change mitigation efforts.

To take on a project of this magnitude, given the Office's already numerous responsibilities, we recommend increasing staff size to ensure water conservation efforts do not come at the expense of other sustainability initiatives. In our view, the long-term financial savings of water conservation, in addition to moving the university toward more sustainable operation, would merit increased investment in staff, as many we spoke with expect water to grow increasingly scarce and costly in the future.

APPENDIX A

Our Fall Semester Learning Experience

Multiple dimensions and demands on water: conflicts between the American dream and sustainability

Perceptions: opportunities, conservation, sustainability, and the freedom to pursue the American Dream	*Jim Ehleringer (Distinguished Professor, Department of Biology)*

Water in a natural mountain setting: drinking water source, recreation and conservation

Introduction to human uses of Wasatch water	*Jeff Niermeyer (Director, SLC Public Utilities)*
The Red Butte Canyon Research Natural Area	*Jim Ehleringer (Distinguished Professor, Department of Biology)*
Preserving, protecting and managing the Wasatch watershed's public lands	*Gale Dick (Founder, Save Our Canyons) and Cathy Kahlow (District Ranger, Salt Lake District, U.S. Forest Service)*
Using and managing the Wasatch watershed for ski and summer resort development	*Onno Wieringa (General Manager, Alta Ski Area) and Ted Wilson (Director of Government Affairs, Talisker/Canyons Resort; Former SLC Mayor; Former Executive Director, Utah Rivers Council)*
A public need: protection of water quality and supply	*Jeff Niermeyer (Director, SLC Public Utilities)*

Water as an integral part of the urban environment

Municipal and commercial development opportunities, green and blue infrastructure opportunities, and new urbanism; municipal obligations, daylighting	*Nan Ellin (Professor, Department of City and Metropolitan Planning) and Brad Stewart (Manager, Development Review Team, Salt Lake City Public Utilities)*
Engineering and science foundations; flood control, ecosystem stability and restoration	*Michelle Baker (Professor Department of Biology, Utah State University) and Steve Burian (Professor, Department of Civil and Environmental Engineering)*
Conservation, restoration, and recreation along urban waterways	*Laura Hanson (Executive Director, Jordan River Commission) and Genevieve Atwood (Geologist, Great Salt Lake specialist, Friends of the GSL)*

Waterways, municipal water treatment, and the public need for clean water systems	*Laura Briefer (Water Resources Manager, Salt Lake City Public Utilities) and Hilary Arens (Water Protection Specialist, Utah Department of Environmental Quality)*
The public need: aesthetics, open space, and thrivability	*Thomas Walsh and Olivia Miller (The Red Butte Creek Project, University of Utah) and Marian Hubbard (Watershed Scientist and Planner, Salt Lake County Watershed Planning and Restoration Project)*
Collaboration and finding solutions to conflict	*Michele Straube (Director, Wallace Stegner Center Environmental Dispute Resolution Program)*

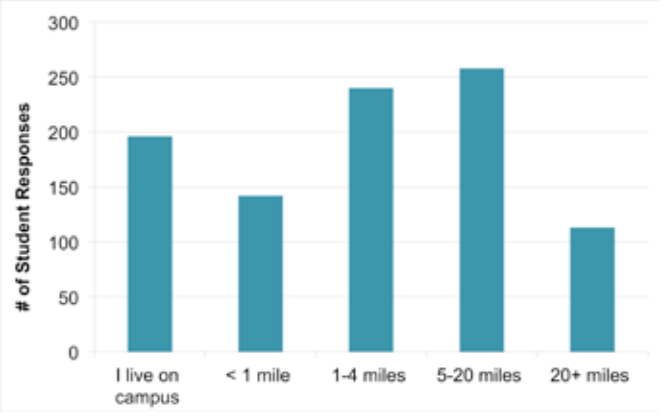
APPENDIX B

University of Utah Student Survey

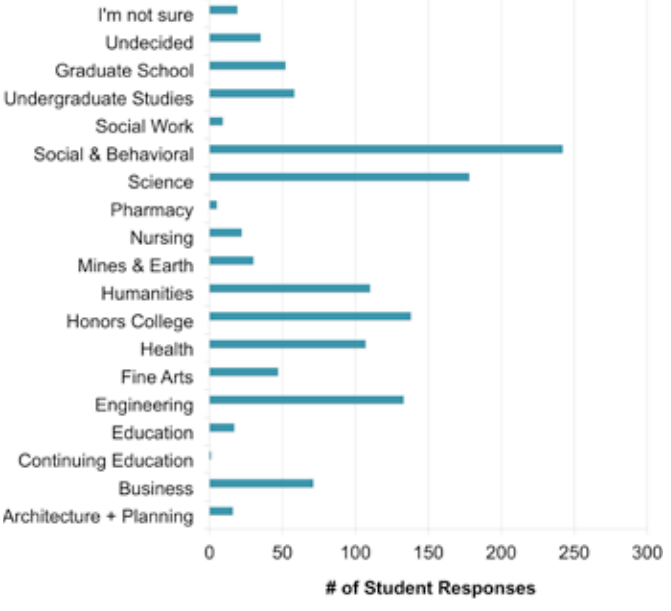
Below is the student survey in its entirety, as administered to mailing lists of University of Utah students during the months of January through March 2013. Also below are the data results and analysis of a total of 950 responses.

Introduction: This five-minute survey was compiled by a University of Utah undergraduate think tank focusing on water. The goal of the survey is to assess people's understanding of water use on campus. Thank you in advance for taking the time to respond to these questions.

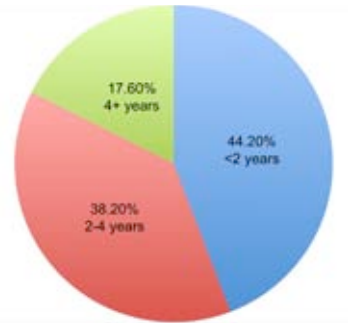
1. How far away from campus do you live?



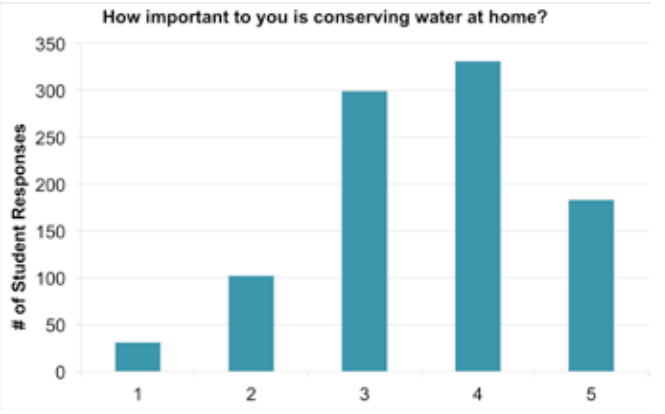
2. What college are you a member of? (Check all that apply)



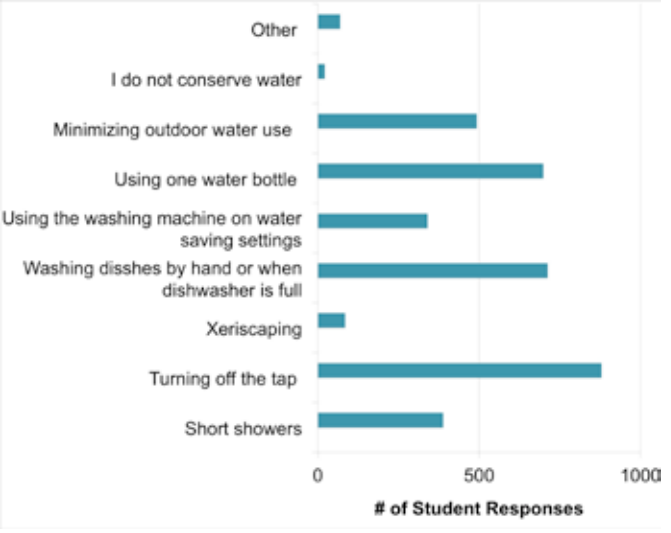
3. How many years have you attended the University of Utah?



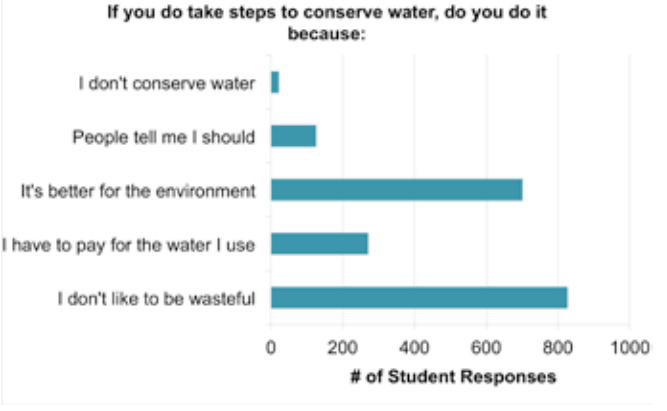
4. On a scale of 1 to 5 (1 being not important, 5 being very important) how important to you is conserving water at home?



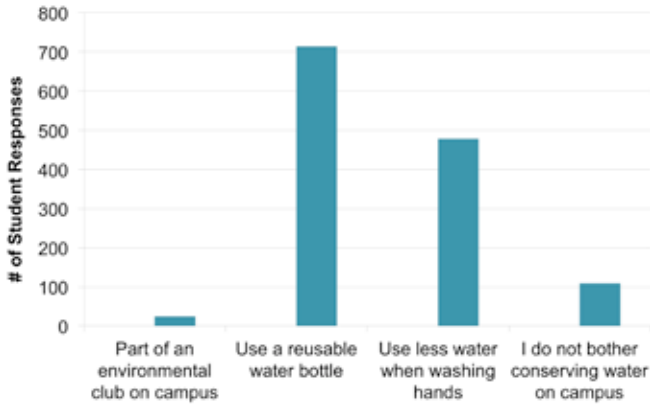
5. If you DO conserve water at home, what practices do you use? (Check all that apply)



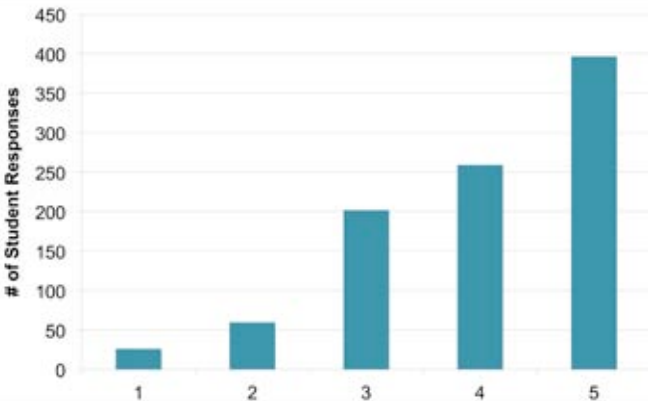
6. If you do take steps to conserve water, do you do it because: (Check all that apply)



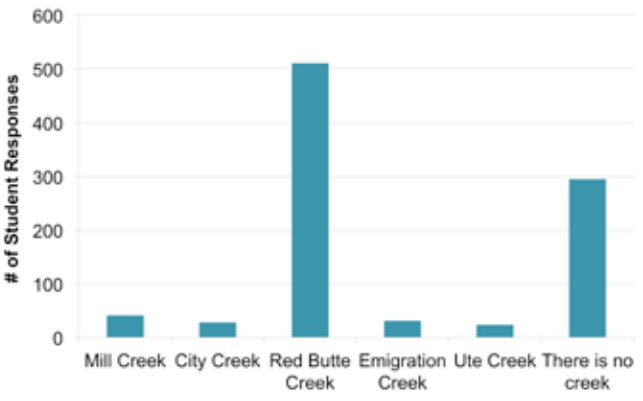
7. What practices do you employ ON CAMPUS to conserve water? (Check all that apply)



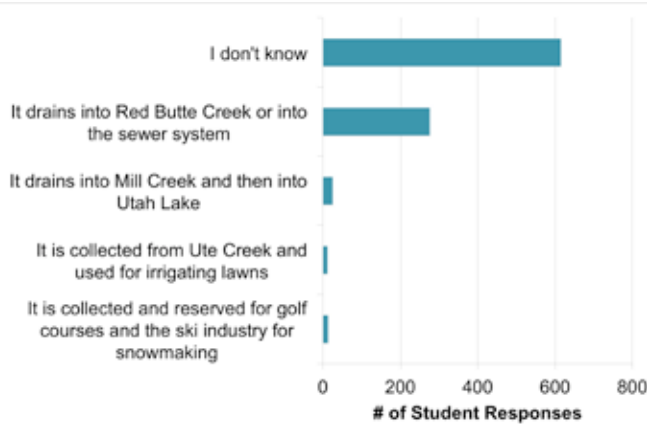
8. On a scale of 1 to 5, (1 being not important, 5 being very important) how important is it to you for the University of Utah to conserve water?



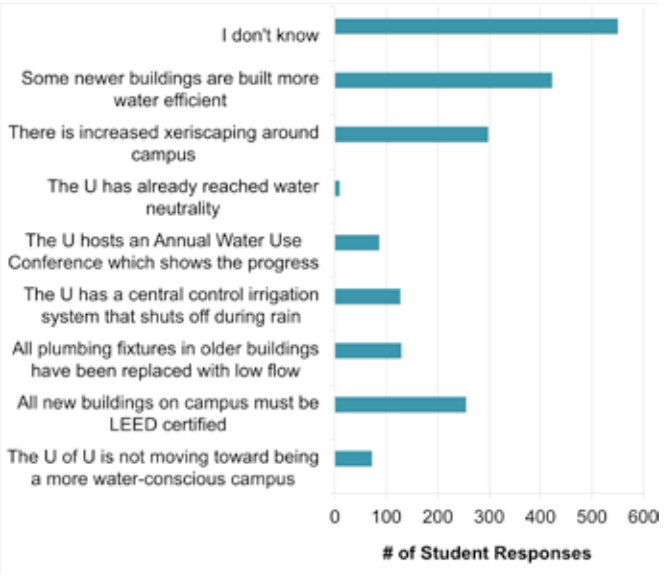
9. What creek runs through the University of Utah campus?



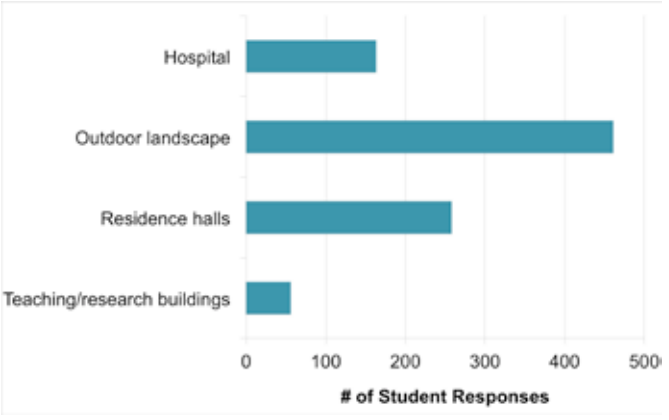
10. When it rains on campus, not all of the water goes into the ground. Much of it flows into stormwater drains. Do you know where the water goes after it enters the storm drains?



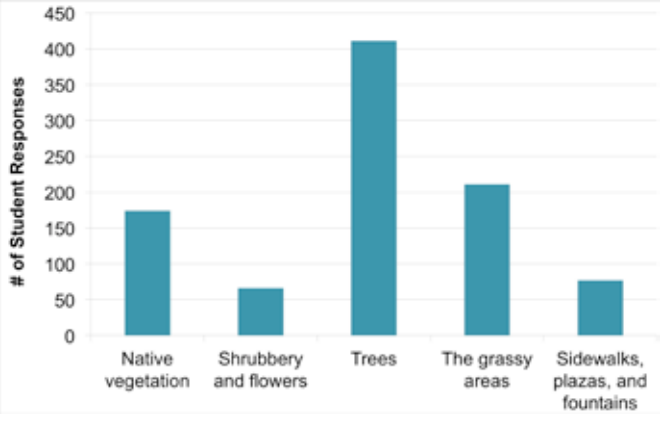
11. Which of the following steps is the University of Utah taking to be a more water-conscious campus? (Check all that apply)



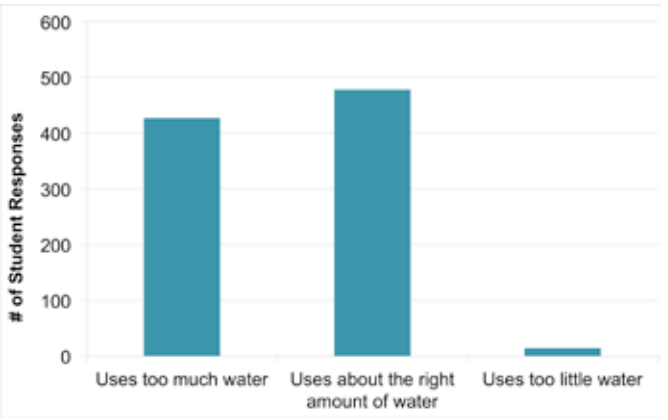
12. If the goal of the U is to reduce water use, it is important to first understand where water is being used on campus. Which of the following do you think uses the greatest amount of water on campus?



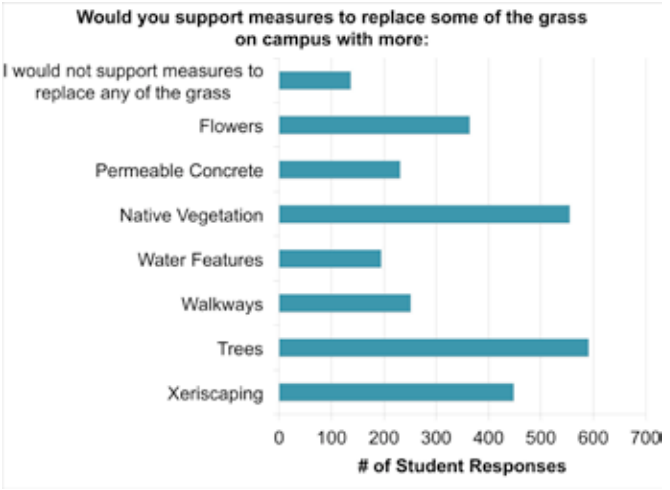
13. Which part of the campus landscape do you enjoy most?



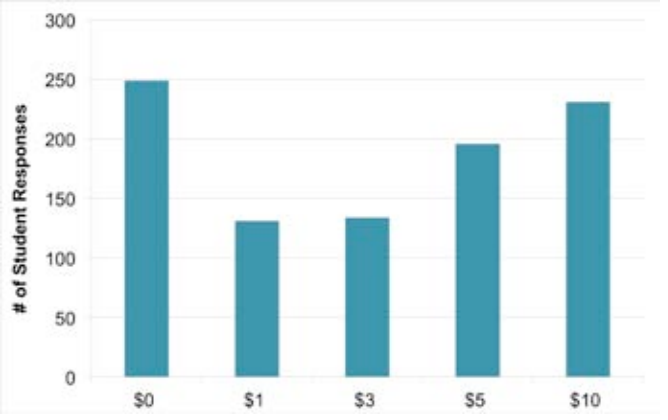
14. Do you think the University of Utah...



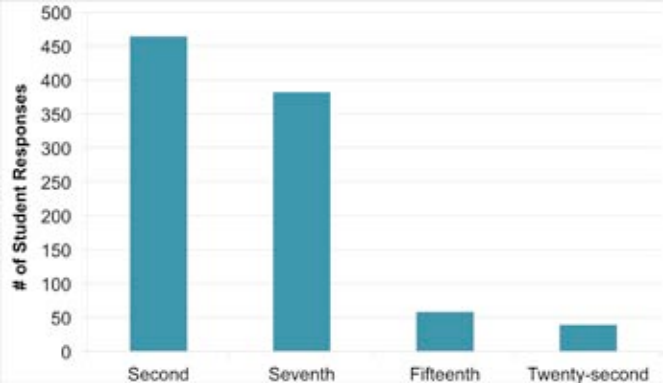
15. Would you support measures to replace some of the grass on campus with more: (Check all that apply)



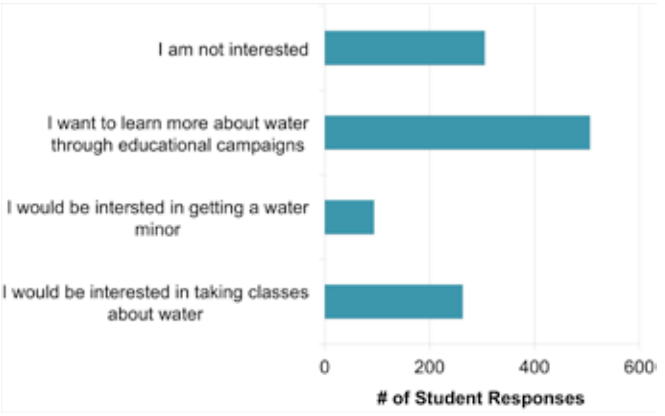
16. Conserving water is an effort that costs money. Would you be willing to contribute to a water conservation effort at the University of Utah through your student fees? If so, how much per semester?



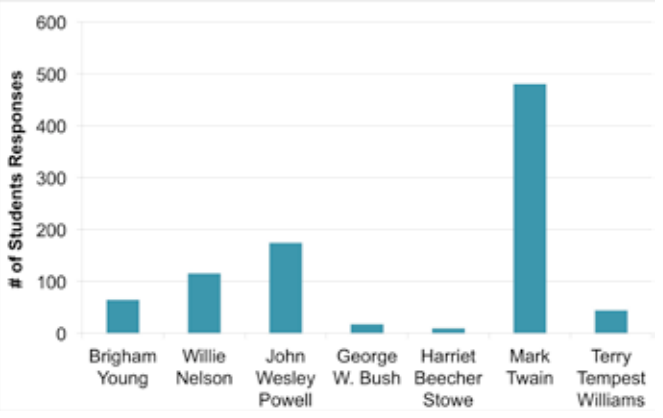
17. States are ranked in terms of their dryness. Where do you think Utah ranks on the list of driest states?



18. How interested are you in learning more about water, water conservation and watershed health? (Check all that apply)



19. Water is an important part of the history of the west. Who said, "Whiskey is for drinking and water is for fighting"?



APPENDIX C

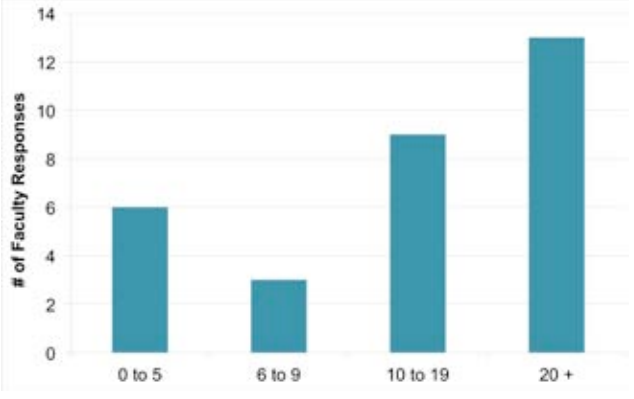
University of Utah Faculty Survey

Below is the survey that was administered to faculty in February and March of 2013. Below are the data results (where applicable) of the 31 responses. In questions involving short response answers, one or several responses have been chosen to illustrate present conditions at the U through individual faculty sentiment.

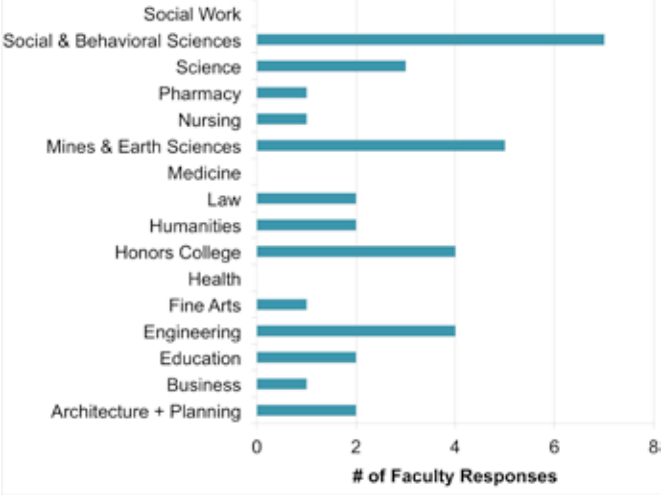
Introduction: The undergraduate students in the Honors Think Tank (Honors 3700-4) "Wasatch Waters: Evaporating Opportunities" are producing an assessment of water use on campus. This includes, among many aspects, how water is used, attitudes towards conservation, and how water fits into the undergraduate curriculum. Here is where we, as students in the class, could really use your input. We are hoping that you will be willing to complete the survey below.

This first section of questions is related to your background and awareness of water.

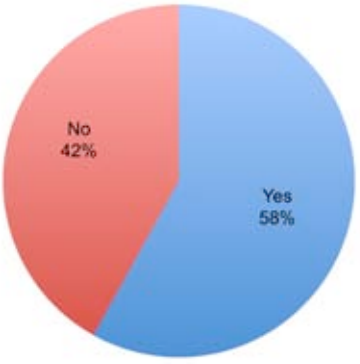
1. How many years have you worked at the University of Utah?



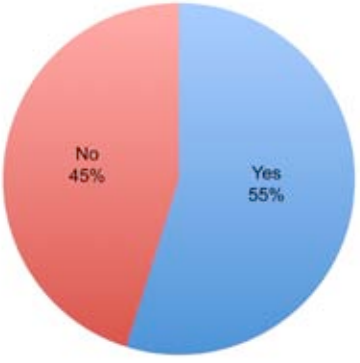
2. What College are you a part of? (Check all that apply)



3. Do you conduct research that involves some aspect of water?



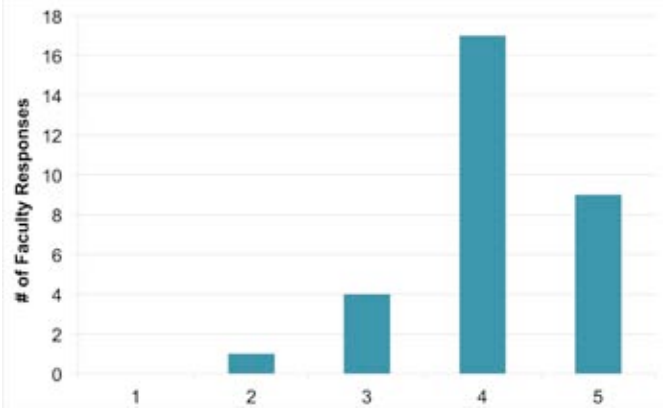
4. Do you currently teach courses that involve some aspect of water?



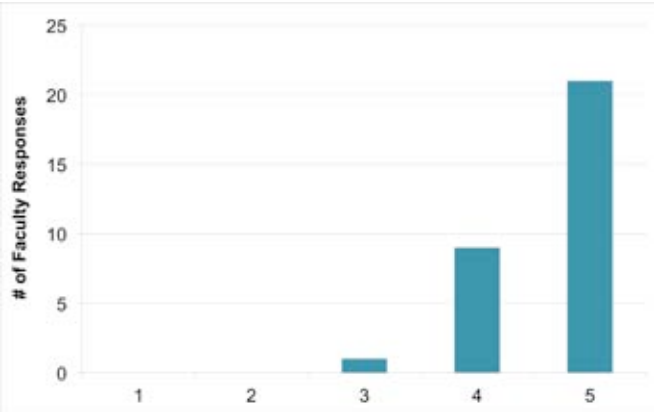
5. Does your department have specific long-term goals for water conservation? Yes or No. If yes, please elaborate.

This was a short-response question that faculty could express their thoughts with. A majority of respondents (amounting to 53% when the data were coded) stated that their departments do not have specific long-term goals for water conservation, with a only 16% stating that they do. Twenty-three percent are unaware of what their department may be doing in terms of conservation, while the remaining 6% made statements to the effect of their department having specific faculty who focus on the topic.

6. On a scale of 1 to 5 (1 indicating not important, 5 indicating very important) how important is conserving water to you?



7. On a scale of 1 to 5 (1 indicating not important, 5 indicating very important) how important do you think it is for students at the University of Utah to know about water conservation and sustainability?

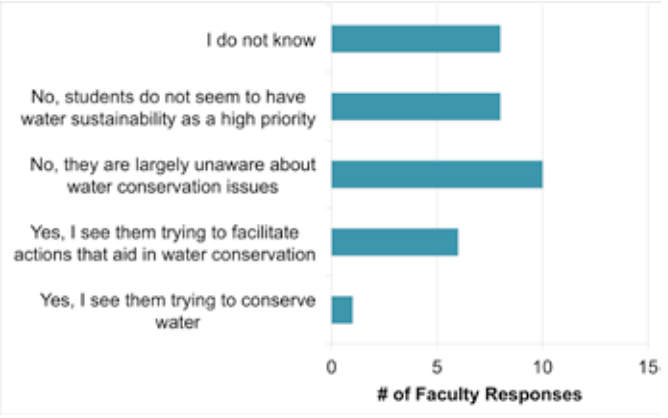


"Writing 3210: Travel Writing Workshop. We take a voluntary fall break river trip on the San Juan River."

8. If you currently teach or have taught courses related to water, please elaborate briefly with the title and description of the course(s).

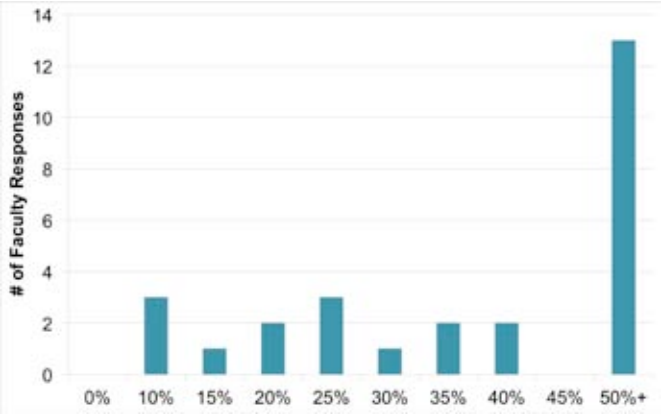
"Both [the] Urban Ecology and Green Communities courses include sections on water use, culture of water, comparative studies of use internationally, and celebration of water."

9. Awareness often comes from education. Do you think the students at the University of Utah are sufficiently aware of water scarcity, water conservation, and of the need for sustainability? (Check all that apply)

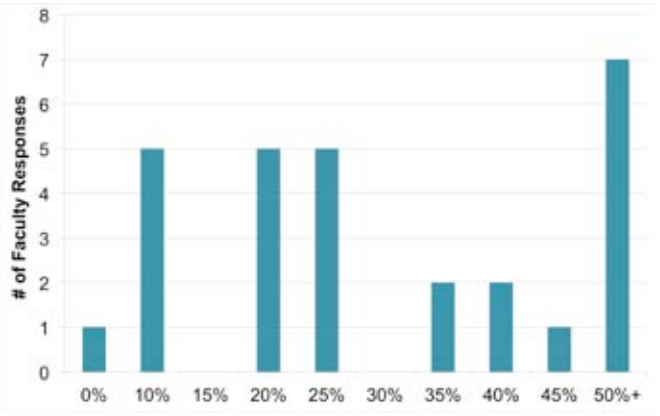


Water in the Curriculum: These questions ask about your perspectives on how relevant water issues currently are to the undergraduate curriculum.

10. Of the undergraduate students in your classes, what percentage do you think are aware of water-related issues, especially those related to water conservation and sustainability?



11. Of the undergraduate students across the University of Utah, what percentage do you think are aware of water-related issues, especially those related to water conservation and sustainability?

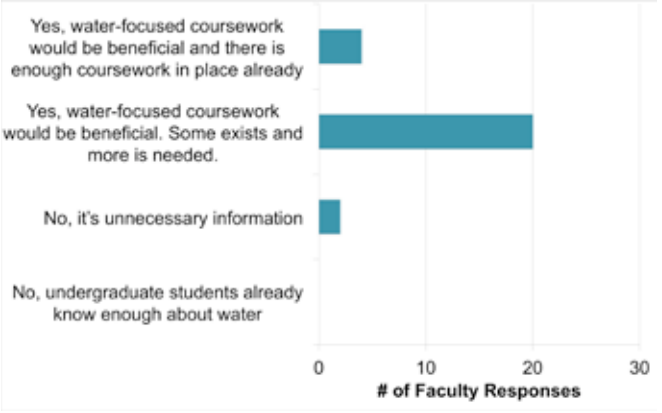


12. Water can be a part of the curriculum in every discipline. What classes are you aware of that involve a consideration of water?

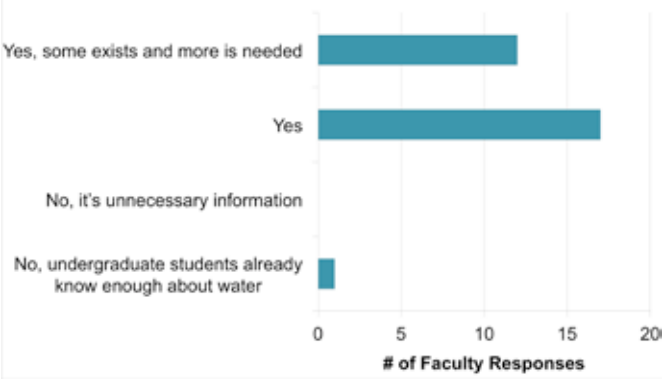
"[The] Pre-Law LEAP Service Learning class has had students working on water usage and preservation."

"All Water Resources and Environmental Engineering courses in Civil and Environmental Engineering."

13. Do you see a need for undergraduate coursework related to water, water use on campus and concepts of water sustainability?



14. Do you see a need for undergraduate educational campaigns related to water, water use on campus and concepts of water sustainability?



Faculty Mentorship: These questions ask about your perspectives on how faculty might help students become more aware of water in their undergraduate education.

15. Would you ever consider teaching a new undergraduate class related to water use and sustainability? (check all that apply)

16. What are your thoughts on creating the option for a student's general education requirements to be satisfied through a series of courses (existing and new) that focused on water—spanning from the arts through the sciences?

"Air, solid waste, water, and land should all be part of such a general ed course, not simply water. The ethical consideration of the whole environment is critical, not just water. In a snowy or rainy area, air quality directly impacts water quality (i.e. diesel exhaust on snow at the end of our great ski season). One aspect does not stand alone, much like conservation is not enough to maintain water quality into the future."

17. What are your feelings about the need for students to be aware of the contrasting aspects of water in both natural and urban regions, such as you would see in the Wasatch Mountains and the Salt Lake Valley? How would you suggest addressing this is an educational setting?

"Water conservation is one of the most important issues in Utah. I think it should be addressed educationally, probably in across disciplines from a number of perspectives/approaches."

"This starts with teaching students about the details of the both the natural water cycle, and then the primary anthropogenic uses of water."

18. In what ways do you think the University of Utah can improve undergraduate education efforts on water related subjects?

"I think a campaign led by students would be the most effective."

"Both specialized courses, interdisciplinary course[s] and content within broader courses as well as conferences and research."

"Put students, to some degree, in charge of such. Let them go to work."

APPENDIX D

Interview Questions

Below are the 8 questions that we used as a foundation for interview with faculty and staff:

1. What is your department/organization doing to make use of water more efficient on campus?
2. Do you have specific long-term goals for water conservation in your particular department?
3. In your time on campus, how has water use and management changed and how does it continue to evolve? Have you seen large trends towards conservation or efficiency?
4. How knowledgeable are people at the university, (administrators, students, etc.) with regard to water use?
5. We have discussed the idea of introducing an integrated water minor or something of the sort that would satisfy Gen Ed requirements around water. It would include the study of water in nature, urban areas, and water sustainability. What are your thoughts on this idea?
6. What would your priorities be to improve the use and management of water on campus? Would they be specific projects or general attitude shifts?
7. In your estimation, is water conservation a priority for the university?
8. Who else do you recommend we should talk to?

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The University of Utah sits at the foot of the Wasatch Mountains, our primary water source.

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the Honors College at the University of Utah.