Weber State University Energy and Sustainability Investment Plan (ESIP II)

February 1, 2015

Prepared for:

Weber State University
Facilities Management
2301 University Circle
Ogden, UT 84408

Prepared by:

E/S3 Consultants, Inc.
P.O. BOX 4595
ENGLEWOOD, CO 80155-4595
303-478-3729
es3consultants.com

TABLE OF CONTENTS

(THIS PAGE INTENTIONALLY BLANK)

ACKNOWLEDGEMENTS

Development of a plan as comprehensive as the ESIP II would not have been possible without the dedication and effort of a number of key individuals at Weber State University. E/S3 would like to acknowledge the leadership and vision of Mr. Kevin Hansen, Associate Vice President for Facilities and Campus Planning. The contributions of Mr. Mark Halverson, Director of Campus Planning, Mr. Viron Lynch, former Director of Operations, Mr. Jacob Cain, Energy and Sustainability Manager, and Ms. Jennifer Bodine, Sustainability Coordinator, were critical to ensure the ESIP II reflected the needs, goals and long range plans specific to the University.

Everyone's patience and participation with the evolutionary nature of Plan development as well as their contributions in reviewing draft material for the Plan elements is greatly appreciated.

The expert guidance of several members of the Facilities Management staff during the on-site visits and surveys of buildings constructed since the original ESIP and with the recommissioning effort at the Hurst Center was instrumental in developing key elements of the Plan. The plan for carbon neutrality itself is built around research and concepts developed by Mr. Cain in concert with Mr. Halverson.

The success of the Futures Workshop and its subsequent opening of new communication channels within the University would not have been possible without the efforts of key individuals from Facilities Management, Information Technology, Academics and the Provost who worked diligently on the planning committee and ultimately the commitment of all the Workshop participants from a great cross-section of the University community.

The excellent response rate to the employee survey from departments within Facilities Management provided valuable insight and was important to developing the organization, education and outreach sections. Discussions of the proposed organizational improvements within Facilities Management with Mr. Hansen formed the basis for further development of that concept and associated individual responsibilities.

Additional resources used in developing the Plan included information and visual aids from equipment manufacturers as noted. Marks owned by manufacturers and other organizations are also identified where appropriate. Photos were provided by Weber State and E/S3. The commissioning responsibilities for the proposed Deputy Director of Operations/In-house Commissioning Agent were adapted from the State of New Mexico Public School Facilities Authority's HVAC and Controls Performance Assurance Program, a state-wide program developed by E/S3 Consultants, Inc. under a contract with that agency.

(THIS PAGE INTENTIONALLY BLANK)

PART 1
EXECUTIVE SUMMARY

1.1 INTRODUCTION

In 2006, Weber State University Facilities Management engaged E/S3 Consultants Inc. (E/S3) to provide consulting services and work with Facilities Management for development of the original Energy Savings Investment Plan (ESIP). The intent of that plan was to ascertain the energy and water conservation goals of the University, identify potential projects for facilities and infrastructure improvements and other energy and water savings initiatives, perform analyses, and make recommendations on contracting vehicles to use for implementation of projects and initiatives to help the University achieve its energy conservation goals.

The resulting Plan, published in January 2008, established a methodology to identify, manage, and evaluate the performance of energy and water saving projects; discussed funding and acquisition strategies; recommended improvements to the organization structure; and provided suggested communication, education and outreach initiatives to implement and sustain the benefits of the Plan over the long-term.

At the same time, the University also made a commitment at the highest level to reduction of greenhouse gas emissions and eventual carbon neutrality by joining nearly 300 other colleges and universities nationwide in the American College and University Presidents Climate Commitment (ACUPCC). The original ESIP provided a foundation for actions to pursue in the first several years of Weber State's commitment and the Climate Action Plan developed by the University as part of its participation in the ACUPCC. A majority of the projects and initiatives identified in the original ESIP have been accomplished or are in the process of implementation.

To achieve true carbon-neutrality with regard to the energy-consuming equipment in its facilities, the University's overall plan must address the core areas of existing buildings, new construction and major renovations, on-site renewable energy generation, and purchase of renewable energy. A long-term vision of what the University's infrastructure will look like is needed, along with a strategy to ensure that all projects are consistent with that vision and all parties act in a coordinated and well planned manner to achieve a common goal.

The University again engaged E/S3 to help Facilities Management develop a long range plan that will meet these requirements. The Energy and Sustainability Investment Plan (ESIP II) that resulted from this collaborative effort is summarized on the next several pages as an introduction to the detailed discussion that is contained in the major parts of the ESIP II. The effort involved in developing the ESIP II was necessarily evolutionary and extended due to the magnitude of the endeavor and the need to develop a plan framework that would be viable over a twenty to thirty year time frame.

While it is anticipated that this Plan will take that long to fully implement, current projections indicate carbon neutrality will be achieved by about 2044 which would be six years ahead of the University's Climate Commitment goal.

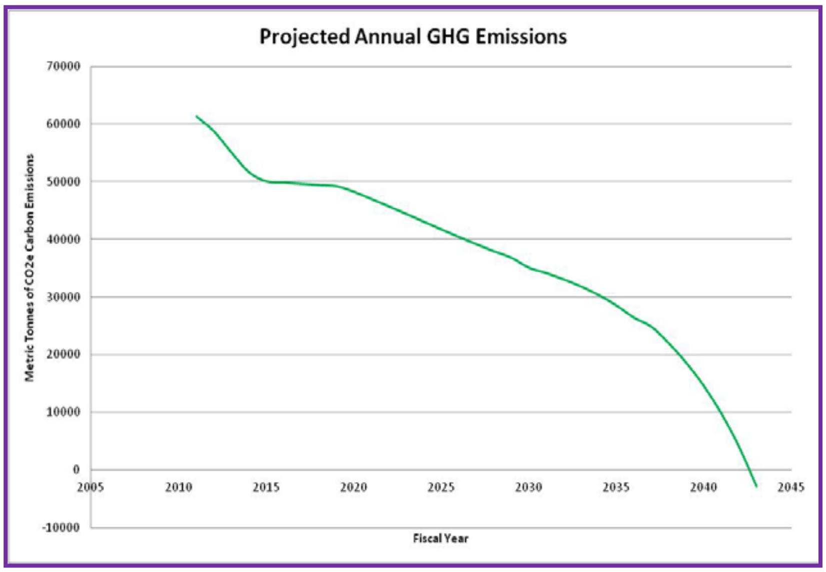


Figure 1-1 Estimated ESIP II Carbon Neutrality Date

The focus of ESIP II is on buildings and emissions related to operation of their energy consuming systems, however a comprehensive carbon neutrality plan must also consider other sources of emissions including fleet vehicles, transportation to and from campuses, and so forth. An overall sustainability and carbon-neutrality planning project is being undertaken by the University and the ESIP II is intended to be a major contributor to that effort.

1.2 ACCOMPLISHMENTS SINCE THE ORIGINAL ESIP

For development of the ESIP II it was important to first compile an update on where the University currently is with regard to the built environment, energy consuming equipment and systems in buildings along with efficiency upgrades and other improvements accomplished since the original ESIP was published. At that time, University facilities consisted of approximately 2.5 million square feet on the Ogden Campus, a single, three-story, 113,275 square foot building comprising the Davis Campus, and two small satellite locations in leased space.

Since then several older buildings have been demolished and there has been a significant amount of new building construction and major renovation. With the new Elizabeth Hall, Hurst Center for Lifelong Learning, Wildcat Village, Wildcat Center and Public Safety buildings and the chilled water plant on the Ogden Campus, the new classroom building and central plant at the Davis Campus and several other property acquisitions the total building area for Weber State now exceeds 2.8 million square feet.

1.2.1 Energy and Water Conservation Improvements

During the baseline period of July 2006 through June 2009, Weber State campuses consumed an annual average of nearly 38 million kilowatt-hours (kWh) of electrical energy and almost 194,000 Dekatherms (DTH) of natural gas, representing approximately 194 million cubic feet. In addition over 54 billion gallons of domestic water were consumed over that same period. Through a concerted effort of implementing conservation measures and increasing awareness of energy and water use throughout Weber State campuses, consumption has been reduced to slightly over 27 million kWh of electricity energy, less than 136,000 DTH of natural gas and under 40 billion gallons of domestic water. Figures 1-2 through 1-4 below illustrates the success of these efforts.

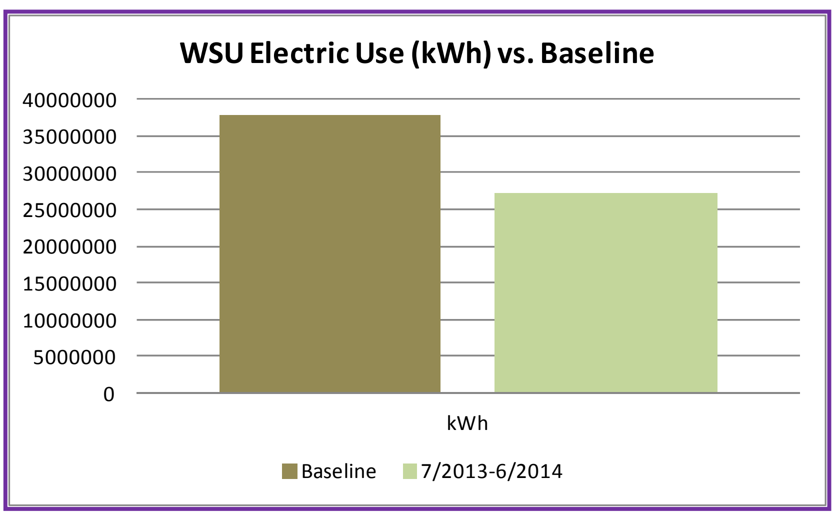


Figure 1-2 FY 2014 Electric Use vs. Baseline

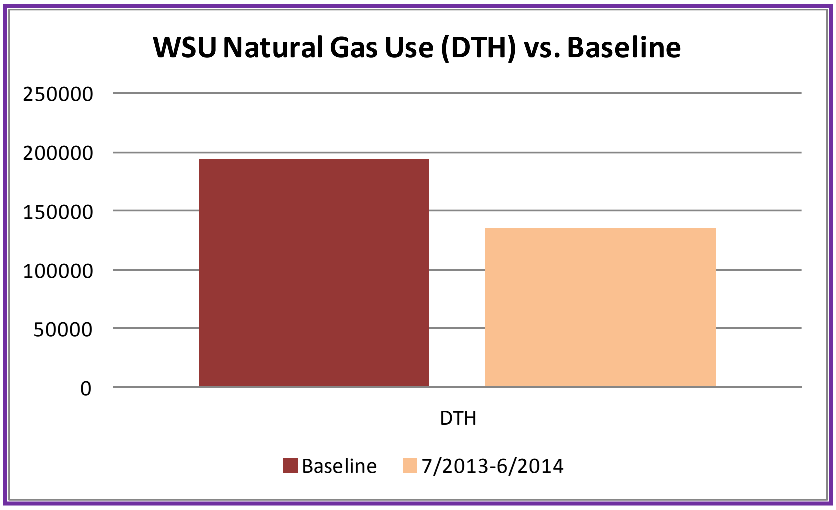


Figure 1-3 FY 2014 Natural Gas Use vs. Baseline

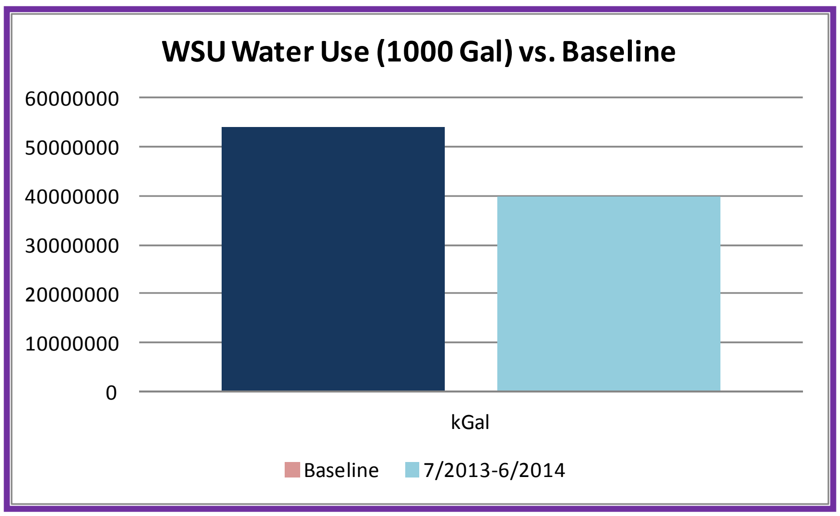


Figure 1-4 FY 2014 Domestic Water Use vs. Baseline

To accomplish these improvements the original ESIP discussed exploring the use of an Energy Performance Contract (EPC) with and Energy Services Company (ESCo) for developing and financing the project. With the business case presented in the ESIP, Facilities Management was able to convince the Utah Division of Facilities Construction and Management (DFCM) to allow Weber State to pursue an EPC as a trial project.

The University, working closely with an Assistant Attorney General and DFCM, created solicitation and contract documents and selected an ESCo to perform an investment grade audit of Weber State facilities. The ESCo then worked with Facilities Management to perform the audit and develop a project proposal. After the audit the ESCo's proposal however did not include several improvements the University needed and the proposed project's economics did not justify using the EPC vehicle. At that point it was decided that Facilities Management would self-implement the conservation measures. Projects were prioritized and a case was made to create a line of credit using internal University funding to finance improvements with repayment from energy and water savings.

Once approved by University Administration and the Board of Trustees an initial amount of $5 million was made available and the Weber State Energy Program moved forward with one of the first "in-house ESCo" approaches in the nation. Based on the original ESIP, Investment Grade Audit and evaluation of additional measures by the Energy and Sustainability Office, thirty two measures have been implemented or are in the process of implementation. This has resulted in considerable energy efficiency improvement and a more comfortable environment for faculty and students.

Some measures, such as the one to use solar energy for generating electricity at the Davis Campus and another for heating the water in the pool at the Swenson Gym on the Ogden Campus, provide an opportunity for integration into the educational curriculum. Details on all of the projects implemented are discussed in Part 2. The in-house implementation approach has also resulted in substantially lower implementation costs with considerably greater savings realized than was projected in the ESCo's proposal. The difference in energy and water cost savings resulting from self-implementation is shown in Figure 1-5.

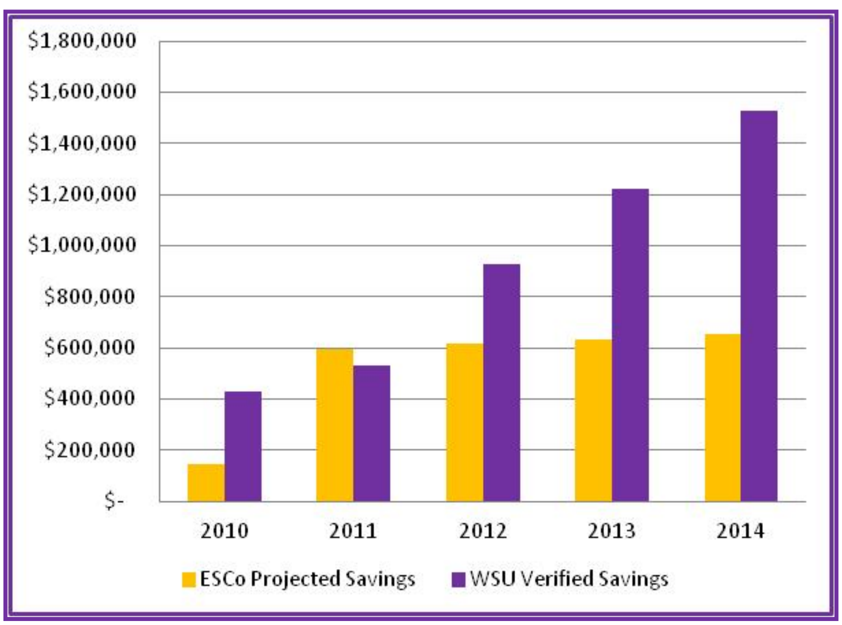


Figure 1-5 Projected vs. Verified Savings

These measures also represent a reduction in power plant emissions, particularly CO_2. In addition to the kWh savings illustrated in Figure 1-2, the reduction in energy use to date has resulted in decreasing associated power plant CO_2 emissions by approximately one third, a significant contribution toward achieving the University's climate commitment goals. The estimated reduction between the baseline and the last complete fiscal year are presented in Figure 1-6. This reduction equates to removing nearly 1,600 automobiles from the roads on the Wasatch Front.

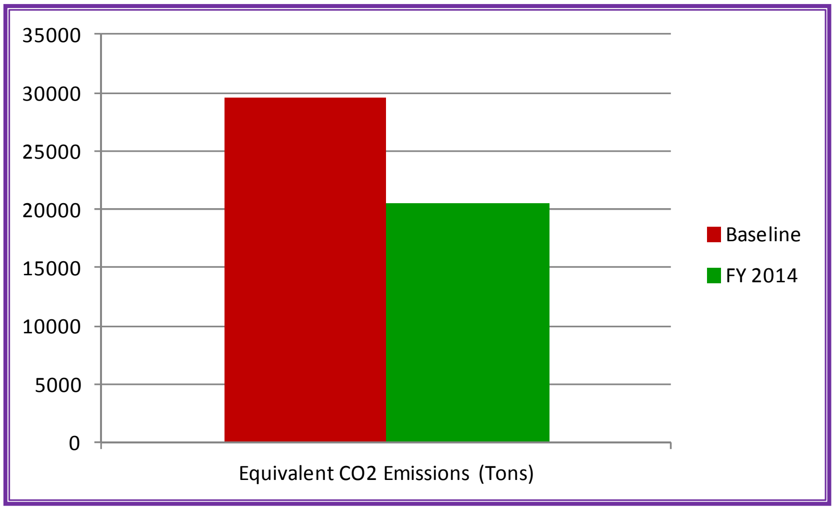


Figure 1-6 CO_2 Emissions Reduction from Baseline

1.2.2 Organization, Communication and Education

The original ESIP also included recommended improvements to the Facilities Management organizational structure, as well as communication and education programs for long-term sustainability of the Plan. Good progress has been made in each of these areas as discussed briefly below and further in Parts 2 and 5.

1.2.2.1 Organizational Structure

Probably the single most effective action resulting from the original ESIP was approval for and hiring an Energy Manager within Facilities Management. This position has evolved to become the Energy and Sustainability Manager with a highly qualified and motivated individual responsible for managing all aspects of energy and water use.

In addition, he has been directly supervising the work of energy project electricians and plumbers implementing projects, monitoring and reporting savings, researching new equipment types, supervising the work of a Sustainability Coordinator and several student Environmental Ambassadors, working with Faculty and Administration to promote sustainability and developing the highly successful annual Intermountain Sustainability Summit. A detailed description of the responsibilities and accomplishments of the Energy and Sustainability Office is contained in Parts 5 and 6.

Over the past several years a number of other organizational improvements have been implemented within Facilities Management to place responsibility for results closer to where work is being accomplished, improve accountability, allow people to maximize their skills and abilities by concentrating on what they do best and ensure the span of control at different levels of management is appropriate and reasonable. The current organizational structure and proposed improvements to support the ESIP II are discussed in detail in Part 5.

Further, an energy efficiency team comprised of representatives from Campus Planning and Construction, the Energy and Sustainability Office, mechanical and electrical shops, and others as appropriate has been established under the direction of the Associate Vice President for Facilities and Campus Planning.

1.2.2.2 Communication, Education and Outreach

The original ESIP also contained several recommendations for communication, education and outreach activities to engage the campus as a whole. A number of these have been initiated by the Energy and Sustainability Office.

One of the most significant outreach efforts has been organizing and hosting the annual Intermountain Sustainability Summit held each spring for the last five years which has generated statewide and national recognition for Weber State's leadership in sustainability.

A few examples of other outreach efforts would include preparing articles for campus publications, developing sustainability programs, creating a sustainability website, providing education on efficiency, sustainability and projects at Weber State, participating in the Faculty Senate's Environmental Issues Committee and working with Faculty to incorporate sustainability into the curriculum.

The result of these efforts and collaboration with other groups has been significant gains in creating a sustainability culture through modification of behavior, improved communication of goals and expectations and commitment to those goals throughout the University community.

1.3 LONG TERM VISION WORKSHOP

As part of developing the ESIP II, a two-day “Weber State Futures Workshop”, professionally facilitated by E/S3, was held with a diverse group of participants representing Administration including Vice Presidents and the Provost Office, Academic Deans and Professors, students, Information Technology, and Facilities Management. The objectives, process, results, and recommended next steps are discussed in Part 3.

This workshop used a "scenario planning" process and was very different from most traditional strategic planning workshops. Scenario planning takes place in the form of developing possible scenarios with key players, then working on each scenario in teams of workshop participants. This process creates a shared vision, but just as importantly develops commitment.

To prepare for the Workshop, a workshop planning group was formed with representatives from Facilities Management, Information Technology, Academics and the Provost to establish goals for the Workshop and develop four possible scenarios or stories about Weber State's future that established the outer boundaries and formed the basis for discussion in four small breakout teams and within the participant group as a whole.

The workshop was designed to help people develop new insights, allow everyone to participate and have their ideas and positions heard, improve communication, and build trust among the participants. The overall sense at the conclusion of the Workshop, and in the responses to a follow-up survey, was that everyone was enthusiastic about working with others in creating more holistic solutions for Weber State.

Many people said they would have liked more time to work, particularly in the small teams, and it is recommended that the University schedule a follow-up session with as many of the same people participating as possible. This session should again be professionally facilitated to cover the major topics and conclude with an action plan as described in Part 3.

1.4 PLAN FOR CARBON NEUTRALITY

Part 4 of the ESIP II describes the long range plan for carbon neutrality in campus buildings including the concepts and practices that need to be adopted for existing buildings, new construction, and major renovations. In addition it discusses renewable energy generation and purchase of power from renewable sources.

1.4.1 Existing Campus Buildings

An important element for achieving carbon-neutrality is reduction of the energy consumed by the existing campus buildings. It is important that energy efficiency be maximized in campus buildings as the first phase of the Energy and Sustainability Investment Plan. This approach provides nearly immediate savings and cash flow to fund additional efficiency projects.

The plan for reducing energy use in existing buildings uses a comprehensive approach that includes energy efficiency measures, control and automation system upgrades, targeted recommissioning, and deep retrofits as discussed in Part 4.

The plan also includes conversion of existing building mechanical equipment to carbon neutral capable types of equipment in accordance with the Mechanical Infrastructure Master Plan. This is a critical component for maintaining the schedule for phasing out the steam infrastructure and achieving the carbon neutrality and renewable energy goals of the University.

Weber State has been following the guidance of the original ESIP to implement many energy and water conservation measures and other upgrades in campus buildings with considerable resultant energy and cost savings. This work will continue under the ESIP II to maximize the efficiency of existing building systems during the interim period before a complete building renovation or a mechanical equipment upgrade to carbon neutral capability is accomplished.

Another important element for ensuring efficient operation of existing buildings is conducting regular, consistent efforts to review mechanical and electrical systems and their operation to make certain problems that have developed over time, or that may have been a legacy from the original construction of the building, are identified and corrected.

To accomplish this, a Weber State University Recommissioning Program was developed as part of the ESIP II and published in a separate program manual.

1.4.2 Carbon Neutral Capability

The principal concept of the ESIP II is "carbon-neutral capable" (CNC) or "net zero" buildings and this must be a critical consideration in the design and construction of all existing building retrofits, major renovations and new construction. It involves reducing heating and cooling loads within buildings, addressing loads passively to the extent possible through improved envelope, natural ventilation, integration of efficient energy-using equipment, and sophisticated controls and strategies to reduce energy usage of new and existing buildings as low as possible.

The University's Mechanical Infrastructure Master Plan described in detail in Part 4 provides the direction and strategy for creating a carbon neutral capable campus infrastructure through conversion to all-electric systems and the phase out of fossil fuels as a heating source. The overall purpose of this concept for Weber State is to ensure that construction, renovation and upgrades of campus buildings over the next twenty to thirty years align with the University's plans to achieve its carbon neutrality goal.

To attain these goals and maintain the integrity of the Mechanical Infrastructure Master Plan and the schedule for phasing out the steam infrastructure, carbon neutral capable building mechanical systems must be designed and installed for new buildings and major renovations in accordance with the Mechanical Infrastructure Master Plan. A number of currently acceptable equipment and system types are described and it is expected that newer more efficient technologies will emerge for consideration as the plan progresses.

It will be critical to also ensure that installed systems meet the University's requirements, are installed and operating properly, and satisfy the design intent. This quality assurance is provided through a robust commissioning process performed by a commissioning agent that is independent of the design and contracting teams responsible directly to Weber State, such as the in-house commissioning agent proposed in Part 5, to assure the University's interests are represented.

The Mechanical Infrastructure Master Plan envisions using the chilled water system piping that is currently in place and major equipment that Weber State has already invested in like the chillers and boilers will continue to be used until they are phased out at the end of their useful life as described further in Part 4.

As the plan progresses the campus chilled water system will be converted to a campus wide ground-coupled heat pump loop ("GCHP" or "GSHP") to provide a first stage of heat rejection and heat source for individual building systems. This loop, connecting all building HVAC systems, geothermal wells, pumping systems, and the cooling towers, will be phased in over time and will ultimately be the primary source for heating or cooling needed within the campus water loop.

In order for the University to achieve its commitment to carbon neutrality, the existing central steam system with boilers that use natural gas, with #2 fuel oil as a backup, must be phased out. Under the Mechanical Infrastructure Master Plan all heating needs of campus buildings will be met by energy-efficient all-electric systems and the existing boilers in the Heat Plant can then be decommissioned. Smaller high efficiency condensing-type hot water boilers may be installed and used minimally to provide supplemental heat for the campus wide GSHP system.

Advantages of this plan include the ability for phased installation and for the upgrade and conversion of existing buildings over time through the normal Capital Improvement and Capital Development processes. A major upfront infusion of funding should not be necessary until possibly near the end when the remaining loads fall below the turn down capacity of the existing heat plant.

This plan also allows the University to avoid the costs associated with end of life replacement of the existing boilers and chillers and a substantial amount of steam infrastructure upgrade. It will also ultimately reduce the costs currently needed to maintain the boiler plant and steam loops. Further, the overall infrastructure will be considerably safer once the plan is fully implemented since the campus will no longer have any piping or systems operating at high temperatures and pressures.

1.4.3 Renewable Energy

The all-electric systems envisioned as part of Mechanical Infrastructure Master Plan will eventually be supported by renewable electric energy production. The University has already begun installing solar photovoltaic systems into the campus infrastructure, particularly on the roofs of new construction, and these systems will be continuously expanded over time.

Weber State currently purchases about four million kilowatt-hours of renewable energy per year from the Rocky Mountain Power Blue Sky Program and that partnership will be maintained. Installation of 5-10 megawatts (MW) of solar PV between the Ogden and Davis campuses would provide 6-12 million kWh/year. At this point the University plans to stop further construction of on-site generation capacity and purchase the balance of its power needs from renewable sources.

1.4.4 Current Projects

Two projects have recently been completed on campus as prototypes for new construction and major building renovations that successfully incorporate elements of the carbon neutral concept and the Mechanical Infrastructure Master Plan.

- The major renovation of the Campus Services Building included complete demolition of the interior and HVAC systems, reconfiguration of spaces with new interior walls, a water-cooled Variable Refrigerant Flow system installed with heat rejection to the return side of the chilled water loop energy efficient windows and additional envelope insulation.

- The recently completed new Public Safety Building also incorporated many of the sustainability and carbon neutral components envisioned for all future University buildings including a high efficiency air-cooled Variable Refrigerant Flow system, tall windows and skylights for natural daylighting, and a solar PV array that provides much of the building's electricity.

The Tracy Hall Science Center currently under construction will be the first major new building designed fully in compliance with the Mechanical Infrastructure Master Plan and it sets the stage for the eventual conversion of the entire campus to the all-electric ground coupled heat pump system.

In addition, the Energy and Sustainability Office has received approval and funding for updating mechanical systems for the carbon neutral capability in the Mechanical Infrastructure Master Plan in conjunction with projects for renovation in the Stewart Library, Lind Lecture Hall, and the Miller Administration Building.

1.5 ORGANIZATIONAL STRUCTURE TO SUPPORT ESIP II

Part 5 of the ESIP II describes the current composition and responsibilities of Facilities Management, with an emphasis on the Operations Group, provides proposed organizational structure improvements needed to support the success of the ESIP II, and discusses future skills and training that will be needed for Facilities Management staff.

The organizational enhancements presented to support the ESIP II are intended to continue Facilities Management's efforts for responsibility for results closer to where work is being accomplished, improved accountability, allowing people to concentrate on what they do best and maximize their abilities, and ensure the management span of control at different levels is appropriate to ensure the long term success of the plan and the people involved.

The ultimate success of the ESIP II and the University's efforts to achieve carbon neutrality will require three significant organizational improvements within the Operations Group. These are summarized here and discussed in detail in Part 5. The overall objective of these organizational improvements is to enhance efficiencies and utilization of resources by having the Energy and Sustainability Office recommend "what" could be done and "why" it should be done, and then allowing the appropriate Superintendent and/or the Deputy Director/Commissioning Agent to determine "how" it will get done and manage the implementation process with resources from the appropriate shop(s).

1.5.1 Deputy Director of Operations and Commissioning Agent

The plan for carbon neutrality depends upon the importance of commissioning on new construction or renovation projects to ensure equipment and systems are operating properly, sustainability requirements are achieved and that the University's interests are fully represented throughout projects. The Weber State Recommissioning Program must also be effectively implemented on existing buildings.

As part of ESIP II development, Facilities Management has examined the costs, benefits, and the value added to projects by a Commissioning Agent (CxA) and has determined that the most cost effective way to perform building and system commissioning is to have an in-house commissioning agent as part of the University's Facilities Management staff.

This position should be at the level of Deputy Director of Operations to be able to utilize the resources available in the Operations shops, have a degree of independence and work in a coordination function for construction and major renovation projects at an equal level with the Project Managers. The CxA position would report to the Director of Operations, providing a back-up when the Director is absent.

1.5.2 Energy and Sustainability Office (ESO)

Currently implementation of projects by the ESO with its own staff has, in effect, created a separate electrical and plumbing shop within the ESO. While this has been very successful, responsibility for the actual implementation and management of projects will be transferred to other areas to permit the ESO to concentrate on the research, analysis, advisory, planning, utility management, energy education, and outreach functions critical to achieving the University's sustainability goals.

The ESO will continue its current energy management responsibilities and focus on sustainability to primarily provide a staff function to the Director and Deputy Director of Operations for planning, studies, analyses, reports and evaluation of new technologies. The ESO will assist with maintaining the larger vision of the ESIP II through participation with the Weber State project team in the design phase of construction and renovation projects and by interaction with University faculty on the education side.

In its advisory role the ESO will be recommending improvements to be implemented and sponsoring projects with its available funding sources. To maximize this core competency of the ESO staff it will be necessary to transfer responsibility for performing the actual construction or renovation work to others.

1.5.3 Construction and Renovation Shop

The Construction and Renovation Shop, led by a Manager equivalent to the other Operations Group Superintendents and reporting to the Director of Operations, will be organized into teams of individuals with skills in the different trades necessary to complete projects assigned. To form the first Project Team, the electricians and plumber that are currently directly employed and managed by the ESO will transfer to the Construction and Renovation Shop. Their roles will be expanded to include electrical and plumbing/mechanical work associated with any projects undertaken by this shop.

This new Shop will continue the work on energy projects currently in progress or planned for existing buildings and perform work for University Departments such as minor space remodels or renovations. It will generally be limited to energy projects and smaller projects that can be readily accomplished to meet customer requirements within a cost ceiling of $25,000 per project. Larger projects, and those involving outside contractors, will continue to be performed and managed through the Campus Planning and Construction Group.

1.6 COMMUNICATION, EDUCATION AND OUTREACH

While implementation of the Plan for Carbon Neutrality in Campus Buildings described in Part 4 will result in decreased energy consumption, cost, and carbon emissions, the ultimate success of the ESIP II will rely on the people at the University. Continued management commitment, organizational and funding structures to support the Plan and an overall culture of sustainability will be vital elements.

The current structure and composition of Facilities Management is well suited to continue in a leadership role assisting the University with achieving the Climate Commitment goals. The responses to the employee survey discussed in Part 6, particularly with regard to the increased importance of energy and water conservation in their jobs and to them personally, make it clear that the people in Facilities Management are even more ready to embrace efficiency and sustainability in their work at the University. Figure 1-7 shows the comparison of this importance between the survey conducted in 2007 and the recent one for the ESIP II.

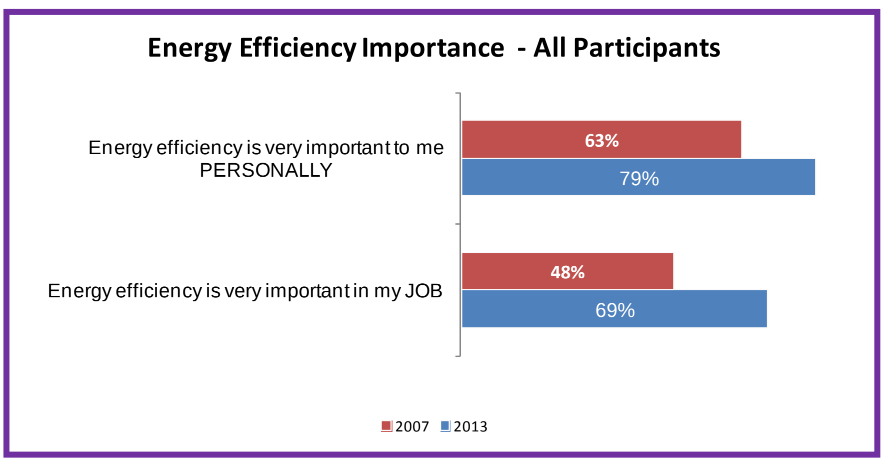


Figure 1-7 Importance of Energy Efficiency

As the ESIP II moves forward it will be necessary to build upon the culture of sustainability that has begun to develop throughout the University to keep administration, faculty and students engaged and informed to ensure the success of the plan. This will be critical to the carbon-neutrality plan and other sustainability efforts and will require a combination of good internal and external communication, education efforts and various levels of targeted outreach.

This part of the ESIP II also includes a summary of current activities related to communications, education, and outreach for Facilities Management staff, the campus as a whole, and the larger community the University serves. Recommendations for additional efforts in each area are presented to engage people in the university community and beyond with whom interaction on the larger scale sustainability plan will be needed.

The recommendations discussed are intended to be used as a basis for creating a comprehensive sustainability plan for the University. The ESIP II does not attempt to design a campus-wide sustainability plan since that is a considerable effort on its own beyond the scope of ESIP II development, requiring involvement of all the shareholder groups at the University. The ESIP II does however provide an outline of key responsibilities for the Energy and Sustainability Office to incorporate into an overall plan.

1.7 FUNDING STRUCTURE

The funding structure for the ESIP II addresses implementing the Mechanical Infrastructure Master Plan, completing energy and water efficiency projects in existing buildings, performing ongoing recommissioning, and erecting renewable energy installations as described in Part 4, along with some aspects of the organizational changes discussed in Part 5. The success of energy efficiency and carbon neutrality efforts of the ESIP II is critically dependent upon continuing the current funding sources.

Strategies for funding each of these elements to accomplish the objectives of the ESIP II and achieve the University's goals are presented in Part 7. The principle behind the funding structure is that the efficiency, carbon neutrality and even some personnel elements continue to pay for themselves as much as possible through energy and water cost savings, allocation of existing funding sources and revenue generation.

The primary source of funding for project implementation is expected to continue to be the line of credit established for energy efficiency and sustainability projects and this source must be protected for the duration of the plan. Energy and water cost savings generated will continue to be used to provide payments on the revolving line of credit and to fund further projects, recommissioning efforts, and other initiatives of the Energy and Sustainability Office.

Other opportunities such as grants, rebates, subsidies, and so on will be pursued by the Energy and Sustainability Office to supplement these funding sources as much as possible. These tend to be more variable however, and will not necessarily be relied upon for planning or budgeting purposes.

To assure funds are available for repayment on the line of credit in order to continue this funding stream it is imperative that the University's utility budgets be maintained at present levels with incremental increases for expansion of overall campus building square footage, as well as in proportion to utility rate increases with respect to the established 2006-2009 baseline.

Figure 1-8 illustrates the expenditures from the line of credit, supplemented by rebates, in each of the five fiscal years since it was established along with the calculated energy cost savings and rebates realized in each year.

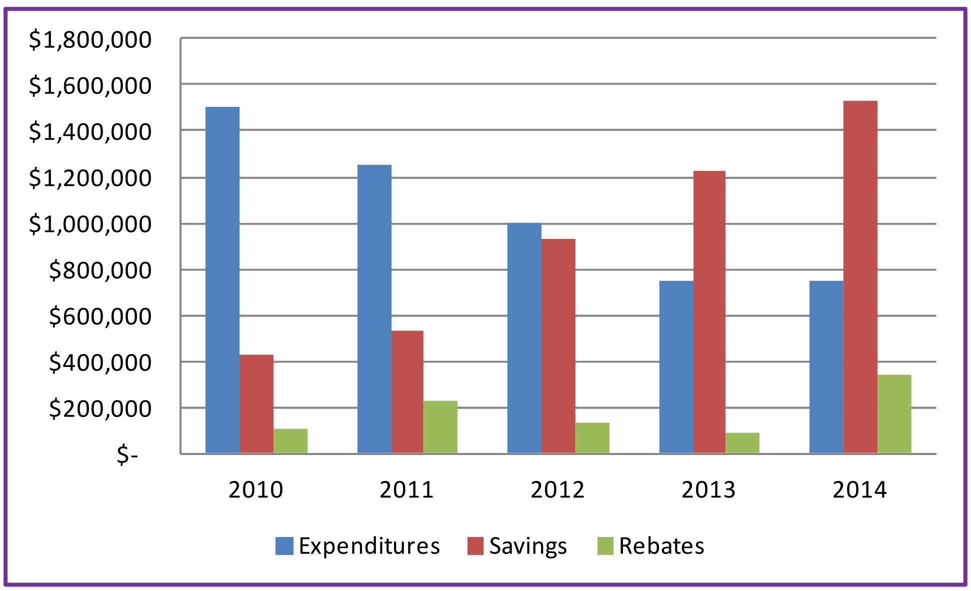


Figure 1-8 FY 2010-2014 Line of Credit Expenditures, Cost Savings and Rebates

The return on the University's investment of funding for energy efficiency and sustainability to date has been well beyond the expectations of the original ESIP and subsequent investment grade energy audit. This return is expected to grow exponentially going forward with the potential of amounting to millions of dollars over the timeframe of ESIP II. The positive cash flow generated will primarily be used to finance plan elements, however it is important to note that it will continue to be generated after debts has been repaid. This means that there will be a point where additional funds could be available for the Administration to redirect to other areas.

(THIS PAGE INTENTIONALLY BLANK)

PART 2
ACCOMPLISHMENTS SINCE THE ORIGINAL ESIP

2.1 OVERVIEW

For development of the ESIP II it was important to first understand current conditions and what has been accomplished within the University with regard to its facilities infrastructure and energy consuming equipment and systems.

The original Weber State University Energy Savings Investment Plan (ESIP) established a methodology to identify, manage, fund, evaluate the performance, and sustain the benefits of energy and water saving projects. It also included recommended improvements to the Facility Management organizational structure, as well as communication and education for long-term sustainability of the Plan. The ESIP has served as an essential guide for the University's development of projects and programs.

A great deal of progress has been made in all of these areas over the past several years. As a result, there have been a number of positive impacts for the University beyond the considerable energy and water savings achieved. On campus, the efforts have positively affected every building and this has been noticed by building occupants who are now asking Facilities Management to push hard for more efficiency and sustainability.

Projects have been undertaken by Weber State that the design community was unwilling to do such as the LED lighting upgrade on the cloud at the Dee Events Center. Beyond that, Facilities Management has performed considerable research into such things as lighting color, mechanical systems, and revisions to commonplace designs that are encouraging the engineering community to move beyond traditional practices to support the University's efficiency and sustainability goals.

All of these successes have led to national recognition for Weber State as a leader in exploring alternatives and establishing processes and funding mechanisms to meet the University's commitment to sustainability. On campus, and at the state level, a tremendous amount of credibility has been built allowing decision makers to be more comfortable with approaches that may be perceived as higher risk.

This Part of the ESIP II will serve as a brief history of the changes, projects and accomplishments since the original ESIP as described in the sections that follow. Additional detailed discussion where appropriate is found in Parts 5 and 6. These achievements have begun to develop a culture of sustainability throughout the University and form a strong foundation as the ESIP II moves forward.

2.2 CHANGES TO THE BUILT ENVIRONMENT

Weber State is a dynamic environment from a facilities perspective and there have been some significant changes since the original ESIP. These include demolition of older buildings, major renovations in existing buildings and new construction. To provide an update, these changes since the original ESIP are briefly summarized in this section.

2.2.1 Demolition of Older Buildings

Since the original ESIP was developed several buildings have been demolished due to their age and to make way for new construction. These include:

- Annex 1 (A1)
- Annex 8 and 10 (A8/A10) for the new Public Safety Building
- Buildings 1 and 2 (B1/B2) for Elizabeth Hall
- Buildings 3 and 4 (B3/B4) for the new Tracy Hall Science Center
- Promontory Tower (PT), LaSal Hall (LS), Stansbury Hall (SH) and Wasatch Hall (WH) for the new Wildcat Village

2.2.2 Major Building Renovations

A major renovation in progress during development of the original ESIP was completed in the Shepherd Union building in 2008. Recently the former Campus Services Building was completely renovated to accommodate the Associate Vice President and the Campus Planning and Construction Group. This was the first full application of the carbon neutral capable mechanical equipment described in the Mechanical Infrastructure Master Plan discussed in detail in Part 4 of the ESIP II.

2.2.3 New Building Construction

Weber State has also seen a significant amount of new building construction over the last several years. These projects are generally driven by the University President, Vice Presidents, Deans, major donors and the State, or a combination thereof to meet the needs of departments, replace aging infrastructure and ensure the University remains a vibrant and attractive place. All new construction projects have an impact on sustainability goals and several of the major recent projects are summarized in the subsections that follow.

2.2.3.1 Chilled Water Plant (CL)

A new 4,600 ft^2 building was constructed next to the existing cooling towers (CT) in 2008 to house the central chilled water plant equipment. Two new high efficiency Trane 1,500 ton chillers were installed along with new pumps and a heat exchanger. One 1,250 ton and one 650 ton chiller were relocated from the chiller plant formerly in the Science Lab (SL).

2.2.3.2 Elizabeth Hall (EH)

Built in 2008, this 94,750 ft^2 building provides new classrooms, computer labs, a lecture hall and offices for the departments of communication, English, foreign languages, and telecommunication and business education.

2.2.3.3 Hurst Center for Lifelong Learning (HC)

Completed in 2009, this 42,000 ft^2 building is immediately next to the Lindquist Alumni Center and the two facilities are connected. It provides meeting space for up to 220 people and houses staff for Continuing Education and the University Advancement division.

2.2.3.4 Davis 03 Classroom Building and Central Plant (D04)

A new 121,146 ft^2 classroom building at the Davis campus was completed in time for fall classes in 2013. Part of the project was to build a separate central heating and cooling plant on campus with underground piping to this building and the existing D02 building.

2.2.3.5 Wildcat Village (R1, R2, R3)

Located on the site of the former LaSal, Stansbury and Wasatch Halls this three building complex provides student housing on campus. The 52,000 ft^2 Residence Hall 1 was completed in 2011 followed by Stewart-Wasatch Residence Hall 2 (88,480 ft^2) in 2012 and Residence Hall 3 (35,465 ft^2) in 2013.

2.2.3.6 Wildcat Center for Health Education and Wellness (WI)

This project completed in 2014 provided a renovation of the former Stromberg Center (SB) and construction of additional space for a new total of 119,680 ft^2.

2.2.3.7 Public Safety Building (PS)

The recently completed new 10,000 ft^2 Public Safety Building on campus incorporated many of the sustainability and carbon neutral components envisioned for all future University Buildings.

2.2.3.8 Tracy Hall Science Center (TY)

Construction has started on the new 173,000 square foot Tracy Hall Science Center. This state-of the art building is the first major new construction project to be designed around the Weber State Mechanical Infrastructure Master Plan described in Part 4. When completed in June, 2016 it will house the Departments of Botany, Chemistry, Geosciences, Mathematics, Microbiology, Physics and Zoology along with the Developmental Math Program offices.

2.2.4 Additional Buildings

In addition to the new buildings and renovation projects described above, the University has acquired some additional property. This includes a building constructed in 1906 in downtown Ogden (WD) that is being renovated to house University Stores and some student activities. Adjacent to the Davis Campus a 35,000 ft^2 facility adjacent that was previously leased to Northrup-Grumman was obtained and will need renovation. Another building, referred to as “875 South” (D13) was also added to the Davis Campus.

2.3 ENERGY AND WATER PROJECTS

Energy and water efficiency projects undertaken at Weber State have followed the plan described in the original ESIP. This has included investigation of the measures recommended for further evaluation in the ESIP and engaging and Energy Services Company (ESCo) to perform an Investment Grade Audit.

2.3.1 Investment Grade Audit

The Financing and Acquisition section of the ESIP contained a discussion of Energy Performance Contracting (EPC) as a possible vehicle for financing and implementing energy and water saving improvements. Building on that, the University established a program to explore the possibility to utilize this alternative delivery method in order to accomplish the goals of the ESIP.

This contracting vehicle was out of favor for state buildings in Utah at that time, however the detailed plan contained in the ESIP, including the business case it made to utilize EPC, allowed the University to be in a strong enough position that Facilities Management was able to convince the Division of Facilities Construction and Management (DFCM) to allow Weber State to undertake a trial project.

Since documents and the process were not available at the State level, the University created Investment Grade Audit and Energy Performance Contract documents working closely with a State Assistant Attorney General for review; developed the Request for Proposals for contractor selection; reviewed contractor responses; conducted oral interviews and ultimately selected an Energy Services Company (ESCo) to perform an Investment Grade Audit of the University's facilities.

Over the course of several months the ESCo, under the direction of Facilities Management, performed a detailed audit of Weber State facilities and preliminary energy engineering work to evaluate several energy and water conservation measures. The majority of these paralleled those in the original ESIP with others considered at the request of Facilities Management or upon recommendation by the ESCo.

Eventually the ESCo presented an Investment Grade Audit Report and Project Proposal that included a number of these measures with associated implementation costs and estimated savings. All of the measures considered are summarized in Table 2-1 along with an indication whether or not the ESCo included each in the project proposal.

The processes and documents developed for the Weber State program eventually provided models and the impetus for the DFCM State Energy Office to launch its current EPC program for all public entities statewide.

ECM No.	Measures Evaluated by ESCo	Location(s)	Included in ESCo Price Proposal
1.1	Interior lighting retrofits	Campuswide	Yes
1.2	Exterior lighting retrofits	Campuswide	Yes
1.3	Lighting occupancy sensors	Campuswide	Yes
2.1	Install steam powered condensate pumps	BC, ED, LI	No
2.5	Install stack economizer on Boiier #2	HP	Yes
3.2	Replace chillers with high efficiency chillers	DC	Yes
3.3	Install VFDs on (3)cooling tower fans	CT	Yes
4.3	Convert DX units to use chilled water	TE	No
4.4	Replace piping insulation in mechanical rooms	Campuswide	Yes
5.1	Install reset controls	BC, ED, KA, LI, LP, MA, MH, SD, SK, SS, SW, TE	Yes
5.14	Integrate VAV boxes with occupancy sensors	ED, SC, SK	Yes
6.1	Replace failed steam expansion joints	Steam tunnels	No
6.2	Replace failed steam traps	Steam tunnels	No
6.3	Install insulation on steam piping and expansion joints	Steam tunnels	Yes
6.8	Replace domestic hot water tanks with converters	LI, MH, SC, SD, SS	Yes
7.1	Convert air handler inlet guide vanes to VFD	TE	No
8.1	Domestic water conservation measures	Campuswide	Yes
9.4	Install exterior weatherproofing	MA, SS, ED	Yes
10.1	Install solar water heating for pool	SW	Yes
10.4	Install solar PV generation	D02	Yes
11.1	Implement computer power management	Campuswide	Yes
11.2	Install vending misers	Campuswide	Yes
11.4	Upgrade greenhouse temperature controls	SL	Yes
11.6	Install swimming pool cover	SG	Yes
14.1	Install building electric, gas, steam and chilled water submeters	Campuswide	No
14.2	Install high efficeincy transformers	Ogden Campus	Yes
14.3	Replace high voltage switches	Ogden Campus	No
16.1	Convert gas rate for boilers to interruptible rate schedule	HP	Yes

Table 2-1 Measures Evaluated in the Investment Grade Audit

2.3.2 Weber State Energy Program

After receipt of the Investment Grade Audit Report and Project Proposal that was developed under the Energy Performance Contract Program, the University decided to pursue self-implementation of measures identified in order to include other needed improvements that were not part of in the ESCo's proposal. This created in effect an "internal energy services company", one of the first in higher education.

The earliest effort in this program was to develop an initial prioritization of projects along with identifying how funding might be obtained. Facilities Management developed a case for creating a line of credit from the University's internal funding to finance the costs of the energy and water improvement projects. This approach was approved by the University's Administration and Board of Trustees with an initial amount of $5 million made available. Projects are implemented by the University and energy cost savings from these projects are quantified and used to repay the endowment, including a nominal interest rate.

Table 2-2 illustrates the projects performed under the Weber State Energy Program and the current status for each. Measure descriptions are in the subsections that follow.

Project	ECM Description	Current Status
1	Interior Lighting - Campus Wide	In Construction - 55% Complete
2	DEC Chiller Replacement	Completed
3	ECM 2.1 Steam Powered Condensate Pumps	Completed
4	ECM 6.8 Replace DHW Tanks with HX	Completed
5	Steam Energy Upgrades Phase 1	Completed
	Steam Phase 2 Insulation	Completed
6	Steam Tunnel Support Repair	Funded as part of steam repairs
7	ECM 4.4 Replace Piping Insulation on AHUs	In Progress
8	ECM 2.5 Boiler 2 Economizer	Completed
9	ECM 3.3 VFDs for Central Plant Cooling Towers	Completed
10	ECM 4.3 Convert DX Units to CHW	Canceled
11	ECM 7.1 TE Convert Inlet Vanes to VFD	Deferred
12	ECM 5.1 Davis 2 VAV Upgrade and IDEC	Completed
13	ECM 5.15 Recomission Sky Suites, ED, SS	Completed
14	ECM 8.1 Domestic Water Conservation	In Construction - 20% Complete
15	ECM 10.1 Solar Water Heating	Completed
16	Solar PV Davis	Completed
	Solar PV Davis Phase 2	Completed
17	Solar PV Union	Completed
18	ECM 9.4 Weatherproofing - SL, LI, MA	Completed
19	ECM 11.1 Computer Controls	Continuous Program
20	ECM 11.4 Greenhouse Temperature Controls	Canceled
21	Swimming Pool Cover	Completed
22	Electric Meters	Completed
23	Steam Meters	Completed
24	Chilled Water Meters	Completed
25	Irrigation Water Meters	Completed
26	High Efficiency Transformers	CI and CD Projects Moving Forward
27	HV Switches	In Construction - 75% Complete
28	Exterior Lighting	In Construction - 95% Complete
29	DEC Power Factor Correction	Completed
30	Domestic Water Meters	Completed
	Summer Boiler and Steam System Shutdown	Completed
	LED Lighting Upgrade for DEC Cloud	Completed
	ECM 16.1 Gas Rate Change	Completed

Table 2-2 Projects Implemented Under the WSU Energy Program

2.3.2.1 Interior Lighting Retrofits

Work in progress on this multi-year project includes replacement of existing inefficient lamps and ballasts with new energy efficient lamps and ballasts, installation of new lighting occupancy sensors in classrooms, offices, conference rooms, restrooms, and hallways to turn off lights automatically when the rooms are unoccupied, and new LED exit signs to replace existing exit signs for savings in both energy and lamp replacement costs.

Integration of zone VAV boxes to lighting occupancy sensors to reset the room temperature when unoccupied is being done at the same time by the energy project electricians to reduce the heating and cooling loads and energy costs.

In addition, a VendingMiser® is being installed on refrigerated vending machines a part of this project to ensure that these machines operate only when necessary while keeping their product at the correct temperature.

2.3.2.2 Dee Events Center Chiller Replacement

This completed project completely renovated the chilled water plant including replacement of three chillers with high efficiency units, new condenser and chilled water pumps and a new cooling tower.

2.3.2.3 ECM 2.1 Steam Powered Condensate Pumps

This completed measure replaced the existing electric condensate pumps in the Browning Center, McKay Education, and Stewart Library buildings with new steam powered condensate pumps to reduce electrical costs. This project also completed a campus wide initiative to standardize on steam powered condensate pumps, which are more reliable and suitable to the campus heating system.

2.3.2.4 ECM 6.8 Replace Domestic Hot Water Tanks with Heat Exchangers

Weber State had previously undertaken a program to replace domestic hot water tanks with steam to water heat exchangers in nine buildings. Unfortunately Capital Improvement funds were sufficient to implement this project in only three buildings. This completed measure installed heat exchangers in Social

Science, the Library (south), Marriott Allied Health (south and north), Student Services, and the Stadium to conclude the original initiative.

2.3.2.5 Steam Energy Upgrades Phase 1

The steam and condensate piping infrastructure at Weber State is primarily installed in subsurface tunnels with three major loops identified as "A", "B" and "C". A thorough inspection revealed substantial work was needed to upgrade and repair the system including expansion joints that had failed, isolation valves that did not hold, a large number of ball joints that needed to be replaced and pipe hangers that were rusted through. Most of the insulation was also in poor condition and asbestos abatement was needed.

A two-year plan was developed to address these issues during summer shutdown of the boilers and steam system. In the first year the following was accomplished:

- Asbestos abatement
- Replacement of steam traps on the high pressure side
- Replacement of expansion joints and ball joints in the "A" and "C" loops
- Replacement of failed isolation valves and check valves
- Repair or replacement of bent, altered, and leaking piping
- Installation of isolation valves in the condensate lines to eliminate gravity feeding condensate to the lower campus and other condensate isolation issues
- Installation of Pyrogel piping insulation with PVC jacket where work was done

2.3.2.6 Steam Energy Upgrades Phase 2

The second phase of the project included abatement of all remaining asbestos in the tunnels. The remaining failed isolation valves, expansion and ball joints, and pipe hangers were replaced, principally in the "B" loop. Installation of the Pyrogel piping insulation with PVC jacket was also completed.

2.3.2.7 Steam Tunnel Support Repair

This project replaced old rusted and broken steam piping hangers in the tunnels with new stainless steel hangers. It was ultimately absorbed into the Phase 2 Steam Tunnel repair project described above.

2.3.2.8 ECM 4.4 Replace Piping Insulation on AHUs

This on-going project replaces missing or damaged insulation on steam, hot water and chilled water piping located in mechanical rooms throughout the campus.

2.3.2.9 ECM 2.5 Install Stack Economizer on Boiler #2- HP

There are typically significant amounts of heat energy lost through boiler stacks. This completed measure installed stack economizers on Boiler #2 to capture this waste heat and reapply it to pre-heating of boiler makeup water.

2.3.2.10 ECM 3.3 Install VFDs on Cooling Tower Fan Motors

This completed measure finished the cooling tower upgrades at the central plant which included replacing drift eliminators, fan blades, and conduit in all five cooling towers. Installing the VFDs in the three towers that did not have them reduces the energy use of the towers and allows the central plant control system to track the condenser water load in a more efficient manner.

2.3.2.11 ECM 4.3 Convert DX Units to Chilled Water – TE

This measure would have replaced existing refrigerant based direct expansion (DX) cooling systems in the Technical Education building with chilled water cooling systems connected to the campus chilled water system. A driving force was the need to provide cooling in the Data Center year-round and reliability issues experienced with the existing DX equipment. This would however require operation of the chilled water plan in the winter when it has previously been shut down and the main loop piping has been drained.

It was apparent that the future plans for the Data Center, which was considering relocation, would dictate the direction this project will take and considerable discussion was held between Facilities Management and the IT Department including a "mini-charette" facilitated by E/S3. Based upon these discussions it was ultimately agreed that further development on this project be dropped from further consideration under the energy program.

2.3.2.12 Convert Inlet Guide Vanes on AHU to VFD - TE

This measure would remove or lock open the existing inlet guide vanes in the three main air handling units in the Technical Education building and convert air flow control to Variable Frequency Drives (VFDs). When implemented, the project will include replacing obsolete existing controls with new Direct Digital Controls for the air handling units so that they can be programmed to operate effectively in the variable flow mode.

2.3.2.13 ECM 5.1 VAV Upgrade and IDEC - Davis 02

This project initially identified and implemented the VAV control sequence updates needed to execute the summer heating shutdown measure described in 2.3.2.32 below. As part of the Davis 03 new classroom building project a central chilled water plant was added to the Davis Campus as noted in 2.2.3.4 above. During this time a great opportunity was identified to convert the Davis 02 building from the existing air-cooled chiller to an Indirect-Direct Evaporative Cooling (IDEC) system that runs on the new central plant. This conversion was completed in the fall of 2014 and has already produced significant energy savings.

2.3.2.14 ECM 5.15 Recommissioning – SK, ED, SS

A recommissioning effort through the Rocky Mountain Power program was performed at McKay Education, Social Science and the Skyboxes. As a result, four major efforts were recommended including control and scheduling improvements on air handling units along with integrating VAV boxes with occupancy sensors that were completed by Facilities Management.

2.3.2.15 ECM 8.1 Domestic Water Conservation

On-going work on these measures includes installation of low flow shower heads, faucets, and flush valves for urinals and toilets. The work is being performed in-house by the energy projects plumber with assistance from the Plumbing Shop as needed. Considerable work has been done by the Energy and Sustainability Office to develop standards for future construction and renovation projects.

2.3.2.16 ECM 10.1 Solar Water Heating – SW

This completed measure installed a solar hot water heating system for the Swenson Gym swimming pool. Solar hot water collectors were installed on top of the roof of the Swenson Gym above the swimming pool area with hot water piping running along the roof to drop down inside the building. The solar hot water system heats the pool return water using a dedicated plate and frame heat exchanger to reduce or eliminate the need for heating from the steam heat exchanger and saves on energy costs associated with heating the swimming pool.

2.3.2.17 Install Solar PV – Davis 02

In this completed project a photovoltaic generation system with a capacity of 20.58 kW was installed on the roof and incorporated into the building power grid. A display mounted in the common area of the building shows in real time how much energy is being generated through the solar panels. Installation costs were funded in part by American Recovery and Reinvestment Act (ARRA) grants through DFCM and with funding from the Rocky Mountain Power Blue Sky program.

2.3.2.18 Install Solar PV – Davis 02 (Phase 2)

In a follow-on project, an additional 20 kW of solar PV generation capacity was installed on the Davis 02 building during the summer of 2013.

2.3.2.19 Install Solar PV – Shepherd Union

This project was funded entirely by ARRA grants through DFCM and installed a photovoltaic generation system with a capacity of 35.52 kW that is incorporated into the building power grid. The project included a "demonstration" element with a fountain powered by electrical energy generated by the solar panels.

2.3.2.20 ECM 9.4 Weatherproofing – SL, LI, MA

This measure, completed in the fall of 2012, included resealing the windows, window frames, and doors of the Science Lab, Social Science, and McKay Education buildings to save on heating and cooling energy use and eliminate drafts.

2.3.2.21 ECM 11.1 Computer Power Management

This measure will install a power management program for the computer lab and other personal computers that will place the computers in a standby mode when not in use. This is an on-going program that the Energy and Sustainability Office will continue to pursue in collaboration with campus IT and each college's IT department.

2.3.2.22 ECM 11.4 Greenhouse Temperature Controls - SL

This measure would install modern greenhouse controls to integrate the operation of heating and cooling and eliminate simultaneous opening of roof vents while the heating system is in operation. At present it has been abandoned because the new Tracy Hall Science Center will replace this building when construction is completed in 2016.

2.3.2.23 Install Swimming Pool Cover – SW

This completed project installed a flexible pool cover and removal and storage device for the pool at the Swenson Gym.

2.3.2.24 Install Electric, Steam and Chilled Water Meters

A significant step in effective energy management is to gain understanding of how much energy is being consumed and where it is being used. Building-level energy consumption information allows facilities personnel to respond directly to improve overall building energy efficiency. The Ogden campus is metered for both electricity and natural gas through central meters that measure consumption in over 2.8 million square feet of buildings so it was not possible to analyze energy use in each building.

Some buildings served by the main meters had electric and steam submeters and some newer buildings were also equipped with chilled water Btu meters. None of the submeters were connected into the campus building automation system however so they were not being regularly monitored.

This completed project installed electric, steam and chilled water meters on buildings to provide the capability for metering electric, steam and chilled water usage. It also included directly connecting each existing and new meter into the campus building automation system. The meters installed under this project provide Facilities Management personnel the ability to perform real-time monitoring of specific building utility use and draw attention to potential problems in buildings with abnormally high or low consumption. It has been the single most significant effort for energy conservation on the Ogden campus.

2.3.2.25 Install Irrigation Water Meters

This completed project installed submeters on the irrigation water system in nine locations. It was managed by the Energy and Sustainability Office but was not funded by the energy project line of credit.

2.3.2.26 Replace Transformers with High Efficiency Transformers

This measure will replace old inefficient 480 volt transformers throughout the campus with new energy efficient transformers and consolidate electrical loads where appropriate to improve the efficiency of the transformers. It will be a phased project under the Capital Improvement program and transformers will be upgraded to high efficiency transformers to lower the losses associated with inefficient transformers thus saving energy costs on an opportunity basis. The completion date is dependent upon opportunity and funding.

2.3.2.27 Replace High Voltage Switches

This project is currently in progress under the Capital Improvement program and will replace old 12 kV switches in various buildings located throughout the campus that have exceeded their useful life and do not have parts available for replacement. It also includes replacing voltage regulators and the recloser at the substation. While the new switches will not save energy, they will greatly improve the reliability and safety of the high voltage system.

2.3.2.28 Exterior Lighting Retrofits

This on-going project includes replacement of the HID lamps on buildings, replacement of all walkway lighting with compact fluorescent lamps (CFLs) and upgrading of street and parking lot lighting to CFLs and/or solar powered LEDs. Considerable research was performed by the Energy and Sustainability Office including procurement and installation of various CFL and solar LED fixtures for testing and evaluation of performance and maintenance costs.

2.3.2.29 Power Factor Correction - DC

This Capital Improvement project was implemented as suggested and funded by DFCM to improve the electrical characteristics and energy consumption of the Dee Events Center.

2.3.2.30 Install Domestic Water Meters

This project installed domestic water meters on all campus buildings to measure domestic water use in real time. Each building's meter data is sent to the Lucid dashboard system at least every fifteen minutes. Installation of the meters was completed in the fall of 2014 and significant savings have been realized in domestic water usage and on leak detection and repair.

2.3.2.31 Summer Boiler and Steam System Shutdown

This measure has had the most significant impact of any of the improvements contributing to natural gas usage savings. Considerable savings have been achieved by shutting down the boiler plants at Davis and Ogden campuses during the months when heating is not needed. Savings are realized from the elimination of reheating conditioned air in spaces served by variable air volume systems.

As commonly applied, VAV systems consist of air flow control boxes throughout spaces, generally with heating hot water coils especially in perimeter zones. Served by a central air handling unit, the VAV system delivers cool air to spaces whenever the air handler is operating. To maintain comfort in spaces the VAV boxes modulate to limit this cool air flow and use small hot water coils to reheat the air if needed before it is delivered to the space.

Using the Davis 02 Building as a test bed, the heating system was shut down to determine the feasibility of this measure. Observation of the effects revealed that turning off the reheat and increasing the supplied chilled water temperature resulted in some rooms being overcooled. This appeared to be due to the minimum position allowed for the damper preventing full closure. Also computer rooms became unable to cool properly.

An experimentation process was followed to try making a change to correct this, evaluate the effect of the change, and then make additional changes evaluating effects as they were implemented. As a result of this process, a new control sequence was implemented to eliminate the heating mode and drive the damper fully closed on the VAV boxes. Driving the damper fully closed prevents overcooling.

With the new sequence, if the outside air temperature is below 65°F the boilers are off. When the space is occupied, the demand for cooling will provide fresh air. Further experimentation may result in shutting boilers off at lower outdoor temperatures. In the computer rooms, Facilities Management worked with a contractor to install additional VAV boxes to ensure adequate cooling.

After successfully implementing this measure at Davis 02, it was expanded to include shutdown of the Heat Plant and steam system on the Ogden campus. This made it possible to accomplish the extensive steam upgrades and repair discussed above and has resulted in substantial natural gas cost savings.

For locations on campus that still required heat during the summer such as the Swenson Gym, Union Building and the Stadium, auxiliary stand-alone boilers were installed for use during main system shutdown. In addition, electric autoclaves in the Science Lab to replace those using steam were installed and instantaneous hot water heaters were provided at the Science Lab, Library, Social Science, Visual Arts, and Miller Administration and Wattis Business buildings.

2.3.2.32 Convert Lighting in "Cloud" to LED - DC

The lighting for the playing surface in the Dee Events Center is contained in a large structure centered above the floor known as "the cloud". This structure contained over sixty HID game and work light fixtures. In addition there were sixteen 750 watt incandescent general/emergency lights. All fixtures were energized via manual switching.

After encountering trouble finding design professionals to assist with engineering an upgrade to LED lighting, the Energy and Sustainability Office decided to undertake the design and installation internally. This work was completed in the fall of 2012 and Weber State became the first NCAA arena in the country with 100 percent LED lighting. This project continues to enjoy considerable positive publicity and visits from owners of other arenas and stadiums considering the use of this application that was originally proven by Weber State.

2.3.2.33 ECM 16.1 Gas Rate Change

This completed measure changed the current gas rate for the heat plant from the existing commercial rate to a new interruptible rate to provide natural gas cost savings.

2.4 ENERGY BASELINE AND SAVINGS MEASUREMENT

A Measurement and Verification (M&V) effort provides ongoing accountability and optimization of energy and water conservation measure performance over time. M&V efforts involve reliably quantifying the savings from energy and water savings projects, or individual conservation measures, by comparing the established baseline with the post-installation performance and use, normalized to reflect the same set of conditions.

With the energy project revolving line of credit used to fund these projects, it is critically important that Facilities Management verify that the savings are actually achieved to provide the cash flow needed to service the line of credit. An agreed-upon methodology for this has been developed by Weber State Facilities Management and Financial Services as described in the subsections that follow.

2.4.1 Energy and Water Baselines

For the purposes of calculating savings each year, a baseline was established for electricity use in kilowatt hours (kWh) and demand kilowatts (kW); natural gas use in dekatherms (DTH); and water use in thousands of gallons (kGal). Each of these baselines was developed from the utility bill data for three years from July 2006 through June, 2009 that was analyzed during the Investment Grade Audit. From these data, a three-year average was calculated for each utility type. This is a commonly accepted practice and helps to mitigate the effects of any anomalies that might occur in individual years.

From these data, baseline kW/ft^2 and kWh/ft^2 for “on” peak hours, and kWh/ft^2 for “off” peak hours were also developed. It was noted that Rocky Mountain Power has a different rate structure for the winter months which results in savings being understated during the summer rate period and overstated during winter months if only an annual average is used for the baseline.

To account for seasonal variations in building use by Weber State and seasonal rate changes from Rocky Mountain Power, a monthly baseline is used in performing savings calculations. This approach compares that actual use for each month against the same month in the baseline. The savings calculated for each month are then rolled up for an aggregate total savings at year end.

2.4.2 Measurement and Verification Methodology

Any measurement and verification (M&V) effort should follow a systematic procedure for determining the functional performance and energy or water consumption over time of the energy and water conservation measures implemented as a part of the project. The *International Performance Measurement and Verification Protocol (IPMVP)* provides the framework for this M&V effort and Weber State is currently performing M&V using an IPMVP Option C – Whole Facility approach.

Option C involves use of utility meters or bills to evaluate the energy performance of a total building or campus and determine the collective energy savings of all conservation measures implemented in the part of the facility monitored by the energy meter. Option C assesses the impact of any type of measures, but not individual measures if more than one is applied to an energy meter.

This approach uses the following basic equation to calculate verified energy and cost savings on a periodic basis:

Savings = (Baseline Period Use - Reporting Period Use) +/- Adjustments

The IPMVP Option C approach makes sense for larger projects like the University's that involve multiple measures, usually with interactivity, in which the predicted energy savings are greater than 10% of the building's total energy use. It also makes sense from the fundamental perspective that Facilities Management and those accounting for repayment of the revolving line of credit can use utility bills to determine if energy savings have been realized.

Typically, an Option C approach requires adjustments to the baseline energy usage based on routine adjustments, specifically calibration of the baseline energy usage to weather data, so that both the baseline and post-retrofit energy consumption can be compared without influence from weather differences in the two data sets. Similarly, adjustments are typically made to account for non-routine adjustments, such as changes in building occupancy, square footage, space use type, and so forth, over the life of an energy efficiency project.

At Weber State however, Facilities Management and Financial Services have agreed upon a “shared risk” approach for the University’s energy efficiency efforts. This results in a simplified approach to Option C in which the necessity to perform regression analysis for bringing the baseline and post-retrofit energy data to the same set of conditions is eliminated. Instead, Financial Services assumes any losses or gains due to changes in building sizes, or changes in energy rates, while Facilities Management absorbs any losses or gains associated with changes in occupancy, internal use of the spaces, or weather differences between the baseline and post-retrofit periods.

The result is that essentially no adjustments are made to the energy data, and the baseline and subsequent energy performance of the buildings are compared “as-is.” This represents a unique arrangement that meets the University’s objectives toward energy efficiency, and provides a cost-effective manner to track and verify energy savings on a sustained basis that suits the needs of everyone involved.

2.4.3 Maintaining Performance and Savings Persistence

Facilities Management also employs a method to help maintain energy performance and persistence of energy savings. To this end, the Energy and Sustainability Manager regularly reviews weekly demand load profiles to look for changes in usage patterns. For example, this might include excessive energy usage during unoccupied periods that might indicate scheduling issues, or unusual spikes that indicate unneeded morning warm up during the swing seasons.

This activity provides the ability at a high level to recognize energy usage pattern anomalies that warrant further investigation and potential remediation or action. It would not have been possible without the installation of building meters discussed previously.

Additional efforts that will achieve a greater level of granularity in system operation and persistence of energy savings are discussed in Part 4. One of these is to perform recommissioning of the systems at each building on a periodic basis. The recommissioning effort follows a site-specific approach targeted at each building’s systems and perceived issues or opportunities for improved energy performance, and would be performed on each building according to a prioritized list.

Another involves an ongoing monitoring-based commissioning practice that would utilize an automated system to continuously monitor system operation and alert operators when system dampers not actuating properly, economizers are not functioning, valve actuators for chilled and hot water coils are open at the same time and so on.

This ongoing commissioning method is typically referred to as fault detection and diagnostics (FDD) and could be implemented over time utilizing the existing and upgraded building automation systems campus-wide.

2.5 ORGANIZATION, COMMUNICATION and EDUCATION

The original ESIP also included recommended improvements to the Facilities Management organizational structure, as well as communication and education programs for long-term sustainability of the Plan. Good progress has been made in each of these areas as summarized in the paragraphs that follow. The result has been significant gains in creating a sustainability culture through modification of behavior, improved communication of goals and expectations and employee commitment to those goals.

As part of this, Facilities Management has made an extensive effort to review and update standards for materials and equipment to identify what is acceptable for use in University buildings based on performance to support efficiency and sustainability goals. The overall objective is to determine equipment types and performance requirements and then communicate those standards to the outside design professional community so they can be met or exceeded in building and system designs.

2.5.1 Facilities Management Organizational Changes

2.5.1.1 Energy and Sustainability Manager

Within a short time after publication of the original ESIP approval was granted for an Energy Manager position within Facilities Management. This position has evolved to become the Energy and Sustainability Manager reporting directly to the Director of Operations, and leading the Energy and Sustainability Office.

The activities and responsibilities of the Energy and Sustainability Office along with recommendations for the future are discussed in detail in Part 5 of the ESIP II, however responsibilities of this office in general include:

- Managing campus utilities.
- Analyzing energy use and data from building submeters.
- Researching alternatives and new technology.
- Recommending improvements.
- Pursuing opportunities for grants and other funding.
- Implementing energy and water conservation projects.
- Monitoring performance and reporting to Administration.
- Preparing reports for the American College and University Presidents Climate Commitment.
- Developing energy and sustainability education and outreach programs.
- Creating the University's Sustainability Plan.
- Coordinating efforts with faculty and assisting with sustainability curricula.

The Energy and Sustainability Manager has been directly managing the successful implementation of energy and water efficiency projects recommended in the original ESIP and the Investment Grade Audit using in-house personnel, along with upgrades to the steam infrastructure. The Energy and Sustainability Office has directly employed two electricians and one plumber for these projects and outside contractors have been used when needed work on the steam system and solar equipment installations.

The office includes a full-time Sustainability Coordinator and a student assistant who are responsible for activities related to sustainability and coordination of three Weber State student Environmental Ambassadors for energy and sustainability awareness and outreach efforts. In addition a part-time Intermountain Sustainability Summit Coordinator in has been engaged in developing this highly successful annual event.

2.5.1.2 Facilities Management Organic Improvements

At the time of the original ESIP there were eight major departments within Facilities Management with each department head reporting to the Associate Vice President. Internal departments such as Operations and Services each had a number of subdivisions or "shops" for specific functions. Each shop then had a manager and generally a supervisor or lead technician.

Over the past several years a number of structural improvements have been implemented within Facilities Management that have combined some departments providing complementary functions and created five main areas of responsibility as follows:

- Business Services Group
- Operations Group
- Services Group
- Campus Planning and Construction Group
- Fire Marshall

Four of these major areas of responsibility are led by a Director and the remaining one is under the Fire Marshall, all of whom report to the Associate Vice President for Facilities and Campus Planning.

Within the large Operations Group, restructuring was also accomplished at the shop level. This involved organizing shops according to areas of expertise, with a Superintendent for each group of shops. This replaced the previous arrangement that had individual shop managers reporting to the Director of Operations, reducing the number of direct reports to five and resulting in better management control. Individual shops now have a "lead" person who is directly involved with performing the work of a particular trade reporting to the Superintendent of that group of shops.

The overall effect of these improvements has been to place responsibility for results closer to where work is being accomplished, improve accountability, allow people to maximize their skills and abilities by concentrating on what they do best and ensure the span of control at different levels of management is appropriate and reasonable.

Late in 2014, the Environmental Health and Safety Group was added to the Facilities Management organization. A more detailed discussion of the organization within Facilities Management, particularly for the Operations Group, is found in Part 5 of the ESIP II.

2.5.1.3 Energy Team

Following the recommendation in the original ESIP an energy efficiency team has been established within Facilities Management. This team, under the direction of the Associate Vice President, is comprised of representatives from Campus Planning and Construction, the Energy and Sustainability Office, mechanical and electrical shops, and others as appropriate.

2.5.2 Energy and Sustainability Office Initiatives

The original ESIP contained several recommendations for communication, education and outreach activities to engage the campus as a whole. A number of these have been initiated by the Energy and Sustainability Office including:

- Publishing sustainability-related articles in the campus Signpost newspaper each semester and the Green Link Newsletter available on line and directed toward energy and sustainability.
- Developing a "Green Department" program to encourage faculty and student energy efficiency and sustainability champions.
- Providing education for decision makers on the costs and savings of energy efficiency and sustainability.
- Competing in the Campus Conservation Nationals, a competition each spring to encourage reduced energy consumption.
- Attending every staff and faculty new employee orientation to discuss energy/sustainability goals and progress.
- Working with the student environmental clubs.

- Participating in all student government meetings to advance energy and sustainability goals and communicate progress.

- Working with construction management students, engineering students, etc. and involve them in energy and sustainability projects and research on renewable alternatives.

- Providing an opportunity for students and faculty to submit green ideas to the Energy and Sustainability Office via the sustainability website.

- Using the Lucid Dashboard to make real-time energy and water consumption data available to anyone via the web.

2.5.3 Outreach Efforts

One of the most significant outreach efforts has been organizing and hosting the annual Intermountain Sustainability Summit held each spring for the last five years. Interest and participation in this conference has continued to grow and Weber State has garnered statewide and national recognition for leadership in sustainability. Both the Energy and Sustainability Office and the Faculty Senate's Environment Issues Committee have been involved in hosting the Summit. In addition, the Energy and Sustainability Office has worked to increase outreach by:

- Conducting class visits and campus tours throughout the academic year.

- Working with a number of professors and classes on campus on projects for Facilities Management that provide students with a learning experience using the campus as a living learning lab.

- Managing the student Environmental Ambassadors Program to provide energy and sustainability awareness and outreach.

- Developing classes that can be offered to University faculty and staff through Weber State's Training Tracker.

2.5.4 University Faculty Engagement for Sustainability

The efforts of the Energy and Sustainability Office have resulted in University faculty engagement in supporting efficiency and sustainability initiatives. Two representatives from Facilities Management now are part of the Environmental Issues Committee and that Committee itself has become much more active in promoting sustainability than it was at the time the original ESIP was developed.

The Environmental Issues Committee hosts a number of speakers and has co-sponsored Weber State's Engaged Learning Series focused on the topics of air, water, and food over the last several years. In addition, the Committee hosts Teaching and Learning Forum sessions and an annual retreat to help faculty incorporate energy and sustainability issues into the curriculum.

On the academic side, this has led to the integration of sustainability into curricula with the addition of sustainability-related courses or components of courses. The Energy and Sustainability Office has provided assistance to faculty for this, including participation in retreats to develop course elements. Some of these courses have included Senior projects that have supported the activities of Facilities Management and many now require students to write technical papers that incorporate energy or sustainability impacts.

PART 3
LONG-TERM VISION WORKSHOP

3.1 OVERVIEW

The Weber State ESIP II is a long-range plan creating a twenty-five year vision to meet the goals for the University with regard to investments in energy efficiency projects, energy efficient design for buildings, carbon footprint reduction, and alternatives for energy production and sourcing, all in support of the University's Climate Commitment goals and Climate Action Plan.

Bringing about the cultural change necessary to accomplish this long-term vision is a key challenge. An early step in the process is to assess overall commitment to the long-term vision and begin to determine what strategies will work with each group of stakeholders.

As part of developing the Facilities Management Energy and Sustainability Investment Plan (ESIP II), an all-inclusive Weber State Futures Workshop was held on two consecutive days for the purpose of gaining a larger perspective on the future of the University. Participants included a diverse group of people consisting of Administration including Vice Presidents and the Provost Office, Academic Deans and Professors, Students, and representatives from Facilities Management (FM) and Information Technology (IT). The objectives, process, results, and recommended next steps are discussed in this part of the ESIP II.

This workshop was different from most traditional strategic planning workshops that are often routine and bureaucratic in that it used a "scenario planning" process. Scenario planning takes place in the form of developing possible scenarios with key players, then assessing each scenario through a stakeholder workshop. This process creates a shared vision but just as importantly develops commitment from the participants.

Under the guidance of Facilities Management, a workshop planning group was formed with representatives from FM, IT, Academics and the Provost. This planning group established goals for the workshop and developed four possible scenarios or stories about Weber State's future that established the outer boundaries and formed the basis for discussion in four small breakout teams and within the participant group as a whole.

This Workshop was professionally facilitated by E/S3 Consultants, Inc. and was intended to be easy and enjoyable while incorporating a high level participation. The underlying concept was that ideas would be freely discussed and the Workshop was not designed to be a forum for decision-making or strategic planning.

There was no attribution of comments and no pressure to take positions or make decisions. Because of this setting, participants were able to have free and open discussions. This open discussion among the diverse group was very enlightening and supportive of the goals of the Workshop and efforts of Facilities Management

The overall sense at the conclusion of the Workshop was that the participants were enthusiastic about working with others to gain different perspectives. Many people said they would have liked more time to work, particularly in the small teams, and it is recommended that the University use this approach again.

3.2 WORKSHOP OBJECTIVES

The primary goal of the Workshop was not predict the future but rather to help the University make better decisions. The workshop was designed to help people develop new insights and a better, more flexible decision process. It was also important that people enjoy the process and that everyone should be able to participate and have their ideas and positions heard. Improving communication and building trust among the participants was also critical.

To accomplish these, the objectives developed by the Planning Team for the Workshop included:

- Encouraging participation, building trust and collaboration, and providing for more interaction between University departments.
- Capturing new points of view and understanding of the needs of the larger University community.
- Avoiding unintended consequences that can often follow change.
- Helping to develop a "sustainability culture".
- Creating support for a long-term vision and outline a plan for how to get there.

To provide additional information and help participants prepare for the Workshop more than 50 articles on Massive Open Online Courses (MOOCs), the Data Revolution, and Advanced Energy Systems were made available through the Futures Workshop Website.

3.3 WORKSHOP SCENARIO DEVELOPMENT

Scenario planning workshops can be challenging because the success of this type of workshop depends on correctly setting up the scenarios. Even though understanding the future requires some complexity, a few simple, understandable scenarios are essential. The workshop participants need to accept the premise of each scenario and build the case that makes the scenario logical and believable. Each scenario should start out as an outer boundary so each team can detail the specifics to help develop good communications, build trust and encourage buy-in.

The scenarios must also be properly set up so the teams don't get bogged down in minutia turning the discussion into a "challenge and response" situation where people argue the details rather than developing the story about the future. This requires carefully avoiding emotional or symbolic terms that could derail the workshop.

Another challenge is the expectation that a "futures" workshop is just another name for "strategic planning". While using "status quo" as one of the scenarios might seem logical, it indicates a desire to do traditional strategic planning rather the creating a story about the future. Scenarios are a richer and more flexible approach than traditional strategic planning.

The Planning Team developed four scenarios about the future for the workshop recognizing these challenges. Each scenario defined outside limits for possible scenarios or stories about Weber State's future and the ending was predetermined.

Each scenario tackled issues such as growing online education, increasing use of IT computer servers both on campus and in the cloud, future use of facilities, new energy requirements and opportunities, and Weber State's commitment to be carbon neutral by 2050. Particular emphasis was placed on incorporating complexity in the planning process and avoiding unintended consequences of singular actions.

One scenario was optimistic about the future – the "rose colored future". Another scenario had consistently poor outcomes. This scenario was nicknamed the "death spiral future". The other two scenarios were a mix of successes and failures. A brief description of each scenario follows.

3.3.1 Scenario 1 - Weber State Doubles Student Population with Online Education, but Energy and Sustainability are a Low Priority

"Online courses have enabled Weber State to double the number of students without increasing the campus footprint. The University is now a national leader in providing "blended" education that combines live and online learning. However, sustainability efforts have been derailed from a lack of support from the University, a poor economy, and a lack of funding."

3.3.2 Scenario 2 - Weber State Doubles Student Population and Becomes a National Leader in Sustainability

"Online courses have enabled Weber State to double the number of students without increasing the campus footprint. The University is now a national leader in providing 'blended' education that combines live and online learning.

Sustainability is now a deep core value. All employees have a sustainability component in their job descriptions and in their performance evaluations. The University is a leader in high performance buildings, on-site renewable energy generation, and a model "smart grid" community."

3.3.3 Scenario 3 – Weber State's Investment in Online Education has Limited Success and Sustainability Funding is Eliminated

"Weber State is heavily invested in online education, but is unable to compete successfully with free university courses offered by other large universities. In addition, sustainability efforts have been derailed from a lack of support from the University, a poor economy, and a lack of funding."

3.3.4 Scenario 4 - Weber State's Online Education Suffers from Competition. Sustainability Thrives, but Power Over-Capacity is a Problem

"With more and more expensive natural disasters, insurance companies take the lead in the fight against climate change. Unacceptable pollution along the Wasatch Front leads to the creation of the Wasatch Front Clean Air Consortium of Mayors. The Utah Legislature joins the effort with funding for energy efficiency and pollution reduction.

Weber is heavily invested in online education, but is unable to compete successfully with free university courses offered by other large universities. In addition Weber has built new server capacity on campus, but too much is underutilized due to competition from other universities."

3.4 WORKSHOP GROUP AND TEAM DISCUSSIONS

The Futures Workshop consisted of two very different half-day events. Day One was a day to talk about solving complex problems and build scenarios about possible futures. This portion of the workshop is non-judgmental and requires a level of creative thinking, trust, and risk taking. The overall goal was to further develop each future scenario and identify critical certainties and uncertainties.

Following introductions, opening remarks, discussion of the process and establishing ground rules, the whole group was introduced to the four scenarios. Participants were then divided into four smaller but still diverse teams, one for each scenario. Each scenario team had a coach from the planning group to keep the discussions on track and on time. Each coach also had background notes for their scenario to be used to supplement the discussion if needed.

The teams were asked to further develop each scenario and then present and discuss their scenario with the entire group. Teams then went back to determine what they liked and disliked about their scenario and conversations within each team were lively, probing, and informative. The whole group reconvened for a brief presentation by each team at the end of the day's session.

The second day began with brief presentation by representatives from Academics, Information Technology and Facilities Management on future plans in the context of the first day of the Workshop, possible big decisions to face in the near future and thoughts about the long-term future at Weber State. After those presentations this was an "analysis day" for the Workshop. Within each scenario each team was asked how they would identify a poor outcome paths (red flag) and courses of action that lead to better outcomes (green flag).

Where certain outcomes were desired, teams developed "green flag" ideas along with strategies to encourage that particular path. Individual team strategies were then discussed with the whole group and elements common to all were identified. These were divided into two pathways: (1) "red flag" pathways leading Weber State into unwanted directions; and (2) "green flag" pathways leading to the most desired future. The workshop ended with a brief group discussion about the workshop approach and what was gained from the perspective of participants.

3.5 WORKSHOP OUTCOMES

The Workshop provided a forum for free and open communication. In addition to some big, new ideas there were also subtle and nuanced ideas such as keeping long-held Weber State values in future endeavors. It was quickly apparent that simple solutions were easily prone to unintended consequences. For example, one simple idea was to limit the number of on campus students and move to more online education. This helped solve the transportation issue and meet carbon reduction goals, but might cause other university problems such as diverting money from live classes and the loss of Weber State values such as the socialization of students.

A desired outcome of the Futures Workshop is the development of "Big Ideas". These differ significantly from "Small Ideas". Small ideas can be partially implemented and still reach some measure of success. For example, if energy retrofits are completed on five building instead of ten, these are successes. However, big ideas, with big potential outcomes need to be 100% ideas, that is, they must be fully (100%) thought out and implemented. There has to be a "bias for action", inclusive involvement from all stakeholders, and careful avoidance of unintended consequences.

Big Ideas have more risks, but much larger outcome potential. Big Ideas can come from the bottom up, but need Champions at the top of the organization to be successful. Big Idea failures can be as small as a failed shuttle bus system or as large as Kodak's failure in digital photography. Big idea successes range from Google and Apple to the re-thinking skyscrapers like the new One World Trade Center in New York.

A number of "Big Ideas" were developed in the workshop. One exciting idea that emerged was "Less Cars and More Students". That concept is to develop and implement comprehensive alternative transportation, more flexible off-peak classes, more community partnerships, better integrated online education, and increased student socialization. This would solve a number of big issues for the University while avoiding some unintended consequences that were identified in the workshop.

It would address the need to increase the on campus student population while decreasing the number of cars. As discussed during the Workshop it would help Weber State meet its Scope III carbon reduction goals, assist Ogden City with its transportation and air quality concerns, maintain teaching staff, create more effective use of buildings, provide for more community engagement, and move Weber State toward being an even more flexible, dynamic institution.

To facilitate accomplishing this, partnership opportunities with Ogden City, UTA, UDOT, industry, community groups and the Utah Governor's Office, which recently announced a clean air initiative, could be explored.

3.5.1 Important Common “Green Flag” Ideas

Each team identified a number of pathways to be encouraged, green flag indicators when on these paths, actions to be supported and incentives that could be developed with respect to creating a positive outcome for their assigned scenario. The following brief descriptions represent some of the ideas the teams had in common. Some of these are already occurring at the University and need to be enhanced while others represent action steps for further development.

3.5.1.1 Create Collaboration and Partnerships with Outside Organizations

Improve UTA discussions with links transit. Work with Ogden City, other communities and higher education institutions. Investigate using strategically located testing center hubs. Further develop satellite campuses to reduce commuting and increase local community involvement.

3.5.1.2 Address MOOCs and Online Issues

Consider hybrid courses, flexibility, improved quality and assessment of online standards and outcomes. Share understanding of MOOCs with other Utah

Higher Education institutions. Explore flexible schedules and options. Create the ability to handle MOOC credits and offer MOOC courses to counter large universities. Assess on-line outcomes such as completion rates, relevance of courses to student and industry needs and acceptability by prospective employers.

Implement best practices for education across campus. Ensure accountability of online instructors including policies such as minimum standards for communication with on-line students. Provide professional development training for faculty, including adjuncts, and adequate staffing levels

3.5.1.3 Foster Social Development of Students

With the growth of MOOCs it's important to remember that social development of students is still an important component of education. Blend on-line courses with face-to-face learning. A better/higher ratio of people living on campus would address a number of other issues in addition to increasing campus community. Renovate underutilized areas or increase space for students to improve socialization. Develop employment opportunities within the University or with companies working on campus.

3.5.1.4 Create Incentives for Sustainability

These could include incentives for mass transit, alternative transportation, and incentives for faculty and students for off-peak classes. Include faculty and staff engagement. Use “nudges” rather than penalties. Increase utilization of the Lucid "dashboard" for highlighting energy use in WSU buildings.

3.5.1.5 Develop Viable Transportation Alternatives

Find ways to have more students but fewer cars. Include reduction of faculty and administration driving. Identify and mitigate barriers to alternative transportation such as bikes, buses, shuttles. Encourage car pooling with incentives such as special parking areas. Reduce student commuting between campuses for classes. Consider flexible schedules and increasing online class enrollment. Foster sustainability in resource use and commuting.

3.5.1.6 Ensure University Values are Incorporated

Describe and promote Weber State core values of learning, community and access. Integrate core values into plans and programs. Improve communication of policies and procedures.

3.5.1.7 Promote Informed Growth

Avoid decisions based on projections that may not have been accurate or sustainable. Promote scalable infrastructure and strategic growth driven by community needs, academic needs, student desires, and program success. Plan future property growth to deliver education close to where students are located.

3.5.1.8 Improve Funding for Energy Efficiency and Sustainability

This may include educating decision makers on economics, prioritizing efforts based on energy and water savings, pursuing alternative funding, and increasing community partnerships.

3.5.2 Common "Red Flags"

Within each of their assigned scenario each team also identified a number of pathways to avoid and indicators when the University might be moving in an unwanted direction ("red flags"). These are not necessarily happening now but need to be enumerated so early indicators can be seen and appropriate actions taken.

The group as a whole identified several of these pathways to avoid, red flag warnings, and actions to be disrupted that were common to all teams. These pathways and some of their red flag indicators are as briefly summarized in the following paragraphs.

3.5.2.1 Over-commitment and Over-emphasis of Online Courses

- MOOC competition from other Universities.
- No plan for where MOOCs are taking Weber State.
- Technology destroying University jobs.
- Over committing to online teaching.
- Over centralization of online/technical infrastructure.
- Loss of student socialization from online.

3.5.2.2 Uncontrolled and Unplanned Growth

- Decisions based on projections that may not have been accurate or sustainable.
- Underutilized space.
- Numbers and growth for growth's sake.
- Not enough administrative space.

3.5.2.3 Lack of Support from Administration, UTA, Community and Legislature

- Reduction in funding for energy efficiency and sustainability.
- UTA political barriers.
- Reduced involvement/engagement becomes red flag for problems.
- Can't build or grow community partnerships.
- Oversize classes (fixed sizes now).
- Not hiring enough faculty (& support staff).
- Poor communication of policies and procedures.

3.5.2.4 Expansion of Commuting

- Increased Scope III emissions – can't achieve University goals.
- More parking required (University plans currently include additional parking).
- Decreased engagement in the University other than for classes.

3.5.2.5 Underutilized Resources

- Excess space or infrastructure not in areas where students are.
- Over capacity in servers and IT infrastructure.

3.5.3 Potential Action Steps from the Workshop

In concluding the discussion of what all of the scenarios had in common the whole group listed several actions for follow up based upon the ideas developed during the Workshop including:

- Use the experience gained from having people from different areas of the University work together in this Workshop, and the ESIP II, to initiate communication with other groups, community members, organizations, and so forth, to truly discuss how to integrate sustainability concepts into the academic community.
- Use ideas developed here to address Stage III emission reductions.
- Increase conversations between all campus groups, including IT, Facilities Management and the Environmental Issues Committee.
- Continue development of discussions regarding growth, building utilization, and space needs, and what metrics are being used for decision making.
- Remember that Weber State has a responsibility to the community at large to reduce (or eliminate) its carbon footprint.

3.5.4 Recommendation for the Future

An open discussion within the group at the end of the Workshop resulted in a number of things to be considered such as:

- Bringing more people into the discussion, identifying who else should participate in this kind of workshop and finding ways to bring people together.
- Creating stronger academic links to sustainability.
- Developing more collaboration to address the big challenge to reduce Scope III emissions.
- Ensuring IT is part of the conversation.
- Improving space utilization and academics.
- Providing more emphasis on how we measure and how we are doing.
- Engaging more of the rest of the university in sustainability.
- Making more investments in longer term projects.
- Continuing good University support for Facilities Management.
- Becoming more involved with University planning.
- Creating a planning group to work on community issues.

3.6 WORKSHOP EVALUATION BY PARTICIPANTS

During the wrap-up discussion the group indicated that the Workshop was valuable for developing smaller steps that could lead to big improvements. Engagement of the various departments and students should lead to more collaboration, bigger range of ideas, follow through and confirmation that everyone must work together as a university in order to succeed together. The Workshop highlighted the impact of student socialization and resulted in a commitment for all participants to work together on this.

Beyond that, participants said the Workshop provided a better understanding of IT and Academics, provided a better understanding of online education, and they enjoyed the creative solutions from the small teams.

In addition to the discussion at the end of the Workshop, participants were invited to complete a survey available on line. Thirteen diversified Workshop participants completed the evaluation survey and the individual comments provided were very helpful. A full 100% of the people responding rated the workshop as either excellent or good. At least five of the articles from the resource list were read by 78% of participants prior to the workshop.

Most liked by the group were the different perspectives and the small group conversations. The overall sense of the workshop was that the participants were enthusiastic about working with others in creating more holistic solutions for WSU's future. Part of this enthusiasm was to avoid the unintended consequences of working in isolation. Many people said they would have liked more time to work, particularly in the small teams, and there were some comments about the lack of specific conclusions. A summary of survey responses is contained in Appendix E.

3.7 RECOMMENDED NEXT STEPS

To be most effective, this kind of workshop would normally be scheduled for two full days but the time frame available required that a few areas be compressed to fit an abbreviated schedule. Scenarios that would usually have been developed by participants during the workshop were prepared prior to the workshop by the planning team. Some of discussions were necessarily shortened in the interest of keeping to the schedule. Further, more time would generally have been spent on consolidating the workshop ideas and developing next steps at the conclusion of the workshop.

One of the comments from the workshop was that the IT people found it valuable to have the bigger picture of where the University was heading and it was also an opportunity for IT to become better known to their users at the University. Facilities Management is highly interested in continuing to work with and educate the rest of the University on their energy investment plans. Another idea from the workshop was to develop larger, more comprehensive plans for the University's future including the idea for alternative transportation combined with alternative class scheduling and the needed incentives all around to make this work.

Responses to the workshop evaluation indicated that people overwhelmingly liked the different perspectives and the small group conversations. Many people indicated that they would have liked more time to work together and further explore the potential for the University to both disrupt "red flag" problems and find ways to encourage "green flag" possibilities. Suggested improvements also included having more participants and follow-up on the action items.

To that end, a follow-up session should be scheduled with as many of the same people participating as possible. This session should again be professionally facilitated to cover the major topics and conclude with an action plan as described in the following paragraphs.

3.7.1 Review of “Red Flag” and “Green Flag” Indicators

During the original Workshop the group identified various "red flag" indicators of pathways that could lead Weber State in unwanted directions and interfere with achieving sustainability goals or otherwise cause long-term problems for the University. The purpose of this is was provide for early recognition of these problems if they begin to appear in order to disrupt them. At the same time a number of “green flag” ideas were also developed that would indicate the University is on a path to more desired outcomes.

This part of the follow up workshop should serve as a refresher for the group and lead into a discussion of specific areas to address. Any changes that have been observed or implemented since the original Futures Workshop or as a result of it should be included to ensure everyone in the group is updated.

3.7.2 “Red and Green Flag Early Indicator" Discussion

In the next part of the session, green flag pathways to pursue would be identified and prioritized. Any "early indicators" of red flag situations that are actually occurring should be discussed as well to determine levels of urgency and develop a strategy to deal with them.

3.7.3 Develop Action Plan and Next Steps

The whole group should then select one or more prioritized areas and work to develop a plan for a concise, focused effort to address the area(s) identified using multidisciplinary "big ideas" that account for unintended consequences, and move the University to desired outcomes. A graphical map should be developed for each to include the "what, how, who, and when" action items as well as barriers, uncertainties, and success measures. Milestones and how progress will be monitored and reported should also be agreed upon.

PART 4
PLAN FOR CARBON NEUTRALITY
IN CAMPUS BUILDINGS

4.1 INTRODUCTION

In late 2007 Weber State University joined nearly 300 other colleges and universities across the country in the American College and University President's Climate Commitment, an unprecedented and aggressive effort with the goal of becoming climate neutral. This commitment, executed for the University at the time by President F. Ann Miller, reflects concern at the top level of management in colleges and universities about global climate change, its scale and speed, and its potential adverse effects on health, society, the economy and the environment on a large scale.

The American College and University Presidents Climate Commitment includes development of a comprehensive plan to achieve climate neutrality. By joining this effort, the University has made a pledge to pursue a number of actions to reduce greenhouse gas emissions and has established the goal to become a carbon-neutral campus by the year 2050. This goal provides the basis for all energy efficiency and renewable energy efforts conducted and planned by the University.

The original Energy Saving Investment Plan (ESIP), published in January, 2008 was designed to support Weber State's commitment by providing a major component of the initial phases and a foundation for actions to pursue in the first several years of the University's efforts. As described previously in Part 2, a substantial majority of the projects and initiatives identified in the original ESIP have been accomplished or are in the process of implementation.

To achieve true carbon-neutrality with regard to the energy-consuming equipment in its facilities, the University's long-term plan must address four core areas as follows:

- Existing buildings
- New construction and major renovations
- On-site renewable energy generation
- Purchase of renewable energy

This is an impressive undertaking for a large established university infrastructure and will require Weber State to convert over time to all-electric campuses. A long-term vision of what the University's infrastructure will look like is needed, along with a strategy to ensure that all projects are consistent with that vision and all parties act in a coordinated and well planned manner to achieve a common goal.

This part of the Energy and Sustainability Investment Plan (ESIP II) describes the concepts and practices that need to be adopted for existing buildings, new construction, and major renovations, as well as the support necessary for comprehensive onsite renewable energy generation. It is expected that this process will take twenty to thirty years and current projections indicate carbon neutrality will be achieved by about 2044 which would be six years ahead of the University's Climate Commitment goal.

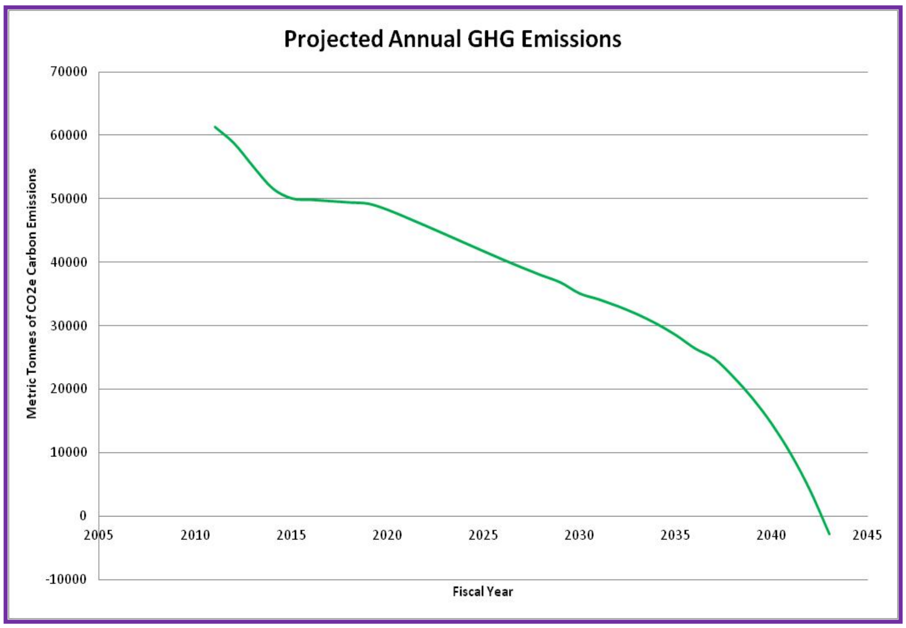


Figure 4-1 Estimated Carbon Neutrality Date

It should be noted that a comprehensive carbon neutrality plan must also consider other sources of emissions including fleet vehicles, transportation to and from campuses, and chemicals such as fertilizer for landscaping. The focus of ESIP II is on buildings and emissions related to operation of their energy-consuming systems. It is intended to be part of overall sustainability and carbon-neutrality planning effort being undertaken by the University.

4.2 GENERAL DESCRIPTION AND GOALS

For existing buildings the goal is to reduce energy consumption by 50% from the 2006-2009 baseline of 37,760,080 kWh. This continues the efforts of the original ESIP and provides the generation of funding for additional projects from savings of money the University is spending on utility costs. Currently Weber State consumes approximately 27 million kilowatt hours (kWh) per year. This consumption and its associated cost will decrease each year due to efficiency projects. Of equal importance, these projects will avoid the need for excess renewable energy generation capacity to make up for inefficient equipment at the building level.

Fundamental to the idea of carbon neutrality is the principal that as much of the energy consumed as possible should eventually be produced by Weber State on- or off-site with renewable technologies, with the balance purchased through one or more third-party partners such as the Rocky Mountain Power Blue Sky Program. Further, carbon emissions sources, primarily those that burn fossil fuels, must be eliminated. The ultimate goal for the ESIP II is that energy needs of Weber State campuses will eventually be satisfied through electricity generated by renewable energy systems and the University would minimize, if not completely eliminate, the use of fossil fuels.

To accomplish this goal a key component of Weber State's carbon neutrality plan is the development of a campus-wide approach to all-electric building systems. From a practical perspective, this means that all equipment for HVAC, domestic hot water, kitchens, and so forth. in existing and new buildings must have electric-only equipment. This will allow the existing steam plant and distribution system at the Ogden campus to eventually be phased out.

The Mechanical Infrastructure Master Plan described in Section 4.3 provides the framework to ensure that all new construction and renovation projects for buildings look for synergies between projects, rather than be evaluated in isolation, in order to continue Weber State's movement in the direction of carbon neutral capable buildings.

Running concurrently with building energy efficiency upgrades, new building construction and major renovations that follow the Mechanical Infrastructure Master Plan will be design and installation of renewable energy generation primarily through the use of solar photovoltaic (PV). This will position the University for the other major component of the ESIP II, which is to ultimately use renewable electric energy generated either on- or off-site to achieve a degree of independence from the cost risks of purchased power.

4.2.1 Reduce Energy Use in Existing Buildings

One key to achieving carbon-neutrality is reduction of the energy consumed by the existing campus buildings. This involves a concerted effort to decrease existing building loads, improve system performance, and retrofit existing systems with energy efficient equipment and controls.

Weber State has been following the guidance of the original ESIP to implement many energy and water conservation measures in campus buildings with considerable resultant energy and cost savings as discussed in Part 2. In addition, substantial work has been done to create standards for energy and water efficient equipment, building automation and controls, and operations and maintenance practices.

This work will continue under ESIP II to support the carbon neutrality goal and help ensure persistence of savings and efficient maintenance of existing and future systems. The plan for reducing energy use in existing buildings is discussed in section 4.4, and includes energy efficiency measures, control system upgrades, targeted recommissioning, deep retrofits, and ongoing commissioning.

4.2.2 Carbon Neutral Capability

As part of the ESIP II, the concept of "carbon-neutral capable" (CNC) or "net zero" buildings will need to be embraced for both existing buildings and new construction. This involves reducing heating and cooling loads within buildings, addressing loads passively to the extent possible through improved envelope, natural ventilation, integration of efficient energy-using equipment, and sophisticated controls and strategies to reduce energy usage of new and existing buildings as low as possible.

The overall purpose of this concept for Weber State is to ensure that construction, renovation and upgrades of campus buildings over the next twenty to thirty years align with the University's plans to achieve its carbon neutrality goal.

The current national average for energy utilization index (EUI), which represents energy usage per square foot, is about 93 kBtu/ft^2. Carbon neutral capable buildings are considered in the range of 78 kBtu/ft^2 and below, with a typical best practice target of 28 kBtu/ft^2, according to the Energy Information Administration. As such, Weber State should use this target EUI of 28 kBtu/ft^2 as their goal for average building energy usage intensity.

The National Buildings Institute has compiled a list of technologies that are most common in carbon-neutral capable or "net-zero buildings" that includes:

- Daylighting
- Efficient lighting
- Variable refrigerant flow systems
- Ground-source heat pumps
- High-efficiency HVAC systems
- Dedicated outside air systems for ventilation
- Heat recovery
- Cool roofs
- Efficient envelope
- High R-value glazing
- Natural ventilation
- Radiant heating
- Under floor air distribution and displacement

Carbon neutral capability will be a critical consideration in the design and construction of all existing building retrofits, major renovations and new construction. The University's Mechanical Infrastructure Master Plan described in Section 4.3 provides the direction and strategy for creating a carbon neutral capable campus infrastructure through conversion to all-electric systems and the phase out of fossil fuels as a heating source.

Mechanical and electrical infrastructure designs for new building construction, major renovations and upgrades of existing buildings shall maintain consistency with this plan in order to ensure the capability for carbon neutrality through the use of these renewable energy sources. Designs based upon older technologies, lower energy efficiency in equipment and systems, or continued long-term use of fossil fuels will not be compliant with the Mechanical Infrastructure Master Plan and shall not be considered.

4.2.3 On-Site Generation With Renewable Energy

The all-electric systems envisioned as part of Mechanical Infrastructure Master Plan will eventually be supported by onsite renewable electric energy production. The University has already begun installing solar photovoltaic systems into the campus infrastructure, particularly on the roofs of new construction, and these systems will be continuously expanded over time.

It is currently estimated that consumption at the Ogden and Davis campuses will be reduced to about 18,800,000 kWh/year from the 37,760,080 kWh in the 2006-2009 baseline by energy efficiency through upgrades in existing buildings and use of high efficiency systems in new construction and renovations following the Mechanical Infrastructure Master Plan.

Weber State currently purchases about four million kilowatt-hours of renewable energy per year from the Rocky Mountain Power Blue Sky Program. As the plan progresses, electricity will continue to be purchased from the local utility (currently Rocky Mountain Power) and that partnership will be maintained. Concurrent with the mechanical infrastructure conversion will be the installation of renewable energy technologies, primarily solar photovoltaic, so that a significant amount of the energy consumed by Weber State should eventually be produced onsite at the Ogden and Davis campuses.

Installation of 5-10 megawatts (MW) of solar PV between the Ogden and Davis campuses would provide 6-12 million kWh/year and this is the point where construction of on-site generation capacity is planned to stop. Given current economics, substantial on-site storage capacity is not part of this plan and balancing solar generation with electric power demands, for example at night, and any energy needs beyond on-site capacity will be provided through the purchase of off-site renewable energy generation. As economics and technology change on-site storage may be reconsidered.

The goal is to have a portfolio of 100% renewable energy from three sources comprised of on-site and off-site generation along with purchased power. While photovoltaics will play a major role in electric energy production, other technologies should also be considered for incorporation into this network. Technologies such as wind-generation and solar thermal collectors represent other renewable technologies that could provide diversification and additional stability to electric energy production.

Similarly, other renewable and alternative energy technologies will be considered, such as solar domestic water heating, biomass power generation, refuse power generation, solar heating and cooling, and solar ventilation preheat. Applicability and economic viability of these systems, either campus-wide or on a project basis, should be assessed through additional feasibility or detailed studies. These studies can be integrated into student education. For example, students are currently doing research on wind power using a "wind trailer".

It is important that energy efficiency be maximized in campus buildings as the first phase of the Energy and Sustainability Investment Plan. This approach provides nearly immediate savings and cash flow to fund additional efficiency projects. Funding for renewable energy generation will primarily be provided through the Weber State Energy Program using funds realized through energy conservation and from avoided costs of purchased electricity with the addition of some grant funding, primarily in the early phases.

Projections indicate that eventually energy conservation investments and associated cost savings will reach a point of diminishing returns. After that these savings will be eclipsed by the energy cost savings from renewable generation and it will make more sense to invest those savings in additional generation. Figure 4-2 illustrates the currently projected "break-even" point.

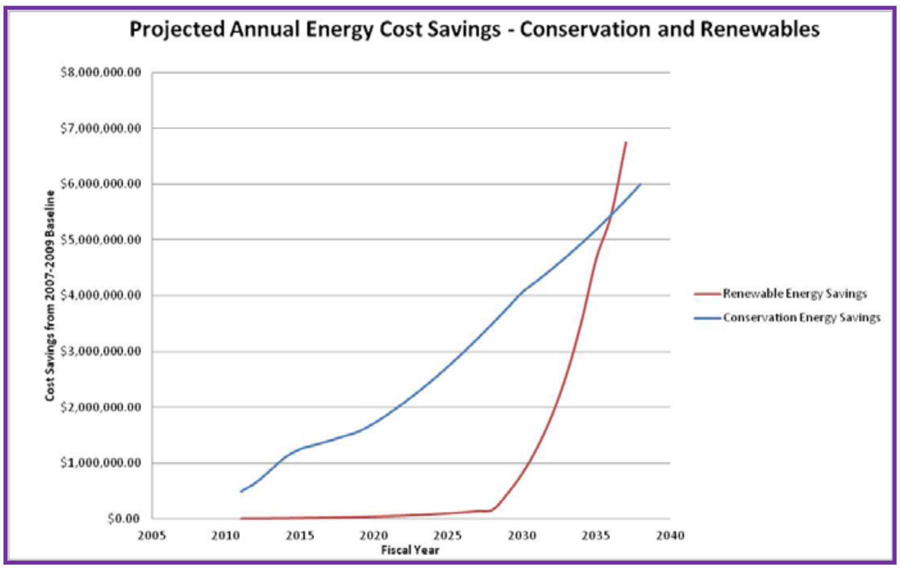


Figure 4-2 Estimated Conservation Savings "Break-even" with Renewable Energy

4.3 MECHANICAL INFRASTRUCTURE MASTER PLAN

The campus wide Mechanical Infrastructure Master Plan begins at the building level and involves the use of all electric, high coefficient of performance (COP) systems that comprise a fluid heat exchange loop within each building. This arrangement efficiently delivers heating or cooling where needed to individual spaces with a high degree of individual zone control. Further, the inherent design of the system provides the capacity to move heat rejected from a zone in the cooling mode to a zone requiring heat rather than creating or providing heat to that zone through a separate system.

System types for buildings include variable-refrigerant flow (VRF) heat pumps, water-source heat pumps (WSHP) and heat pump chillers. Each of these has advantages for particular situations and they are described in section 4.3.1 below. As the plan progresses newer more efficient technologies that emerge will be considered. A heat exchanger or water piping directly connected to the campus chilled water loop integrates the systems in each building with the existing infrastructure to provide a heat source or sink and expand the ability to move heating or cooling between buildings. Figure 4-3 below presents a basic line diagram of this concept.

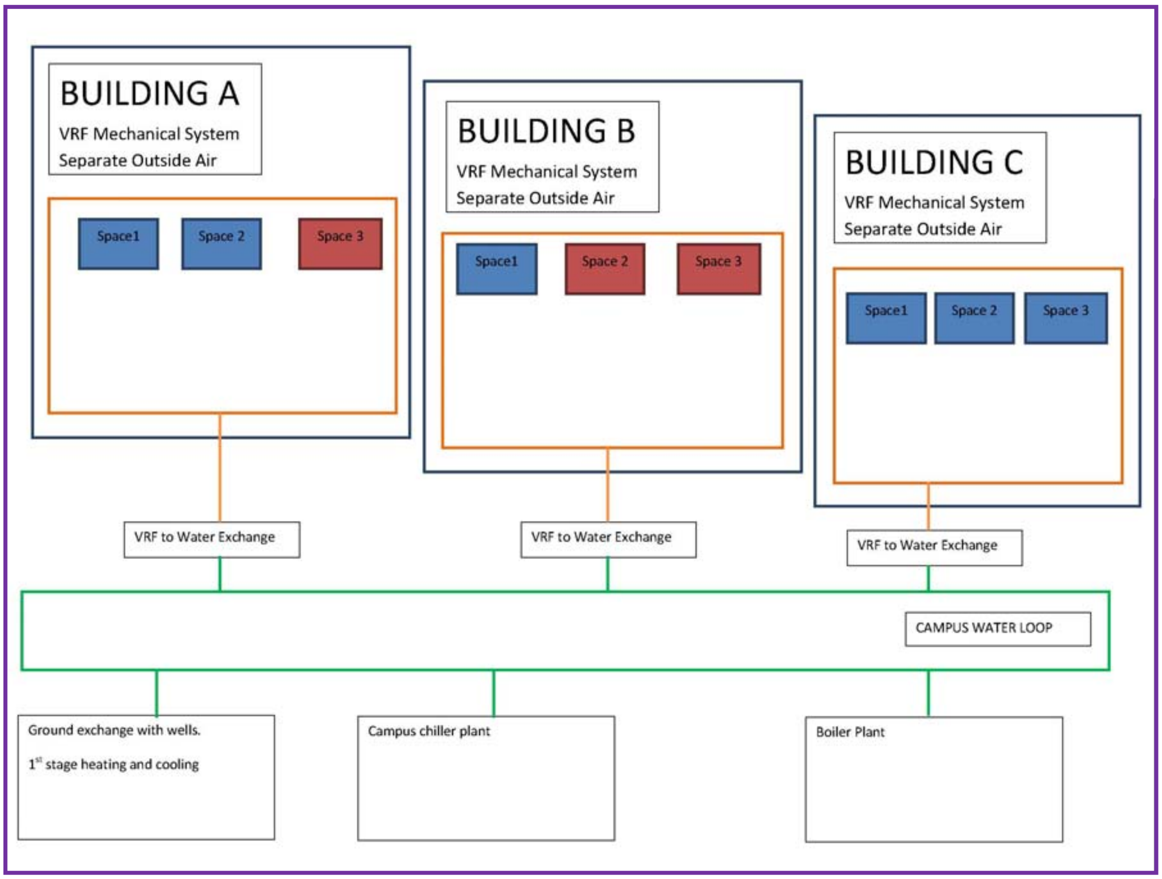


Figure 4-3 Mechanical Master Plan Line Diagram

Advantages of this approach include the ability to allow for phased installation and for the upgrade and conversion of existing buildings over time as projects through the normal Capital Improvement (CI) and Capital Development (CD) process. A major upfront infusion of funding would not be necessary until possibly near the end when the remaining loads fall below the turn down capacity of the heat plant. This is discussed further in section 4.6.3.

This approach also allows the University to avoid the costs associated with replacing Boiler #2 and a substantial amount of the steam infrastructure upgrade work described in the study performed by WHW Engineering, Inc. in 2012. Further, the overall infrastructure will be considerably safer once the plan is fully implemented since the campus will no longer have any piping or systems operating at high temperatures and pressures.

4.3.1 Building Mechanical System Types

4.3.1.1 Variable Refrigerant Flow Systems

Variable refrigerant flow (VRF), sometimes also referred to as variable refrigerant volume (VRV) heat pump systems, were first used in Japan nearly thirty years ago and have been installed in Europe since 1987. In the US, strong marketing only began around 2005, however there are at least five major manufacturers selling these systems here today with a large base of installed systems and tonnage.

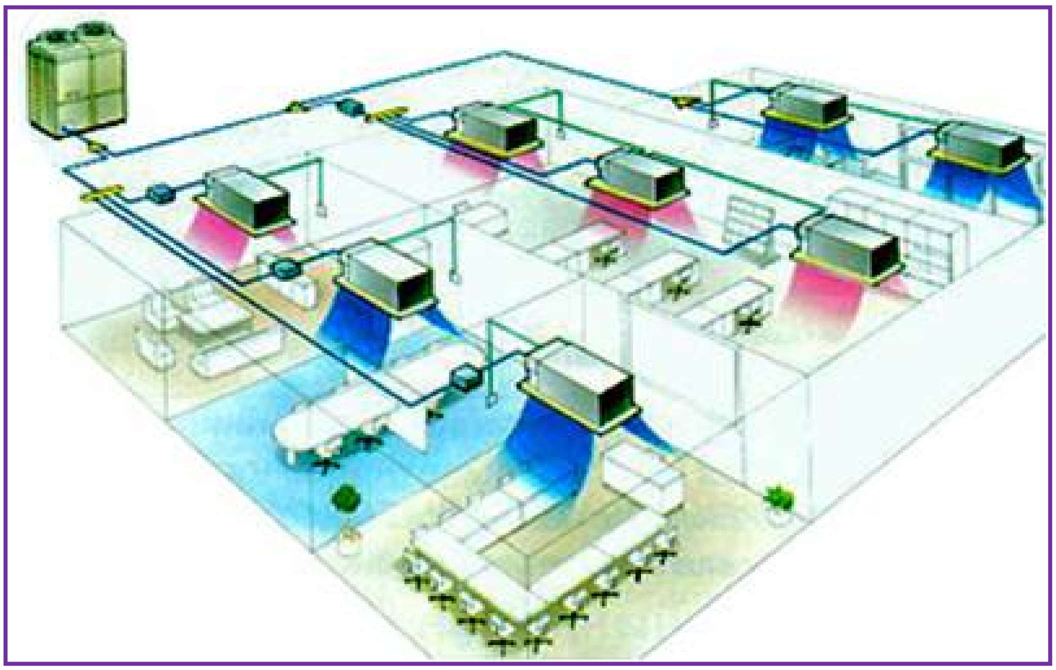
The VRF systems incorporate high efficiency heat pumps and generally have one or more “outdoor” condensing units connected through refrigerant piping to multiple “indoor” units with fans and refrigerant coils, which can be of differing capacities and configurations. The systems provide quiet operation, compact design, and high coefficient of performance (COP).

VRF systems use refrigerant as the cooling and heating transfer medium. The term “variable” is used because these systems have the ability to control how much refrigerant is flowing to each of the indoor unit coils in response to the heating or cooling load in the space. By operating with varying flow, VRF units work only at the needed rate allowing for substantial energy savings particularly at partial-load conditions.

Each indoor unit is independently controllable, providing individualized comfort control in its zone. These systems also have the added benefit that each indoor unit contributes heat to, or draws heat from, the common refrigerant loop allowing the system to make use of varying heating and cooling needs within the same building for heat recovery. Essentially, the heat pumps can transfer heat from a space being cooled to a space where heat is needed or they can enhance the flow of heat from a warm area to a cool one.

Unlike direct expansion (DX) heat pumps, such as those discussed in section 4.3.1.2 below, that each have individual condensing units, the VRF indoor heat pumps are all served by one or more separate condensing units through the common refrigerant piping. This arrangement provides more efficient operation as well as reduced maintenance. The condensing medium can be water from a ground coupled loop making these systems an excellent choice with the campus water loop envisioned in Weber State's Mechanical Infrastructure Master Plan described previously.

Figure 4-4 illustrates a typical air-cooled VRF configuration. For Weber State's plan, water-cooled condensing units served by the campus water loop would be used instead of the air-cooled equipment shown in the upper left corner.



Source: Bonneville Power Administration (www.bpa.gov)

Figure 4-4 Typical Air-cooled VRF Configuration

VRF systems require refrigerant piping throughout the building including headers and branches to serve each of the indoor units resulting in considerable requirements of refrigerant. This is not much different from the "split" type air conditioning systems that have been installed for decades so there should not be significant additional challenges.

Current VRF systems use refrigerant R-410A, which is a non-ozone-depleting blend of two hydrofluorocarbon (HFC) refrigerants. It does have a relatively high Global Warming Potential (GWP) however. R-410A operates at higher pressures than HCFC-22 while providing a higher refrigeration capacity and coefficient of performance. As with previous split systems, thorough pressure testing of the refrigerant piping is required to ensure a leak-free installation and this shall be provided for in the project specifications.

The Weber State Project Manager for each project shall establish an aggressive refrigerant leak detection and management plan in accordance with the University's Standards for materials, construction, piping support and pressure testing. On-site verification of all testing performed by contractors shall be by the Weber State Commissioning Agent, Project Manager and Mechanical Supervisor, along with the project's Mechanical Engineer.

The refrigerant leak detection and management plan will be adapted for continued post-construction implementation by the Operations Group to minimize discharge of the high GWP refrigerant to the atmosphere through procedures to be included in instructions and other documentation for preventative maintenance and repair service. Outside contractors shall also be required to abide by this plan.

VRF heat pump systems include a complete control package saving the cost of a separate controls system. The VRF system controls must interface with the University's Johnson Controls Building Automation System.

VRF heat pump systems, combined with systems to provide the necessary ventilation air, will be the preferred first choice for new construction or major renovation projects and mechanical upgrades in existing buildings.

4.3.1.2 Water Source Direct Expansion (DX) Heat Pump Systems

Water is the heat-transfer medium for this type of system with the source and the sink for heat being the campus water loop. These systems have been installed for decades and in the last several years have incorporated a ground source/sink heat transfer loop. When installed with a ground-coupled loop these systems are referred to as ground source heat pump (GSHP).

The actual equipment within the building is the same in either case with each zone normally having its own heat pump. Each heat pump contains a compressor, a condenser, fan, filter, valves, sensors, and a digital controller, generally packaged into one unit in a confined space. The individual building heat pumps would be distributed for each zone with water piping either directly connected to the campus water loop or through a building heat exchanger connected to the loop. As with the variable refrigerant system, ventilation air needs to be provided where needed through a separate system.

This type of system provides relatively high COP using electricity and offers similar advantages for comfort control in individual zones as a VRF system, but substantial investment in infrastructure and generally a high degree of automation for its control systems is typically required. A WSHP/GSHP system at Weber State would use the campus ground-connected water loop as the source/sink for heat transfer.

Other than filter replacement, coil cleaning or minor repairs, most service on the heat pumps is commonly performed on an exchange basis by disconnecting and removing the entire unit to be worked on in a shop and replacing it with another entire unit. In systems with many zones, the maintenance and repair of individual heat pumps tends to become a dominant cost factor.

4.3.1.3 Ventilation Systems

A fundamental concept to both the VRF and WSHP/GSHP systems in general is that there is no need for a return air system. This saves on installation costs by eliminating the need for large return air ducts and saves energy because large air handling unit motors are not necessary.

There is a significant energy efficiency gain and installation cost savings in this approach and it is a large component of the savings in addition to the efficiency gains of the new systems.

Ventilation needs with these applications are satisfied by a separate dedicated outdoor air system where needed for the introduction of fresh air and for exhaust. These systems will typically include one or more ventilation units ducted to and from the occupied spaces as illustrated in Figure 4-5.

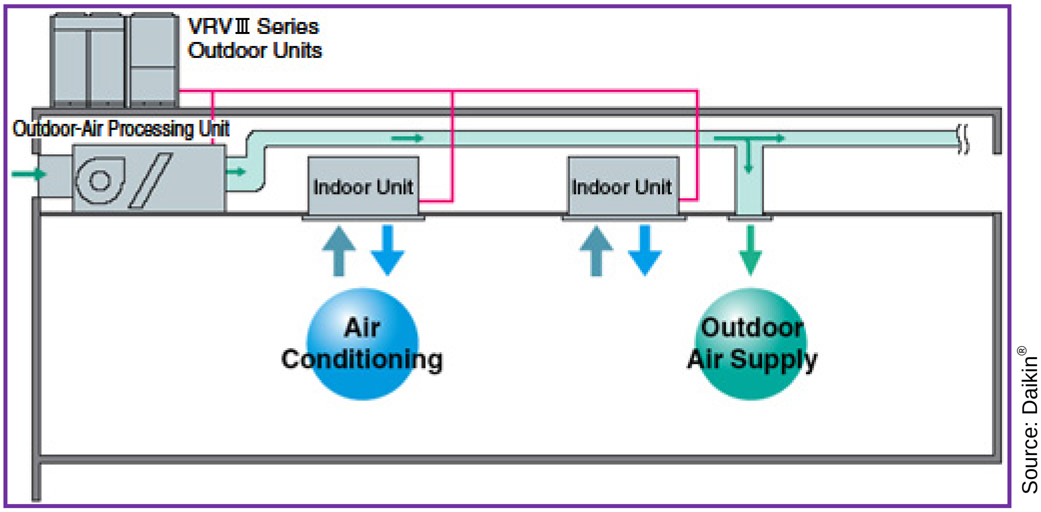


Figure 4-5 Example Ventilation Air Configuration

Designs for new construction and major renovations of buildings will drive ventilation requirements as low as possible preferably with energy recovery. Where there are areas in a building that have significant ventilation requirements, heat pump chiller systems as described in section 4.3.1.5 should be used in those areas.

4.3.1.4 Heat Recovery Ventilator

Incorporating a heat recovery ventilator (HRV) as part of a VRF system will provide additional energy performance to the overall system. A HRV provides fresh outside air for ventilation and recovers heat energy that would be lost through exhaust. It does this by transferring heat from the warmer exhaust air to the incoming colder outdoor air through a heat exchange medium thereby conserving energy and reducing the load on the air conditioning system.

This has the effect of reducing room temperature changes caused by ventilation and also potentially improves indoor air quality and safety due to reduced risk of reintroducing contaminated air into the building. The University also intends to include a coil and glycol loop to provide additional heat recovery in the project for the new Science Lab Building. Figure 4-6 illustrates the process utilized by the HRV. Note that the glycol coil would be installed where the

"Heating by DX Coil" is located in this diagram and humidification of the incoming outside air can be included where needed.

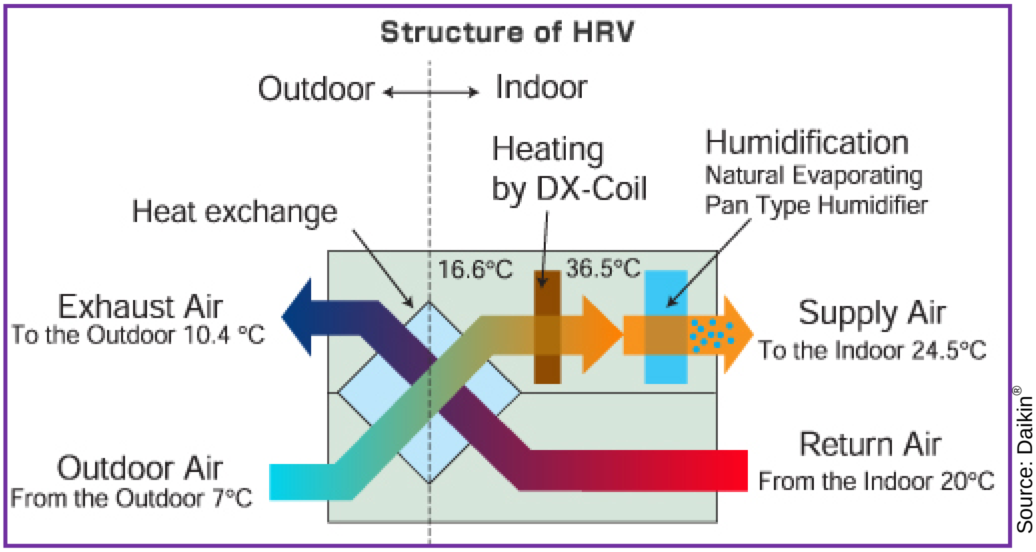


Figure 4-6 Typical Heat Recovery Ventilator Process

Additional energy savings can be accomplished using the HRV system through advanced control strategies including:

- Auto-ventilation Mode Changeover Switching to automatically switch the ventilation mode (Total Heat Exchange Mode/Bypass Mode) according to the operating status of the air conditioning system.

- Pre-cool, Pre-heat Control to reduce the air conditioning load by not running the HRV while air is still clean immediately after the air conditioning is enabled.

4.3.1.5 Heat Pump Chiller

A typical individual building chiller system removes heat from the building chilled water system and transfers it to the chiller's condenser for removal by cooling towers in the condenser water system.

Heat pump chillers are water chillers that are also capable of operating as water-to-water heat pumps. For the Weber State Mechanical Infrastructure Master Plan, these units remove heat from the building water system and reject it to the campus water loop or remove heat from the campus water loop and raise the temperature of the water on the building side for use in beneficial heating. These chillers can also be ground coupled either directly or through the campus water loop.

The majority of heat pump chillers currently in production use a hydrofluorocarbon (HFC) refrigerant, HFC134a (R-134a), which does not contain chlorine and therefore has an ozone depletion potential (ODP) of zero. This refrigerant does have some global warming potential (GWP), however so stringent management and leak detection protocols shall be utilized.

A less common refrigerant used in some chillers is the hydrochlorofluorocarbon HCFC-123. While this refrigerant has a very low ODP and GWP, according to the manufacturer its use is limited to applications where it can be effectively contained within the operating equipment because HCFC-123 has an allowable exposure limit (AEL) of 50 ppm, In addition this refrigerant is under a schedule for phase-out, with production and importation ending in January, 2030 making it a questionable choice for the long-range plan envisioned by ESIP II.

For buildings or building areas that require significant ventilation requirements greater than can be provided by heat recovery ventilator systems, heat pump chiller systems will be utilized in conjunction with air handling units sized only for the ventilation air requirements and chilled beam systems in the conditioned spaces. Heating and auxiliary capacity may be provided in these areas with VRF equipment or passive chilled beams.

4.3.1.6 Chilled Beam Systems

To achieve the University's goal of reducing fan energy and reliance on reheat, a chilled beam system provides a desirable alternative to conventional variable air volume (VAV) systems. Chilled beam units are installed as part of the ceiling and use fin tubes through which chilled water flows. The two main types of chilled beam systems commonly used are "passive" and "active". The major difference between them is how ventilation air is handled. A third type can also integrate other ceiling elements like lighting, fire sprinkler openings, and speakers; however these are generally used for customized applications.

Passive chilled beams cool air by convection similar to the way heating radiation systems work using hot water or steam. Warm air rises from the space and passes over the fin tube where it is cooled. The cold air then falls back into the space and the cycle is repeated. This principle is illustrated in Figure 4-7 below.

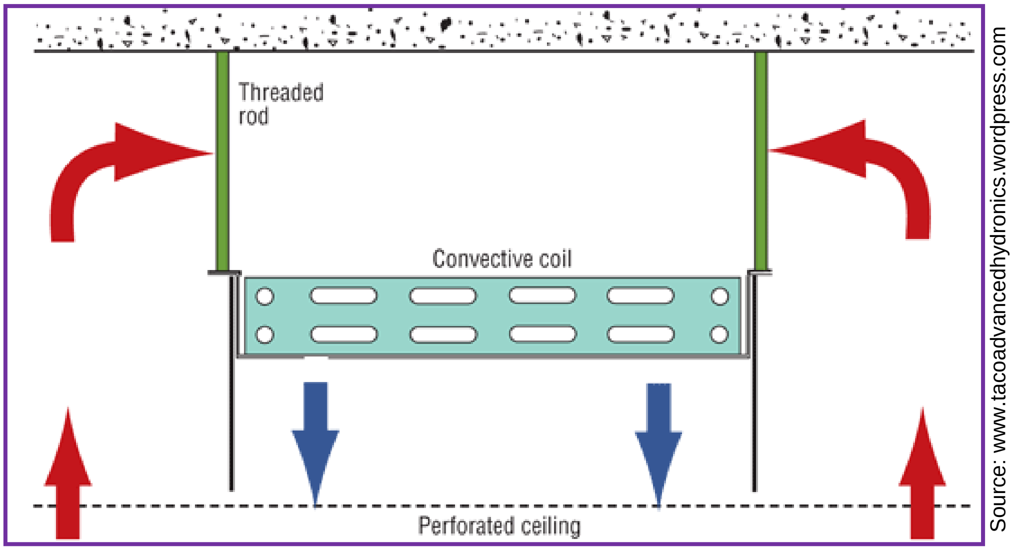


Figure 4-7 Example Passive Chilled Beam System

This type of chilled beam system requires separate provision of ventilation air and will most likely be considered when auxiliary capacity is needed for spaces. In active chilled beam systems the ventilation air is provided from an air handling unit through ductwork to the chilled beam. As this air passes through the chilled beam it induces air from the space into and over the cooling coil where it mixes with the ventilation air and is returned to the space through the diffuser as shown in Figure 4-8.

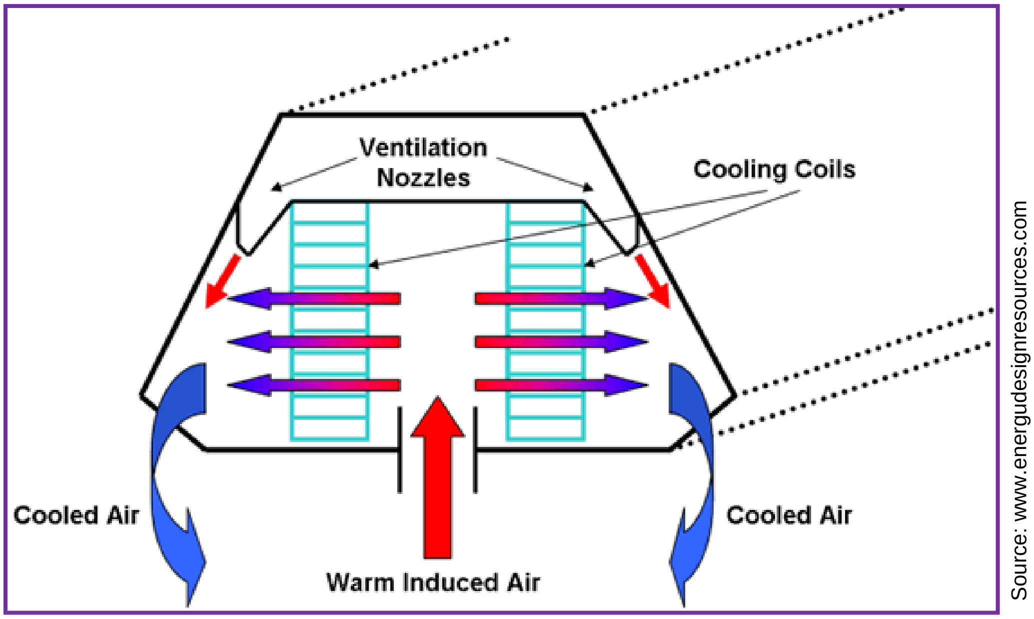


Figure 4-8 Example Active Chilled Beam System

Active chilled beam systems, used in conjunction with the heat pump chillers described previously, are the system of choice when space ventilation requirements are higher than can be provided through a heat recovery ventilator. This design allows the air handling unit and associated ductwork to be sized only for the ventilation requirement minimizing fan energy needed and saving the cost of installing large air handling equipment and ductwork.

Advantages of chilled beam systems include easy maintenance and quiet operation since there are no moving parts, elimination or substantial reduction of fan energy use and cost over conventional systems like VAV, and better air distribution for increased occupant comfort.

Chilled beams may cost more than conventional VAV systems and infusion of financial support for these incremental costs may be needed. In addition, the ceiling must provide adequate space for air to flow to and past the coils. Proximity to heat sources such as copy machines, printers must be avoided to prevent offsetting the cooling from the beam. Further, there are limits to the amount of cooling a chilled beam can provide and temperature conditions must be maintained within a certain range or condensation can occur. Finally many engineers are not very familiar with this technology which may require some education of the design team on the part of the University.

4.3.2 Campus Water Loop

4.3.2.1 Use of Campus Chilled Water System

The Mechanical Infrastructure Master Plan envisions using the chilled water system piping that is currently in place and this major equipment, that Weber State has already invested in, will continue to be used until life cycle phase out. The temperature of the campus water loop will be maintained initially with the existing Chilled Water Plant and Heat Plant equipment. Ultimately this equipment will be phased out as described further in Section 4.6; however the cooling towers will remain as a key part of the system for heat rejection.

Each building's VRF, water source heat pump or chiller heat pump system as they are installed will be connected to the campus water loop's return side. Heat rejected from the building will be transferred to the campus water loop directly or through building heat exchangers. This water will naturally cool somewhat on the way back to the Chilled Water Plant where it passes through a heat exchanger transferring heat to the cooling tower water system for removal after which it enters the chillers.

The chillers will then drive the campus water loop temperature the rest of the way down to about 51°F to serve buildings that have not yet been converted to the VRF heat pump systems. Once all buildings have been converted, this chiller operation will no longer become necessary. Small condensing boilers added to the Heat Plant will also be connected to the campus water loop to provide additional heat if needed.

Implementing the campus water loop plan provides several advantages. There will no longer be the high pressures and temperatures associated with the steam system once it is eliminated, greatly increasing safety. Additionally, the costs for long term upgrades and repairs to the steam system, along with the projected replacement of Boiler #2 will be avoided.

Further, since the difference in temperature between the water temperature and the air temperature in the utility tunnels (or the ground for direct-buried piping) will be minimized, heavy pipe insulation should not be required with the possible exception of the piping used for exchange with the ground source.

While maintenance and repairs on the steam infrastructure will be reduced and ultimately eliminated over time the likely need for additional maintenance on the campus water loop must be considered. Currently the chilled water loop, chillers, pumps and cooling towers are operated only during the cooling season and the entire system is drained each fall and refilled each spring.

Conversion of the existing chilled water loop to the heat pump campus water loop will require year-round operation of the pumps and cooling towers to accommodate heat rejection. This will probably call for repair of isolation valves that do not operate properly, correction of leaks, and additional service on pumps and other mechanical equipment. Weatherizing portions of the loop for year-round operation may also be necessary.

4.3.2.2 Conversion to Ground-Coupled Heat Pump Loop

The Mechanical Infrastructure Master Plan also includes the development and incorporation of a ground-coupled loop to provide a first stage of heat rejection and heat source for individual building VRF, water source heat pump or chiller heat pump system. This is known as a ground-coupled heat pump (GCHP) or ground-source heat pump (GSHP) system.

In due course the campus chilled water system will be converted to a campus wide GSHP, connecting all building VRF or heat pump systems, geothermal wells, pumping systems, and the cooling towers, that are phased in over time. The planned addition of ground exchange with wells will ultimately be the primary source for heating or cooling needed within the campus water loop.

Typical heat pump heating and cooling systems exchange heat with outside air or circulated water in order to provide heating or cooling. The effectiveness of “air to air” heat pumps to provide heat drops off dramatically as outdoor temperatures decrease. Water source heat pumps, which are more efficient, operate under more stable temperatures but additional equipment such as boilers and cooling towers are needed for the infusion or rejection of heat from the water system.

A GSHP system is a central heating and cooling system that transfers heat to or from the ground. It uses the earth as a heat source (in the winter) or a heat sink (in the summer). This design takes advantage of the moderate temperatures in the ground to boost efficiency and reduce the operational costs of the heating and cooling systems.

GSHP systems employ a field of wells through which water is pumped to provide a neutral energy sink/store to maximize heat pump efficiency by minimizing the temperature difference across the heat pump circuit (ΔT), or the difference between desired room temperature and sink/store. The advantage of a GSHP system is that it uses the large reservoir of nearly constant temperature in the ground for a heat source or sink while retaining the efficiency of using water as the heat-exchange fluid.

Sound Geothermal Corporation (SGT) performed a thermal conductivity test for the University in late 2013. The study involved drilling three test boreholes and the collection of thermal conductivity data to assess the potential performance of a geoexchange system on campus. The study considered drilling data, thermal conductivity data, and an analysis of the test boreholes.

The tests were performed according to the recommended procedures described in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter, as well as the procedures described by the International Ground Source Heat Pump Association (IGSHPA). Data were analyzed using the "line source" method, and the following results were provided:

- Formation thermal conductivity: 1.71 Btu/hr-ft-°F
- Formation thermal diffusivity: 1.20 ft^2/day
- Undisturbed formation temperature: 55.7-57.4°F

The results of these formation thermal test properties can be subsequently used, along with other parameters, as inputs to commercially available loop-field design software to determine the required size and loop length of a potential bore field. Those results will then allow costs to be developed, so economic analysis can be performed. A copy of the report with the results of this study is included as Appendix F.

Ground-source wells will be constructed and will serve as a third plant connected to the existing chilled water loop to provide the "first stage" of heat or heat rejection for the campus heat pump systems. The size and location of the existing chilled water loop provides the ability to construct geo-exchange plant equipment in various locations on campus. Multiple ground-source wells can also be constructed in different locations if necessary.

The chillers currently serving the campus water loop will eventually not be needed for GSHP campus-wide water loop. The existing cooling towers will be retained to provide supplementary heat rejection for the campus water loop via the heat exchanger between the campus water loop and the tower water system.

The requirement for heat provided by the Heat Plant will also be substantially reduced over present needs due to the campus-wide GSHP system so only one or two smaller condensing boilers will be necessary to provide this supplemental heat under extreme conditions only.

4.3.3 Stand-alone Buildings

Some of the University's buildings on campus are "stand-alone", that is they are not connected to the existing steam and chilled water infrastructure. Examples of these include the Hurst Center for Lifelong Learning and the Dee Events Center and others may be constructed in the future. It is also possible that the campus water loop may be extended to these buildings as part of the Campus Master Plan. In addition there are satellite buildings at locations remote from the Ogden campus.

Stand-alone buildings should follow the same guidelines for equipment as described in the Mechanical Infrastructure Master Plan. These will include individual systems such as air-cooled VRF, ground-source VRF or heat pumps, and heat pump chiller for new construction or major renovations. A good candidate for such a renovation is the Dee Events Center where the extensive parking lot could serve as the ground-source bore field for heat pump chillers installed to eliminate the need to replace the existing boilers.

4.3.4 Domestic Hot Water Considerations

The phased elimination of the steam system requires a plan for providing domestic hot water once building converters on the campus steam system are no longer in use. Observed data from building meters installed as part of the energy and water submetering program included in the original ESIP indicates that actual usage in existing buildings on campus has been considerably less than what the original design anticipated.

The overall plan for the ESIP II is to use reduced capacity or hybrid heat pump water heaters. These will be installed in mechanical rooms to harvest the ambient heat in those spaces with internal electrical resistance heaters to supplement or back up the heat pump cycle. In some cases small electric point-of-use heaters may be used such as those that have previously been installed to provide hot water where needed during the summer steam system shutdown.

On buildings that have high domestic hot water requirements, electric water heaters, assisted where possible by solar thermal installations, will be considered. Some buildings are already using solar thermal energy for heating domestic water. Examples include Davis 03, the Swenson Gym, the Stadium and Res Life 1. Others have the necessary piping installed to provide capability to install these systems in the future. These include Res Life 2 and Res Life 3, and it could potentially be done at the Shepherd Union Building. This capability and the required piping or other hardware will be the minimum requirement for all new buildings and renovations.

4.4 PLAN FOR EXISTING BUILDINGS

4.4.1 Overview

The plan for reducing energy use in existing buildings uses a comprehensive approach that includes energy efficiency measures, carbon neutral capability conversions, control and automation system upgrades, targeted recommissioning, and deep retrofits as discussed in the following paragraphs.

The foundation for the energy efficiency measures being implemented is the original ESIP and the Investment Grade Audit performed by an Energy Services Company as described in Section 2. Since that time additional improvements have been identified as well as newer technologies representing greater savings potential than previously envisioned. These upgrades are intended to maximize the efficiency of existing building systems during the interim period before a complete building renovation or a mechanical equipment upgrade to carbon neutral capability is accomplished.

The plan also includes conversion of existing building mechanical equipment to carbon neutral capable types of equipment in accordance with the Mechanical Infrastructure Master Plan. This is a critical component for maintaining the schedule for phasing out the steam infrastructure and achieving the carbon neutrality and renewable energy goals of the University.

Another important element for ensuring efficient operation of existing buildings is conducting regular, consistent efforts to review mechanical and electrical systems and their operation to make certain problems that have developed over time, or that may have been a legacy from the original construction of the building, are identified and corrected.

A Weber State University Recommissioning Program was developed as part of the Energy and Sustainability Investment Plan II effort using practical experience from a project at the Hurst Center for Lifelong Learning to be a guide for these efforts. The methods are summarized in section 4.4.5 and the separately published Weber State Recommissioning Program Manual contains a full description of the process and requirements.

In addition to the carbon neutral capability conversions in existing buildings, the deep retrofit process will be pursued. This involves a highly collaborative integrative design, promotes resource efficiency and requires considering systems holistically to derive multiple benefits as described in section 4.4.6.

4.4.2 Energy Efficiency Upgrades

Weber State Facilities Management, led by the Energy and Sustainability Office, has been working to upgrade the energy efficiency of campus buildings for the last several years. In addition to the recommendations of the original ESIP and Investment Grade Audit, a considerable amount of work has been performed to upgrade and repair the steam system. This program has resulted in a number of improvements that have been completed as discussed in Part 2 and will remain an ongoing effort for the next four to five years. Some of the measures being implemented campus wide include:

- ***Interior and exterior building lighting:*** This project retrofits existing lighting to high efficiency fluorescent lamps and ballasts, compact fluorescent lamps, LED lighting, and occupancy sensors.
- ***Campus walkway, parking lot and street lighting***: These outside areas of the campus are being upgraded with compact fluorescent lamps and LED lighting.
- ***Integration of zone variable air volume controls with lighting occupancy sensors:*** This measure combines zone comfort control with lighting occupancy sensors to reduce heating and cooling energy use when the space is unoccupied.

- ***Computer power management:*** To save the considerable energy idle computers and monitors consume, this initiative turns them off when not in use.
- ***Domestic water conservation:*** This program converts fixtures and faucets to reduce water use.

Beyond these campus wide initiatives, several energy conservation projects are planned or under consideration for individual campus buildings as illustrated in Table 4-9.

Bldg 2-ltr ID	Building Name	Gross Ft^2	Year Built	Energy Conservation Measures Planned
	OGDEN CAMPUS			
A2	Annex 2 - English	3,654	1956	May perform lighting upgrade, high efficiency furnace
BC	Browning Center for Performing Arts	173,479	1964 1966 1999	Lighting occupancy sensors (planned for Dec 2013 through summer 2014); Connect occupancy sensors to VAV or even AHUs for control; High efficiency transformers through CI project within next 5 years
CL	Chilled Water Plant	4,607	2008	Lighting upgrade; Improve chiller staging especially on start-up
CT	Cooling Towers	5,167	2001	Convert to secondary water
DC	Dee Events Center	161,969	1977	VFDs on AHUs; Demand control; ventilation Envelope improvements; Install high efficiency transformers and replace high voltage switches under future CI projects.
DM	Dee Events Center Marquee	562	1979	Convert lighting to LED
ED	McKay Education Building	67,305	1973	Lighting occupancy sensors; Occupancy sensors connected to VAV boxes
EH	Elizabeth Hall	94,951	2008	Lighting update
ES	McKay Education Building Storage	166	1977 2004	N/A
ET	Engineering Technology	75,305	1977	Lighting occupancy sensors; High efficiency transformers; Next major renovation targeted within 5 years.
FM	Facilities Management	25,721	1974 2000	Insulation; IDEC (Coolerado) units in the shop. Continuing rcommissioning in-house due to testing.
HC	Hurst Center		2008	Lighting occupancy sensors; correct ballast types;
HP	Heating Plant	10,868	1952 1994	None. Planning to repurpose plant as part of carbon neutrality plan.
KA	Kimball Visual Arts	74,420	2001	Lighting occupancy sensors; Daylight harvesting controls; Demand ventilation control; Automate exhaust hood control; HVAC zone occupancy sensors; Update electronic & pneumatic controls to DDC; other RCx related upgrades. High efficiency transformers under future CI project.
LI	Stewart Library	159,062	1965	Replace high voltage switches under future CI project. Major mechanical upgrade planned next 0-5 years.
LL	Lind Lecture Hall	46,737	1970	Improvements coordinated with new Science Lab (building utilities are from existing SL). Under discussion includes reconnecting to campus steam, stand-alone boiler, water-cooled VRF options.
LP	Lampros Hall	21,892	1966 2003	Lighting upgrade; High voltage switches in future CI project
MA	Miller Administration Building	45,147	1970	High efficiency transformers in future CI project; major renovation planned within the next five years
MH	Marriott Health Sciences	88,256	1987	Control strategies (RCx)
RD	Receiving & Distribution Services	23,823	1982 2007	None
SB	Wildcat Center (was Stromberg)	78,846	1990	High efficiency transformers in future CI project
SC	Student Service Center	82,700	1995	High efficiency transformers in future CI project
SD	Stromberg Stadium Offices	20,347	1966	Lighting occupancy sensors; Seasonal reset AHU MAT; HVAC zone occupancy sensors. High efficiency transformers in future CI project.
SK	Stewart Stadium Sky Suites	39,507	2001	Lighting upgrades; Lighting occupancy sensors; Connect VAV boxes to occupancy sensors. High efficiency transformers in future CI project;
ST	Stewart Bell Tower	534	1972	Upgrade iplighting
SU	Shepherd Union	186,840	1961 2008	Lighting upgrades; Lighting occupancy sensors; Water softner - to provide soft water to the new boiler to avoid calcium build up
SW	Swenson Building (Stromberg Complex)	94,082	1960 2005	Finish Lighting and occupancy sensors project; high voltage switches; VAV boxes controlled by zone occupancy sensors. High efficiency transformers in future CI project.
TE	Technical Education	87,976	1957	Lighting upgrades; Lighting occupancy sensors; Replace high voltage switches under future CI project.
TR	Davidson Track Locker Rooms	4,390	2005	Lighting upgrades; Lighting occupancy sensors
WB	Wattis Business Building	52,269	1983	Lighting upgrades; Lighting occupancy sensors; Water conservation
R1	Wildcat Village (Stewart-		2013	Recommisioning
R2	Wildcat Village		2013	Recommisioning
R3	Wildcat Village		2013	Recommisioning
WR	Stromberg Strength Training	4,891	1966 1998	Lighting upgrades; Lighting occupancy sensors; HVAC occupancy sensor connected to rooftop unit.
	DAVIS CAMPUS			
D02	Davis Building 2	113,580	2003	Finish Lighting and occupancy sensors project; Recommissioning; Upgrade JACE
	CAMPUSWIDE			Complete campuswide lighting projects; Submeters to be complete by November 2013; Complete steam system repairs; Recommissioning per priority list and plan developed in ESIP II.

Table 4-9 Planned Energy Efficiency Upgrade Projects

4.4.3 Mechanical Conversions for Carbon Neutral Capability

Using the Capital Improvement program the University plans to gradually retrofit existing building mechanical systems to the carbon neutral capable systems described in the Mechanical Infrastructure Master Plan. This will involve replacement of current air handling units, variable air volume terminals, and heating/reheat equipment with variable refrigerant flow and/or chiller heat pump systems. Ventilation requirements will be satisfied with separate smaller systems as described previously.

Based upon current funding levels the University is planning on completing renovation of the heating, ventilating and air conditioning (HVAC) systems on an existing building about every two years. For this work an investment of $1.25 million to $1.5 million a year will be made using a combination of CI money provided by the State that is supplemented with some of the funds generated from the University's energy saving programs.

It is estimated that it will be a twenty to thirty year process to get all of the buildings upgraded to coincide with the planned decommissioning of the Heat Plant and steam system. During that time period some existing buildings are likely to be scheduled for replacement or major renovation, therefore, careful planning and coordination will be needed to assure mechanical systems renovation investments are made only on those buildings that do not fall into this category and have a reasonably expected life beyond the term of this plan.

In order to have a starting point, the ESIP II Team developed an initial prioritized list through an evaluation process that identified and ranked University campus buildings based upon four metrics. These are:

- A subjective classification of whether the building mechanical equipment was high or low efficiency by whether the building was in the top or bottom 50% of campus buildings for Energy Use Index.
- The age range of the mechanical equipment.
- The planned building major renovation schedule. Note: This only included a zero- to 5- year period with buildings actually planned or reasonably assumed for renovation.
- A subjective classification of the intensity of effort required for repairs and maintenance.

These criteria resulted in the creation of a matrix which was then used for assigning an initial carbon neutral capability conversion priority as shown in Table 4-10.

CNC Conversion Priority	Mechanical Equipment Efficiency	Mechanical Equipment Age	Building Major Renovation Plan	Equipment Maintenance Intensity	Buildings Included
1	Low	>20 Years	Unknown	High	ET, MA, TE
2	Low	5-20 Years	Unknown	High	CCE, 875
3	Low	0-5 Years	Unknown	High	N/A
4	Low	>20 Years	Unknown	Low	LL, WB
5	Low	5-20 Years	Unknown	Low	FM, WR
6	Low	0-5 Years	Unknown	Low	N/A
7	High	>20 Years	Unknown	High	MH
8	High	5-20 Years	Unknown	High	KA, SS, SW
9	High	0-5 Years	Unknown	High	HC, SU, R1, R2 & R3
10	High	>20 Years	Unknown	Low	N/A
11	High	5-20 Years	Unknown	Low	HP, LP, RD, WI, SD, SK,
12	Low	>20 Years	0-5 Years	High	LI
13	Low	5-20 Years	0-5 Years	High	N/A
14	Low	0-5 Years	0-5 Years	High	B3, B4, SL, SS
15	Low	>20 Years	0-5 Years	Low	N/A
16	Low	5-20 Years	0-5 Years	Low	N/A
17	Low	0-5 Years	0-5 Years	Low	N/A
18	High	>20 Years	0-5 Years	High	N/A
19	High	5-20 Years	0-5 Years	High	N/A
20	High	0-5 Years	0-5 Years	High	N/A
21	High	>20 Years	0-5 Years	Low	N/A
22	High	5-20 Years	0-5 Years	Low	D02
23	High	0-5 Years	Unknown	Low	CL, DC, EH
24	High	0-5 Years	0-5 Years	Low	N/A

Table 4-10 CNC Conversion Initial Priority List

4.4.4 Building Automation System Upgrades

4.4.4.1 Current Conditions

Various generations and designs of Johnson Controls, Inc. (JCI) systems are used in buildings on the Ogden campus. These all communicate in varying degrees with a JCI campus wide building automation system (BAS). The major system categories include:

a) ***Metasys® Extended Architecture®:*** This is the current generation of JCI BTL-listed products and is the system type used in the most recent construction on campus including the Chilled Water Plant, Elizabeth Hall, and the Hurst Center. It is also installed in the Stewart Bell Tower. In general, the designs use complete Direct Digital Control (DDC) with electronic actuation and DDC sensors for zone control. In addition, an IP-based "integration" controller from this generation is also used as a gateway to the older systems.

b) ***Metasys®:*** This is the previous generation of JCI automation using "NCM" controllers and proprietary N1/N2 protocols. All but five of the Ogden campus buildings have this system generation and in several cases this is in combination with the DSC system described below. No generalizations can be made about the designs of these systems concerning the use of full vs. partial DDC (i.e., pneumatic zone thermostats), the use of pneumatic vs. electronic actuation, and the existence/use of any legacy pneumatic controls in mechanical equipment rooms. Four NCM's are exclusively used as gateways to the oldest generation of JCI systems used on the campus described in (c) below.

c) ***DSC/S2:*** This is the original JCI DDC technology and controls from this generation are still in use in several buildings. Normally, these systems do not use full DDC; zone control is via pneumatic thermostats and pneumatic actuation, and legacy pneumatic controls may be in use with DDC in the mechanical equipment rooms.

The D02 Building on the Davis Campus uses a Siemens Talon® Tridium® Niagara® based system utilizing LonMark® equipment and zone controls. The design utilizes full DDC control with electronic actuation but is not integrated into the JCI campus wide BAS for operator interface. All operator interface functions for this system are provided by the web-serving capabilities of the installed JACE R2s.

In recent years Facilities Management installed a JCI Extended Architecture® controller to communicate some data, primarily from building submeters, to the JCI campus wide BAS. The new D03 Building on the Davis Campus uses the current generation JCI Metasys® Extended Architecture® described above.

4.4.4.2 Upgrades to Existing Control Systems

The age and obsolescence of the thirty plus year old DSC systems are problematic for the University with regard to support for service and particularly replacement components. The more recent systems using NCM controllers still represent technology around twenty years old and it can be anticipated that these systems will also present some challenges. In some cases it may be necessary to upgrade devices or controllers due to lack of service or parts availability. However, these types of replacements will be considered as exceptions,

In general, the University does not intend to invest in comprehensive controls and automation upgrades on existing HVAC systems in campus buildings. These upgrades will occur as part of overall system replacement when performing the complete mechanical renovations to the carbon neutral capable systems described previously.

Controls and automation upgrades will also be included as part of major building renovation projects under the Capital Improvement or Capital Development Programs. In some cases however, the University may decide to pursue a project to upgrade controls on existing mechanical systems that makes sense on an individual basis and supports the overall goals of the ESIP II.

4.4.4.3 Carbon Neutral Capable Upgrades

New controls are included with carbon neutral capable upgrades. In general, variable refrigerant flow systems have individual on-board controls for space temperature in the indoor units along with system controls for condensing units and refrigerant flow controls. Heat pumps will have similar individual controls that will also need to be integrated into the JCI systems. These new controls will need to include an interface with the JCI building automation systems (BAS), and will be integrated into the campus-wide BAS at the building level greatly reducing the need for a separate control system within the building to those needed for ventilation systems and heat pump chillers.

4.4.5 Recommissioning (RCx)

Recommissioning (RCx), also sometimes referred to as retrocommissioning, supports the University's efforts to attain carbon neutrality and is a cost effective means to improve the performance of existing buildings. RCx involves a review of the building's systems and their operation that identifies problems due to changes over time, system operation deficiencies design issues that occurred during the original construction of the building, and those that may have developed during the building's existence.

As part of ESIP II development, a recommissionng program was created for Weber State. Goals of the RCx Program include reducing energy use and peak demand usage, improving system performance, improving occupant comfort, and reducing maintenance issues and costs. Typical energy efficiency measures identified during the RCx process will focus on improving control of existing equipment or correcting hardware and sensor malfunctions.

This program also has the objective to incorporate a larger vision with regard to whole building and systems performance to uncover system level issues, determine the reasons behind these issues, and develop solutions to resolve these issues in a cost-effective, lasting manner that will improve building operation and energy performance.

As part of RCx program development one building was selected from the initial priority list for a recommissioning project. The purpose of this effort was to provide direct experience with an actual building to refine the process, develop model strategies for building HVAC equipment and controls types, and provide training for Weber State team members. The building selected for this effort was the Hurst Center for Lifelong Learning.

The RCx effort performed at the Hurst Center identified thirty two (32) issues and opportunities on mechanical equipment, the building automation and controls system and with electrical power quality. These represented measures that are typically found during the RCx process and many were corrected along with other improvement opportunities implemented during the RCx on-site work or shortly after at little or no cost. Energy savings associated with the RCx process at the Hurst Center were estimated at $15,730 annually, representing a 39% reduction in energy costs for this building.

4.4.5.1 Process Description

The objective of the RCx process is to ensure that equipment and systems operate as efficiently as possible through no-cost and low-cost operational improvements while maintaining or improving occupant comfort. The RCx effort will also identify opportunities for larger scale capital improvements to be potentially analyzed as part of additional studies.

This approach includes investigation and assessment of HVAC, building automation and electrical systems based upon identification of known or perceived deficiencies at the start of the RCx effort on a building and issues uncovered during the work on site.

RCx efforts should focus on larger systems and specific problem areas and projects should not recommission the entire system. The intent of this program is not to perform a large scale, expensive effort that might, for example, check every sensor calibration, every actuator, every valve, or perform full functional performance tests on all equipment.

While the process is scalable to whatever degree is appropriate for a particular project, the underlying intent is to concentrate on finding energy efficiency opportunities, improving operation, correcting issues, increasing comfort, identifying/implementing no-cost and low-cost improvement measures, training Facilities Management personnel on RCx, documenting pre- and post-RCx conditions, compiling a recommissioning report and preparing a brief description of building operation for future reference.

This process consists of preparation, on-site observation, investigation and testing, implementing operational improvements to control strategies, and some mechanical repairs as the work progresses. Follow-up work for programming, additional mechanical repairs, trend data collection and analysis, utility analysis, estimated energy savings calculations for the improvements implemented and preparing documentation are also part of this process.

The systems and equipment selected for RCx will be identified through discussions with Facility Management personnel to center on known or perceived issues and areas believed to represent the greatest opportunities for improved performance. This preliminary evaluation will be performed for each building so that a targeted RCx plan can be developed unique to each building's systems and perceived issues. The initial standard targeted RCx process is described in Figure 4-11 for general information purposes. The most recent version of the Weber State University Recommissioning Program Manual, which is published separately, will contain the most up-to-date details for the process to be used and other program requirements.

1	Off-Site Work: Preparation	Identify RCx Team members
		Review available building documentation
		Perform Utility Analysis; generate a benchmarking score
		Prepare Functional Performance Tests where appropriate
		Advise building occupants of RCx project and schedule
2	On-Site Work: Conduct Building RCx Kickoff Meeting and Building Tour	Review information on building and rationale for selection
		Establish goals for RCx of selected building
		Define roles & responsibilities for RCx process
		Establish schedule outline
		Tour building. Audit equipment & operating status. Take spot measurements.
		Perform system-by-system evaluation through group discussion to develop areas of emphasis for RCx effort.
		• Identify known or perceived deficiencies
		• Target specific areas
		• Determine how to investigate target areas
		Develop an RCx activities plan that will identify systems to be investigated, and methods to be employed including:
		• Observation
		• Spot measurements
		• Trending through BAS
		• Short-term monitoring if needed
		• Functional Performance Tests where appropriate
		• Tasks, personnel assigend & time frame for completion
		• Safety Requirements
		Create Equipment Schedule
3	On-Site Work: Perform Field Investigation	Conduct Coordination/Update Meeting if not started in conjunction with Kickoff Meeting
		Perform field investigation and execute RCx plan
		Set up trending, Conduct performance tests
		Interview occupants & Facilities Management staff, Review maintenance issues and practices
		Identify deficiences and opportunities for improvements
		Implement and document "quick fixes"
		• Improved control strategies/sequences of operation
		• Minor mechanical repairs
		Develop Issues & Opportunities Log
		Create & Enter Work Orders, Identify responsible Shop(s) and funding source
		Provide training for WSU personnel during process
4	Off-Site Work: Analyze Results and Prepare Recommendations	Perform data analysis on measurements and trending
		Review observations and results of Functional Performance Testing
		Update Issues & Opportunities Log
		Quantify energy savings associated with "quick fixes" implemented and other performance improvement
		• Savings directly attributable to RCx effort
		• Help justify continuation of RCx projects in future
		Prepare plan for remediation
		Identify but don't quantify additional larger repair or capital improvement projects for separate further study
5	Off-Site Work: Prepare Reports	Prepare RCx Report
		• Results of field investigation observations, trending, Functional Performance Testing
		• Documentation of "quick fixes" implemented
		• Estimated energy and cost impacts (if any)
		• Identify but don't quantify additional larger repair or capital improvement projects for separate further study
		• Outline methods to help ensure persistence of enery savings
		Prepare Building Operator's Manual

Figure 4-11 Recommissioning Process

4.4.5.2 Implementation Plan

An initial prioritized list was developed through a selection process performed by the ESIP II Team that identified and ranked University campus buildings that represented the best candidates for recommissioning. This process considered criteria such as building energy use, existing control type, and projected renovation plans. These are:

- A subjective classification of whether the building's mechanical equipment was high or low efficiency by whether the building was in the top or bottom 50% of campus buildings for Energy Use Index.
- The control system type. These were classified as "DDC" if the building has Johnson Controls NCM or newer controllers (see 4.4.4.1.a and b); "Obsolete" if there were pneumatic or legacy DDC Controls (see 4.4.4.1.c); and "Hybrid" where there is a combination of obsolete and NCM or newer controllers.
- An estimated mechanical equipment renovation schedule. Note: This may not necessarily be the same as the planned building major renovation schedule because mechanical equipment renovation may need to occur sooner in some instances to maintain the Mechanical Infrastructure Master Plan timeframe.

These criteria resulted in the creation of a matrix which was then used for assigning an initial recommissioning priority. Within each priority level a committee will create an order for the buildings in that level and select one or more buildings to recommission based upon a discussion about the characteristics of the buildings. This committee will consist of the Facilities Management Director of Operations, the Director of Campus Planning and Construction and the Energy & Sustainability Manager. Additional committee members may include the Mechanical Shop Superintendent, Electrical Shop Superintendent, Building Automation/Controls Programmer, Associate Vice President for Facilities and Campus Planning and Construction, and possibly the outside RCx Program consultant.

Table 4-12 summarizes the initial priority levels for targeted RCx efforts to be performed. As part of the Carbon Neutrality Plan, RCx studies will be performed according to these priorities which can be adjusted as building metrics change. It should be noted that due to the recent RCx efforts at the Hurst

Center for Lifelong Learning (HC) and major renovation at Campus Services (CS) these two buildings have not been included in this current list.

Bldg 2-ltr	Building Name	RCx Priority	Major Renovations Planned (Mechanical)	Expected Life (yrs)
EH	Elizabeth Hall	1	23	75
DC	Dee Events Center	1	23	50
CL	Chilled Water Plant	1	23	30
SK	Stewart Stadium Sky Suites	1	11	40
CT	Cooling Towers	1	11	30-50
SD	Stromberg Stadium Offices	1	11	20-30
SU	Shepherd Union	1	9	50
KA	Kimball Visual Arts	1	8	50
SC	Student Service Center	1	8	40
SW	Swenson Building	1	8	30
CCE	Center for Continuing Education	1	2	30
D02	Davis Building 2	3	16	50
TE	Technical Education	5	1	10-15
D13	875 South University Park Blvd	6	2	30
ED	McKay Education Building	7	11	60
LP	Lampros Hall	7	11	50
HP	Heat Plant	7	11	30-40
RD	Receiving & Distribution Services	7	11	15-20
BC	Browning Center for Performing Arts	7	11	
FM	Facilities Management	7	5	25
TR	Davidson Track Locker Rooms	8	11	30-50
MH	Marriott Health Sciences	9	7	50
WB	Wattis Business Building	11	4	40
SB	Wildcat Center	13	11	40-50
WR	Stromberg Strength Training	13	5	20-30
SS	Social Science	14	14	5
MA	Miller Administration Building	14	1	50
SL	Science Lab	15	14	3
LI	Stewart Library	15	12	50
LL	Lind Lecture Hall	15	4	20-30
ET	Engineering Technology	15	1	20-30

Table 4-12 Recommissioning Initial Priority List

Following this order and updating the list as existing building characteristics change will provide the maximum return on investment; targeting buildings that represent good candidates for RCx efforts that will provide maximum energy savings and improved system performance resulting from those efforts.

At a minimum, RCx efforts should be performed for all of the buildings listed in Table 4-12 within ten years. RCx should be performed again for these and all future buildings on a regular basis to occur at least every ten years or more frequently if resources are available.

The Shepherd Union, Wildcat Village and University Village are not included on the list because they are auxiliary buildings billed for their energy usage and have their own maintenance crews. Weber State Facilities Management should use examples of campus RCx efforts to justify to the people responsible for the auxiliary buildings that RCx should be performed in those buildings as well.

4.4.6 Deep Retrofits

When considering and implementing energy efficiency projects on existing infrastructure as part of the carbon neutrality plan, Weber State intends to adopt the methods and philosophies integral to the deep retrofit process. Some of these concepts and practices are already being incorporated by the University, for example; the upgrade of HVAC systems in existing buildings to carbon neutral capability. The current plan is to perform a deep retrofit on one existing building about every two years using CI funds from the State with infusion of internal University funds when needed. Each retrofit would include an upgrade of the building's HVAC, controls and BAS, eventually phasing out any remaining legacy control systems.

4.4.6.1 Concept

Deep retrofits utilize the idea of integrated design as applied to existing buildings and retrofit projects. Integrative design is a highly collaborative and iterative design process that promotes resource efficiency. It employs whole-systems thinking to derive multiple benefits from single expenditures, often economically justifying much larger resource savings than is typically achieved.

Buildings are composed of multiple systems and whole-building analysis recognizes how one kind of efficiency gain can affect other building systems and attributes. By simply recognizing how systems are interrelated, design teams can cause small improvements to cascade into substantially larger benefits. As such, deep retrofits improve the economics of efficiency measures as well as incur myriad other benefits.

4.4.6.2 Process

The deep retrofit process, applied to the existing infrastructure, will help reduce loads and promote significant energy efficiencies which will, in turn, support Weber State's carbon neutrality goals. This process involves the following design steps which should be addressed and adhered to for all retrofit and major renovation projects:

a) ***Define specific end user needs:*** Identify the needs and services required by the building occupants. Start from the desired outcome(s). Think of purpose and application before equipment.

b) ***Assess the existing building structure and systems:*** Understand and assess the current state of the building. Determine what needs are not being met and why they are not.

c) ***Specify the scope and costs of planned or needed renovations:*** Evaluate which systems or components require replacement or renovation for non-energy reasons. Consider the costs of interruptions to service or occupancy.

d) ***Reduce loads:*** Select measures to reduce loads, first through passive means such as increased insulation, then by specifying the most efficient non-HVAC equipment and fixtures.

e) ***Determine how loads can be met passively:*** Consider methods such as natural ventilation and nighttime air purge.

f) ***Select appropriate and efficient HVAC systems:*** After reducing loads as much as possible, consider what HVAC system types and sizes are most appropriate to handle these drastically reduced loads.

g) ***Find synergies between systems and measures:*** Seek synergies across disciplines. An example would be high performance windows that increase thermal comfort, reduce lighting energy use, and reduce heating and cooling load enough to downsize mechanical equipment. Also, find opportunities to recover and reuse waste streams such as exhaust air heat recovery.

h) ***Optimize controls:*** After the most appropriate and efficient technologies have been selected, the focus should shift to optimizing the control strategies.

i) ***Realize the intended design:*** Tune the project requirements and implement measurement and verification (M&V) and ongoing commissioning to ensure realization of the intended design. M&V will also help prevent problems, ensure correct diagnoses, permit monitoring to improve operation and future retrofit work, and educate Facilities Management staff and building occupants.

j) ***Celebrate success:*** Make sure that others recognize the team's success. Seek certifications such as LEED™, EnergyStar®, and design awards. This helps motivate everyone involved, makes it easier for other teams and other projects to follow and will help ensure funding mechanisms remain in place.

4.5 PLAN FOR NEW CONSTRUCTION AND MAJOR RENOVATION OF EXISTING BUILDINGS

4.5.1 Overview

New building construction and major renovation projects under the Capital Development Program are funded by the State on a needs basis. Historically the University gets a project funded under this program about once every five years. A new construction project on the Ogden Campus will generally include demolition of an existing building and a major renovation usually entails removal and reconstruction/replacement of everything within a building's shell.

The Mechanical Infrastructure Master Plan provides the overall vision for an energy efficient, all-electric campus using carbon neutral capable heating, ventilating and air conditioning equipment with a ground coupled campus water loop. This will ensure the ability of Weber State to ultimately use renewable energy produced on site efficiently for the majority of campus needs with any needed additional energy purchased from renewable sources through the local utility.

While this is designed to help meet the University's climate commitment for carbon neutrality it has the significant benefit of allowing Weber State a high degree of energy independence, avoiding the risks of future power availability and costs.

To achieve these goals and maintain the integrity of the Mechanical Infrastructure Master Plan and the schedule for phasing out the steam infrastructure, carbon neutral capable building mechanical systems must be designed and installed for new buildings and major renovations in accordance with the Mechanical Infrastructure Master Plan.

Beyond designing for and installing carbon neutral capable system types it is vital to ensure that these systems meet the University's requirements, are installed and operating properly, and satisfy the design intent. This quality assurance is provided through a robust commissioning process performed by a commissioning agent that is an independent third party responsible directly to Weber State, or an in-house Facilities Management person, to assure the University's interests are represented.

Weber State and the State of Utah have adopted the use of LEED™ principals with an established target of LEED™ Silver certification as a minimum. This process should inherently provide energy efficiency and sustainability in new construction or major renovation and includes the requirement for a commissioning effort. The design team is responsible for the building's design performance and must ensure that requirements for certification are actually achieved.

4.5.2 System Types for New Construction and Renovation

In general, new construction and major HVAC renovations will use energy efficient, high COP all-electric systems. These system types will enable onsite renewable electric energy production to satisfy the energy needs of the Weber State campuses. In particular, all new construction and major renovation projects will use energy efficient systems, VRF and GSHP for heating and cooling with the addition of heat recovery ventilators to provide for the fresh air and exhaust needs within the buildings. Both VRF and GSHP system types represent systems that will provide low building energy profiles, and can be supported by the planned onsite renewable energy production.

VRF will be the system of first choice for new construction or major renovation projects with heat pump chiller systems added when needed to satisfy higher ventilation requirements. VRF and GSHP system types may be evaluated on a project-by-project basis to determine which system or combination of the system types is best suited for the proposed new building or renovation project. The goal will be to identify how best to incorporate energy efficient features and control strategies to maximize their benefits in a cost-effective manner. Fresh air ventilation and exhaust will be provided by separate ventilation systems with heat recovery.

Heat pump chiller systems will be used in buildings or building areas where ventilation requirements are significantly higher than can be provided by heat recovery ventilator systems. These systems will include air handling units sized only for the ventilation air requirements and chilled beam systems in the conditioned spaces. VRF equipment may be used to provide heating and auxiliary capacity in these areas.

An integrated design process will be incorporated into each of these projects, with the participation and input of the Facility Management Operations Department; particularly the Energy and Sustainability Office.

4.5.3 Commissioning

Commissioning (Cx) of building systems is a key contributor to energy efficient operation. When a building is initially properly commissioned it undergoes an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures that the new building operates initially as the owner intended and that building staff are prepared to operate and maintain its systems and equipment.

ASHRAE Guideline 0, The Commissioning Process defines commissioning as "a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria." The main objective of the commissioning effort is to affect the safe and orderly handover of the building from the constructor to the University and guarantee its operability in terms of performance, reliability, safety, and information traceability. Additionally, when executed in a planned and effective way, commissioning normally represents an essential factor for the fulfillment of schedule, costs, safety, and quality requirements of the construction project.

Commissioning ensures building quality using peer review and in-field or on-site verification. Commissioning also accomplishes higher energy efficiency, environmental health, occupant safety and improved indoor air quality by making sure the building components are working correctly and that the plans are implemented with the greatest efficiency. Commissioning is a quality assurance-based process that delivers preventive and predictive maintenance plans, tailored operating manuals and training procedures for all users to follow.

Commissioning is often misinterpreted to focus solely on testing during the end of the construction phase. However, commissioning is actually a collaborative process for planning, delivering, and operating buildings that work as intended. For the standard construction process, the commissioning effort should be included in the design, construction, start-up, acceptance and training phases. The earlier the commissioning process can begin, the greater the impact this effort can have on the project.

The commissioning process can be applied in a variety of approaches focusing on building systems/assemblies and can be customized to suit project needs. However, regardless of the commissioning approach and system focus, it always requires clear definition of performance expectations, rigor in planning and execution, and thorough project testing, operational training, and documentation.

Proper planning and execution of a commissioning process requires specialized expertise that is generally provided by a Commissioning Agent (CxA). The CxA should be an independent third-party professional representing the interests of the University such as a Weber State in-house CxA or an outside firm directly contracted by the University. An outside company or individual, along with any subcontractors he uses, must have no direct or indirect financial control or interest in a project's design firm(s), manufacturers or suppliers, contractors, and others that sell, install or repair the systems to be commissioned under that project.

4.5.4 Ensuring LEED™ Requirements Are Achieved

The US Green Building Council's (USGBC) Leadership in Energy & Environmental Design (LEED™) is a sustainable building certification program that recognizes best-in-class building strategies and practices. To achieve LEED™ certification, building projects satisfy prerequisites and earn points to achieve different levels of certification. Points are achieved by satisfying requirements distributed across six credit categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design. A commissioning process, as discussed in section 4.5.3, is also part of LEED™ certification.

The original ESIP recommended that all new campus buildings or major renovations incorporate LEED™ principals and requirements. This includes construction practices, energy and water efficient design and operation, sustainable materials and practices, as well as comfortable and healthy working and living environments.

Weber State University standards require that new buildings or renovations achieve a minimum level of LEED™ Silver certification. The State of Utah has also adopted this standard which requires the building to achieve a minimum of 50 points under the rating system.

The commitment by the University and State to the LEED™ certification program provides a visible example of environmental responsibility and supports the goals of the ESIP II. It provides a process for adhering to environmentally responsible best-practices across various disciplines when constructing new buildings and renovating existing ones.

To date the new construction projects for Elizabeth Hall, the Hurst Center for Lifelong Learning, the Wildcat Village Residence Halls (R1, R2 and R3) and the Davis 03 building have achieved LEED™ Silver certification. For all new construction such as the Tracy Hall Science Center, and renovation of existing campus buildings, incorporation of LEED™ Silver certification at a minimum will continue to be required as part of the delivery process.

Of at least equal importance is ensuring that requirements for certification, particularly in regard to those that have an impact on the energy and carbon neutrality goals of the ESIP II, are actually achieved and sustained. Some of the key elements for making certain the building performs as intended include:

- Requiring realistic energy modeling by the design engineer with copies of the models and results provided to the University for future reference.
- Specifying appropriate energy and water consuming equipment that complies with Weber State's long-range mechanical plan, carbon neutrality requirements, and other University standards.
- Ensuring that any equipment designated as "or equal" to the basis of design actually provides equal performance.
- Disallowing substitution of lower-performance equipment proposed during "value engineering" or by contractors during construction.
- Incorporating a robust and thorough commissioning effort beginning in the design phase and continuing through the construction and any post-construction periods. This should be performed by an independent third-party that is not part of the design or contracting teams such as a Weber State in-house commissioning agent or an outside firm directly contracted by the University.
- Performing a recommissioning effort under the Weber State Recommissioning Program within three to five years after construction is complete and at the same intervals thereafter.

The design team is responsible for ensuring the building's design performance is achieved. The Weber State Project Manager assigned to each project, supported by

DFCM and the Weber State Energy and Sustainability Office, must make certain that the University's standards and requirements related to design and construction, including those key elements listed above, are satisfied before final acceptance of the project.

The Weber State Project Manager will manage the commissioning process and provide review and approval of all reports from the commissioning agent. The Operations Group will also review and provide comments as appropriate on commissioning documentation and will manage subsequent recommissioning efforts.

4.6 PLAN FOR EXISTING PLANT INFRASTRUCTURE

4.6.1 Overview

This section provides discussion of the plan for the two main plant and infrastructure systems on the Ogden Campus as the Mechanical Infrastructure Master Plan is implemented. These are the chilled water plant and existing campus chilled water piping system along with the Heat Plant and the steam/condensate piping system serving campus buildings.

The campus chilled water loop will be converted to supply water for the heat pump systems throughout campus buildings and provide geothermal heat exchange through wells. Conversion to all-electric systems will permit phase-out of the steam system and heat plant avoiding future major expenditures for repairs or upgrades and replacement of boilers. Overall this approach considerably increases safety with the elimination of the high pressures and high temperatures associated with the steam system.

As the Mechanical Infrastructure Master Plan progresses, equipment in both plants will continue to be used until they are no longer needed. During this process the current Chilled Water Plant can be repurposed to be the main location for ground source equipment. Similarly, the Heat Plant could have a new role providing supplemental heating to the campus heat pump water loop through one or two small hot water boilers. In both cases the costs for end-of-life replacement of the existing chillers and boilers will be avoided.

4.6.2 Campus Wide Ground-Coupled Heat Pump Loop

A common campus-wide heat pump water loop will be needed to serve the heat pump systems envisioned throughout the campus. Use of a campus-wide heat pump loop will allow for the transfer of energy from building to building, such that loads can be more evenly distributed throughout the campus, reducing peak loads currently experienced by individual buildings or building exposures. The Mechanical Infrastructure Master Plan repurposes the existing campus chilled water loop to serve as this ground coupled loop.

The process to convert the University's chilled water infrastructure to the planned campus-wide heat pump water loop will be phased over time. The first priority is ensuring that new construction and major building renovations utilize VRF and/or chiller heat pump systems and that these systems are used when retrofitting HVAC systems in existing buildings. With plans for new buildings replacing existing ones about every five years and renovations of existing buildings occurring about every two years, it is expected that an overall twenty to thirty year time frame will be needed to convert all of the buildings to these carbon neutral capable systems.

The second component involves connecting these individual building heat pump systems to the campus-wide chilled water loop. This will require operating the chilled water loop throughout the year. The VRF heat exchangers and chiller heat pump systems will be connected to the return water side of the campus water loop. This will be the source of heat and the heat rejection sink for each building. The existing plate/frame heat exchanger at the Chilled Water Plant will transfer excess heat to the cooling tower water loop for removal by the towers. The existing chillers will maintain a campus water loop supply temperature sufficient to provide chilled water cooling to those buildings where HVAC equipment has not yet been converted to heat pump systems.

To ensure enough heat energy is available to the heat pump systems from the campus water loop during the heating season one or more new condensing-type hot water boilers dedicated for this purpose will be installed and connected to the campus water loop. These would probably be in the two to three million Btu input range and installed at the Heat Plant for convenience, but a combination of smaller boilers could be placed elsewhere on campus, if appropriate, due to the flexibility afforded by the size and geography of the campus water loop.

Other heat sources could also be used to help supplement heat in the loop. One example would be the addition of a VRF heat pump system to the data center, which could provide a constant heat source during the winter months.

Finally, one or more ground source wells will be constructed to provide a first stage heat source and heat rejection for the campus water loop. The ground source well(s) will be connected to a heat exchanger to provide the addition or rejection of heat with the campus water loop through the geothermal source/sink. It is currently estimated that this heat exchanger capacity will need to be in the range of approximately 1000-2000 tons and this will be refined through a separate engineering study.

This heat exchanger would probably be installed at the Chilled Water Plant but could be located anywhere on campus depending on the location of the wells so long as it is in proximity to the campus water loop. Another possibility is the installation of distributed heat exchangers in locations accessible to the campus water loop in the event that there are multiple appropriate well site locations.

Once installed and in operation the geothermal heat exchange will allow the chillers to be brought offline and the existing cooling towers will be used to provide supplemental heat rejection as necessary. Similarly, once the ground source wells and campus heat pump water loop are operating the campus steam system can be decommissioned and the majority of the boiler plant can be shutdown.

4.6.2.1 Repurposing of Existing Chilled Water Plant

The original design of the Chilled Water Plant when it was built in 2008 projected that a combination of two of the chillers would be in operation continuously during the cooling season providing chilled water at 45^{o}F on the supply side of the campus chilled water loop.

The energy projects and summer heat shutdown implemented by the University following the original ESIP have resulted in the need for only one chiller to be on line with occasional use of a second chiller during some conditions.

Further, it has been observed that sufficient cooling for buildings can now be provided with a chilled water supply temperature of 50°-52°F. This reduction in load is expected to continue as further energy projects are completed.

As the campus buildings are converted to VRF and heat pump chillers, loads on the campus chiller plant will be reduced further. This means that the existing chillers will most likely be able to satisfy cooling needs until total conversion of campus buildings and the ground coupled loop is complete. The plan calls for this to be accomplished within the next thirty years which will coincide with the anticipated end of the useful service life for the existing chillers. At that point these chillers can be decommissioned and removed eliminating the need and cost to ever replace them.

The Mechanical Infrastructure Master Plan includes repurposing of the Chilled Water Plant to house the ground source loop equipment, and serve as a staging area for this equipment. This would place the ground source equipment in close proximity to the existing cooling towers which will provide supplemental heat rejection for the ground source loop. The University's largest parking lot is immediately adjacent for use as the geothermal well field. The remaining area of the buildings can be used for Facilities Management storage space or some other purpose.

4.6.3 Phase-out of Existing Steam Infrastructure

The existing central steam system uses boilers fueled by natural gas, with #2 fuel oil as a backup, and must be phased out to support the carbon neutral campus-wide profile. Eventually all heating needs of campus buildings will be met by energy-efficient all electric systems as described in the Mechanical Infrastructure Master Plan. The existing boilers in the Heat Plant will be decommissioned and smaller high efficiency condensing type hot water boilers will be installed. It is expected that these new boilers will only be needed minimally to provide supplemental heat for the campus wide GSHP system.

Originating at the Heat Plant, the campus steam system consists of underground tunnels with steam and condensate piping in three major loops (A, B and C). Individual campus buildings served by the steam system generally have a converter on the steam supply that provides hot water for space heating, although some use steam directly for this purpose.

The system ranges in age from 10-55 years and considerable upgrade and repair work has been done on this infrastructure as part of the energy program that followed the original ESIP. This work consisted primarily of critical repairs such as replacement of expansion joints, steam traps, pipe hangers and insulation on piping. In addition asbestos was abated in the tunnels. The University also commissioned a study performed by WHW Engineering, Inc. in 2012 to determine the long range repair and upgrade needs on the steam, condensate and natural gas piping systems as well as the tunnel structures themselves.

The Mechanical Infrastructure Master Plan provides the opportunity for phasing out of the existing steam and condensate infrastructure, increasing safety and avoiding the costs for future boiler replacement and long-term repairs or upgrades to these systems. It will also ultimately reduce the costs currently needed to maintain the boiler plant and steam loops. This will in turn make more funds available to dedicate toward the campus-wide GSHP conversion or other projects.

The Mechanical Infrastructure Master Plan allows for a gradual approach to eliminate buildings from the steam infrastructure over the same twenty to thirty year time period for conversion to the campus wide GSHP system. As buildings are converted to VRF & GSHP and only utilize the campus water loop, the sections of the steam and condensate systems serving these building can be shut down and abandoned.

The current Heat Plant and steam infrastructure will be needed to satisfy the heating requirements of existing buildings that have not yet undergone an HVAC renovation. This load, however, should continue to decrease as more buildings are eventually converted to all-electric heating systems. Since all new buildings will be designed in accordance with the Mechanical Infrastructure Master Plan, no additional steam loads are expected. Further, geothermal wells will be phased into the campus-wide heat transfer system reducing the load on the steam plant and heat rejection systems until the geothermal wells can satisfy approximately 90% of the total load.

As the campus is converted to VRF heat pump systems, and the load on the boiler plant falls off, the efficiency of the plant will subsequently decrease due to limitations associated with the turn-down capability on the boilers. Once the minimum turn-down point for the boilers is reached and the steam system is only serving a few buildings, a decision will need to be made with regard to whether the last remaining buildings will be converted all at once and the steam system fully decommissioned. This would avoid the costs of continued operation of the steam plant at very low efficiency to serve only a small quantity of buildings but will require careful planning to assure the necessary funds were available for the conversions.

One consideration may be to plan the conversion of Swenson Gym and the Shepherd Union to the VRF systems last in the process. These two facilities have auxiliary boilers that were installed within the last few years as part of the energy projects for summer operation while the Heat Plant and steam system is shut down. If the Swenson Gym and Shepherd Union auxiliary boilers have adequate capacity, they could operate year-round to satisfy the heating needs for these buildings until they are converted without use of the steam plant.

If there are any other buildings still utilizing campus steam for their heating systems similar distributed heating systems that serve only these buildings will be required once the steam plant is decommissioned. Eventually, renovation projects will need to be undertaken for these buildings to retrofit the existing heating systems to the VRF heat pump systems.

4.6.3.1 Repurposing of Existing Heat Plant

During the process of implementing the campus ground coupled heat pump system, a hybrid approach can be used with the existing steam system whereby the Heat Plant supplements the heating for the campus heat pump water loop. A converter will need to be installed to provide heated water to the campus water loop.

Boiler #2 is over forty years old and nearing the end of its useful service life. The university plans to replace this boiler within the next 5 years or so with a new two to three million Btu condensing-type hot water boiler for providing supplemental heat to the campus water loop.

The remaining boilers will remain as backup until the steam loop is no longer needed. The University's plan calls for the campus ground coupled heat pump system to be complete within the next thirty years which will coincide with the anticipated end of the useful service life for the remaining boilers.

As with the chillers in the Chilled Water Plant these boilers will then be decommissioned and removed avoiding the need and cost to ever replace them. The space created in the buildings can then be used by Facilities Management for other purposes.

4.7 Provisions for Individual Building Projects

The Mechanical Infrastructure Master Plan defines the long-term vision for the University's facility infrastructure that will achieve carbon neutrality goals and ultimately position Weber State to substantially reduce the cost risks of purchased electricity through the use of on-site generation to supply campus needs. In the process the plan implements energy efficient, high coefficient of performance strategies for heating and cooling, including the use of a renewable energy ground-coupled system.

It is expected that completion of the plan will be over a time frame of the next twenty to thirty years based upon current projections for available funding, new building construction, major renovations of existing buildings, and mechanical upgrades for buildings that are not scheduled for major renovation or replacement during that time period. It is critical that the end goal for the University be at the forefront in the planning, design, and implementation of all future construction and renovation projects.

4.7.1 Requirements for Designs

4.7.1.1 Mechanical Systems

The Mechanical Infrastructure Master Plan provides direction for the overall infrastructure and acceptable system types for individual buildings. Weber State's built environment is a long term investment for the University and the State of Utah. Typical building life of fifty years or longer is not uncommon. Therefore, to prevent disruption of the Plan and negative impacts on the University's goals and time frame, construction or renovation of buildings with long life spans using design approaches that require the continued use of legacy systems will not be acceptable.

A prime example of unacceptable designs would be those that necessitate continued use of the existing steam system thus preventing the University from realizing the value and cost savings associated with executing the steam infrastructure decommissioning. The current campus chilled water loop will eventually become a ground-connected heat pump loop and the existing chillers will not be needed, so designs contemplating use of chilled water must provide for production of that chilled water within the building or the capability to be readily converted in accordance with the plan.

The University intends that all designs shall drive toward carbon neutral capabilities and the Mechanical Infrastructure Master Plan. The two factors on which design decisions will be based are the life cycle cost analysis (LCCA) for the equipment with respect to the whole campus and the contribution to carbon neutral capability and the Mechanical Infrastructure Master Plan. The achievement of the goals and end results of the plan represent considerably higher overall value for Weber State than any incremental initial cost savings proposed through the exercise commonly referred to as "value engineering" on individual projects might provide.

It will not always be possible to implement all elements of the Mechanical Infrastructure Master Plan immediately in the new construction or renovation of buildings. The reasons for this may vary from limitations of equipment currently available to project budget constraints and provisions may need to be made for individual buildings.

In all cases it is imperative that the project team, including the University, the Division of Facilities Construction and Management and the design professionals work closely together to ensure that the project design is consistent with the Mechanical Infrastructure Master Plan and the capabilities for future implementation of any plan elements not included in the original project are incorporated. A good example of how this should work is found in the current design development for the new Tracy Hall Science Center.

4.7.1.2 Controls and Building Automation Systems

The University has standardized its requirements for controls and the campus wide building automation system around the industry-standard BACnet® communication protocol. All new DDC control systems designs shall use the BACnet® communication protocol and all controllers and workstations/servers shall be BACnet® Testing Laboratories (BTL) listed.

An important challenge for many projects is the integration of equipment manufacturer-provided controls with the building automation systems, such that these controls can participate in the required overall sequence of operation needed for the building. Some equipment controls, particularly on packaged units, require the addition of a BAS to properly execute sequences such as optimal start/stop, morning warm-up, day/night scheduling, demand ventilation, smoke control, etc.

Equipment manufacturer-provided controls shall be BTL-listed where possible. At a minimum, the controls shall have a proven track record of communicating via BACnet® since not all equipment categories include products that have achieved BTL listings. In some cases Modbus-485 communications may be an acceptable alternative to BACnet® for categories of equipment that do not offer BACnet® communications such as electrical equipment for example. The project Design Professional is responsible for researching these two exceptions and providing for it in the specifications.

It is also the project Design Professional's responsibility to research the sequence of operation capabilities of equipment manufacturer provided controls and to develop the BAS sequences to properly complete and/or supervise these controls. Unless the Design Professional and manufacturer of the HVAC equipment that is the basis of design can determine that the factory controls can properly participate in the required overall sequence of operation, controls for HVAC equipment should be specified to be installed in the field by the controls contractor.

4.7.2 Current Projects

4.7.2.1 New Tracy Hall Science Center

The new Tracy Hall Science Center will be the first new construction building designed in compliance with the Mechanical Infrastructure Master Plan and it sets the stage for the eventual conversion of the entire campus to the all-electric ground coupled heat pump system. To assist with project costs, the Weber State Energy and Sustainability Office is providing a portion of the funding for the high efficiency systems.

The HVAC systems will include VRF heat pumps with water source condensing units piped to the return side of the campus chilled water loop. It is expected that these will serve approximately seventy percent of the building. Ventilation for those areas will be provided through a separate dedicated system for fresh air and exhaust with heat recovery.

For the building areas with higher ventilation requirements such as lab spaces, an air handling unit, sized for the ventilation requirements only, will be used with chilled beams for cooling. A heat pump chiller system is planned for this remaining thirty percent of the building for providing the necessary chilled water; however the project economics and schedule will not support installing this equipment at present. The project's team's solution is to provide chilled water to the building from the Chilled Water Plant via the campus loop and provide space in the building for installation of the heat pump chiller and connecting piping at a later date.

4.7.2.2 Campus Services Building Renovation

The existing Campus Services Building was constructed in 1956 and underwent some remodeling in 2002. This approximately 16,000 square foot building was served by the campus steam system and the chilled water loop for heating and cooling respectively.

A major renovation project was completed in January 2014 that included complete demolition of the interior and HVAC systems, reconfiguration of spaces with new interior walls, energy efficient windows and additional envelope insulation. A water-cooled VRF system was installed with heat rejection to the return side of the chilled water loop.

This project was intended to be a prototype for major building renovations and included most of the building side elements of the Mechanical Infrastructure Master Plan. The building has been operating effectively for several months with temperatures within the building and in the loop successfully maintained in spite of very cold days this past winter.

4.7.2.3 New Public Safety Building

The recently completed new Public Safety Building on campus incorporated many of the sustainability and carbon neutral components envisioned for all future University Buildings. It features a high efficiency air cooled VRF system, tall windows and skylights for natural daylighting, and a solar PV array on the roof that provides much of the building's electricity.

4.7.2.4 Additional Projects

The next major State-funded capital project in the works is renovation of the Social Science Building. It is expected that project development will follow the same approach as currently being used for the new Science Lab.

In addition, the Energy and Sustainability Office has received approval and funding for updating mechanical systems to carbon neutral capable following the Mechanical Infrastructure Master Plan in conjunction with projects in development for various levels of renovation in the Stewart Library, Lind Lecture Hall, and the Miller Administration Building.

4.8 ONGOING MONITORING-BASED COMMISSIONING

Persistence of energy performance of new and existing buildings at the Weber State campuses is a key component to achieving carbon neutrality. In addition to commissioning on new construction or renovation and regular recommissioning (RCx) efforts, the ESIP II includes incorporation of an on-going monitoring-based commissioning (MBCx) program. As a critical component of the ESIP II, MBCx efforts are designed to:

- Prevent building "drift" and provide sustained energy savings through long term tracking and trending procedures.
- Give Weber State the ability to make informed, effective, data-driven energy decisions.
- Allow for continuous fine tuning of measures to ensure optimal operation.
- Protect investments in energy efficiency as they have a significant impact on bottom lines.

4.8.1 Key Elements

The MBCx efforts can be incorporated into buildings in a phased approach and should be integrated into the Weber State Recommissioning Program. Implementation can be accomplished following initial commissioning for new construction and renovation and just after existing buildings have been recommissioned. The MBCx program should involve the following elements.

4.8.1.1 Performance Indicators

This includes the establishment of key performance indicators at component and/or system level to define the performance bands outside which communication and/or corrective response is needed. These indicators should be consistent with achieving close to the desired building-level energy performance defined by the Weber State Energy and Sustainability Office.

4.8.1.2 Monitoring

Based upon the key performance indicators, points to be monitored by the building management system will be indentified, along with monitoring interval and duration. These will then be set up in the building automation system with alarm levels.

4.8.1.3 Operation

This includes assignment of responsibilities for communication of performance issues and implementation of corrective actions.

4.8.1.4 Training

Continuous training of building operators in proper maintenance best-practices for the new, modified or recommissioned systems and equipment must be provided to maintain program effectiveness.

4.8.2 Levels of MBCx Efforts

There are three basic levels for an on-going commissioning effort from basic Energy Information Systems to sophisticated software analytics and fault detection programs. Each of these is discussed briefly in the following paragraphs.

4.8.2.1 Energy Information Systems (EIS)

Also referred to as Dashboards, this first level is similar to what Weber State is currently doing and generally provides benchmarking, monitoring and reporting of building meter level data. It also includes analysis of change in usage patterns and data filtering for normalization.

4.8.2.2 Manual Trend Analysis and "Smart" Alarms

The next level up from an EIS involves a manual trend analysis and setting up "smart" alarms using the University's Building Automation System. Implementation of this level requires that operators be trained to analyze trend data to identify operational issues and generally requires some resources.

4.8.2.3 Fault Detection and Diagnostic (FDD) Systems

The highest level for MBCx currently is the use of software analytics and automated Fault Detection and Diagnostic (FDD) systems to monitor system performance and note when an operational parameter is different than specified (normal) operation based on rules that are set up and adjusted for specific system types and specific system operation.

These systems can recognize system operational failures immediately, identify duration of faults and associated costs, prioritize faults based on associated costs, and identify when operational adjustments or repairs are needed such as schedule or set point changes, malfunctioning economizers, simultaneous heating/cooling, leaky valves, abnormal equipment cycling, and so forth.

Many manufacturers offer products that utilize a "Software as a Service" (SAAS) approach. This involves software and associated data that are centrally hosted in the cloud. The packages range from a variety of depth and features, including live connection to the BAS or exported trend data, quantification of energy and cost impacts, connection with other systems such as work orders, and active control functionality. Initial research into several of these products was performed as part of ESIP II development and some features of each are summarized in Table 4-13 below.

Company	Product	Key Features
Ezenics	Optimized Operational Readiness™	SAAS packaged offering – built in rules with option to write, emphasis on fine tuning, standardized naming conventions, mobile apps
KGS Buildings	Clockworks™	SAAS packaged offering – quantifies costs (prioritizes on multiple criteria), gives possible causes of faults, built in rules, modules for custom analysis
SCIEnergy	SCIwatch™	SAAS packaged offering – designed for larger buildings, built in rules, pushes data nightly, ranks faults by equipment types
SkyFoundary	SkySpark™	Software license (can be set up on cloud) – flexible customization for systems and rules; scalable; requires detailed knowledge to integrate, connect systems, and write rules

Table 4-13 Fault Detection and Diagnostic (FDD) Systems

4.8.3 Next Steps

The University is already making good use of the building metering systems and Lucid Dashboard as an Energy Information System and the recent addition of a controls programmer to the Facilities Management team will allow expanding the effort to include manual analysis of trending and the implementation of "smart" alarms within the Johnson Controls Building Automation System.

The capabilities and functionality of the Lucid system need to be evaluated further to determine if it can serve as an FDD system. The key will be to select a system that has the best flexibility for meeting the needs of the University.

4.9 Funding Considerations

Both new construction and major renovation of existing buildings must include the systems and equipment with carbon neutral capability required for the Mechanical Infrastructure Master Plan. Support for incremental costs of the carbon neutrality components may be provided when needed from savings generated by other energy efficiency and on-site renewable generation projects.

When considering the costs associated with the heat pump systems and distribution loop in the Mechanical Infrastructure Master Plan, the substantial current costs of the steam plant and distribution system should be considered in a comprehensive life cycle cost analysis. A comparison of these current and future steam tunnel master plan costs and the costs associated with the proposed campus-wide heat pump loop should be evaluated, so that economic justification can be made for this eventual transition.

For existing buildings, a dedicated amount of Capital Improvement funds should be applied each year each year to accomplish mechanical and controls systems upgrades for conversion to carbon neutrality capability in accordance with the Mechanical Infrastructure Master Plan. This will allow the University to gradually retrofit systems to variable refrigerant flow and/or chiller heat pump systems over the twenty to thirty year period envisioned to get all of the buildings converted and off of the steam system. Further discussion of funding sources for ESIP II is included in Part 7.

PART 5
ORGANIZATIONAL STRUCTURE
TO SUPPORT THE PLAN

5.1 OVERVIEW

Weber State University Facilities Management is comprised of a considerable number of people with valuable expertise in different areas and their active participation will be critical to the success of ESIP II and achieving the University's goals. Continued management commitment and a flexible structure for implementing the plan will be fundamental elements. As described in Part 2, a number of organizational improvements within Facilities Management were put in place following publication of the original ESIP.

This part of the ESIP II describes the current composition and responsibilities of Facilities Management, with an emphasis on the Operations Group, and provides recommended improvements in structure, responsibilities and staffing to support the plan moving forward. It concludes with a discussion of the future skills and training that will be needed for Facilities Management staff. Several key areas are emphasized including building systems, campus heating and cooling infrastructure, commissioning and recommissioning, and renewable energy.

5.2 CURRENT FACILITIES MANAGEMENT STRUCTURE

5.2.1 Management Level

Weber State Facilities Management provides the people, services and expertise necessary to build, operate, and maintain the entire learning environment and is well positioned to implement the ESIP II and help move the University to a sustainable future. To provide the best service possible to the academic, administrative, student and other users of campus facilities, effectively manage resources and the skills of its people, and provide accountability, the department comprises six key areas of responsibility based upon the core competency of each.

These include the people in Campus Planning and Construction who are responsible for construction of new buildings and major renovations to existing ones and those in the Operations Group who are responsible for operating and maintaining the built environment. The ESIP II will be implemented primarily by these two; however all of the Facility Management organization will be engaged to some degree in these efforts.

Five of the major areas of responsibility are led by a Director and the remaining one is under the Fire Marshall. The current organization structure and responsibilities for the Departments within Facilities Management is illustrated in Figure 5-1.

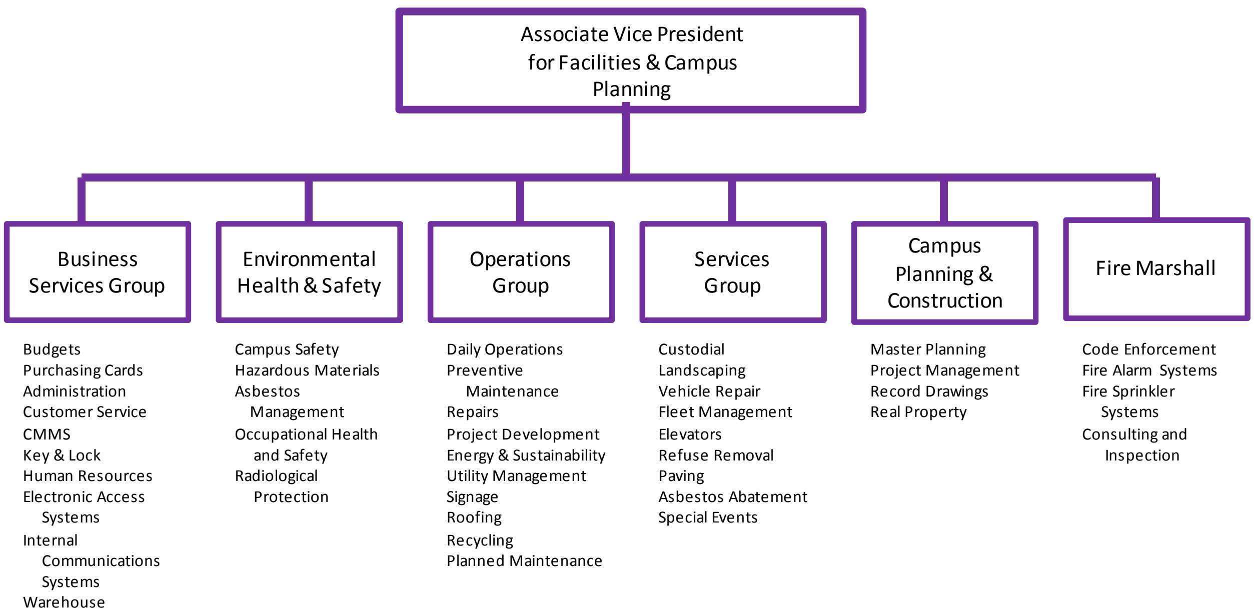


Figure 5-1 Current Weber State Facilities Management Departments and Responsibilities

5.2.2 Operations Group

The Operations Group is led by the Director of Operations and consists of a number of shops, grouped according to areas of expertise, with a Superintendent for each group of shops. The majority of the work undertaken to implement the ESIP II for existing buildings and infrastructure will be the responsibility of Operations Group. The people in this part of the organization will also play a key role in interacting with Campus Planning and Construction to ensure the requirements of the plan are incorporated in new construction and major building renovation projects.

The Energy and Sustainability Office within the Operations Group is responsible for managing all campus utilities and has been a driving force in implementing the recommendations for energy and water efficiency projects recommended in the original ESIP. In addition, this office has developed significant education and outreach programs, and is creating an overall culture of sustainability on Weber State campuses.

Figure 5-2 illustrates the current organization of the Operations Group and is provided as a reference since this is the department for which the organizational changes to support the ESIP II are recommended.

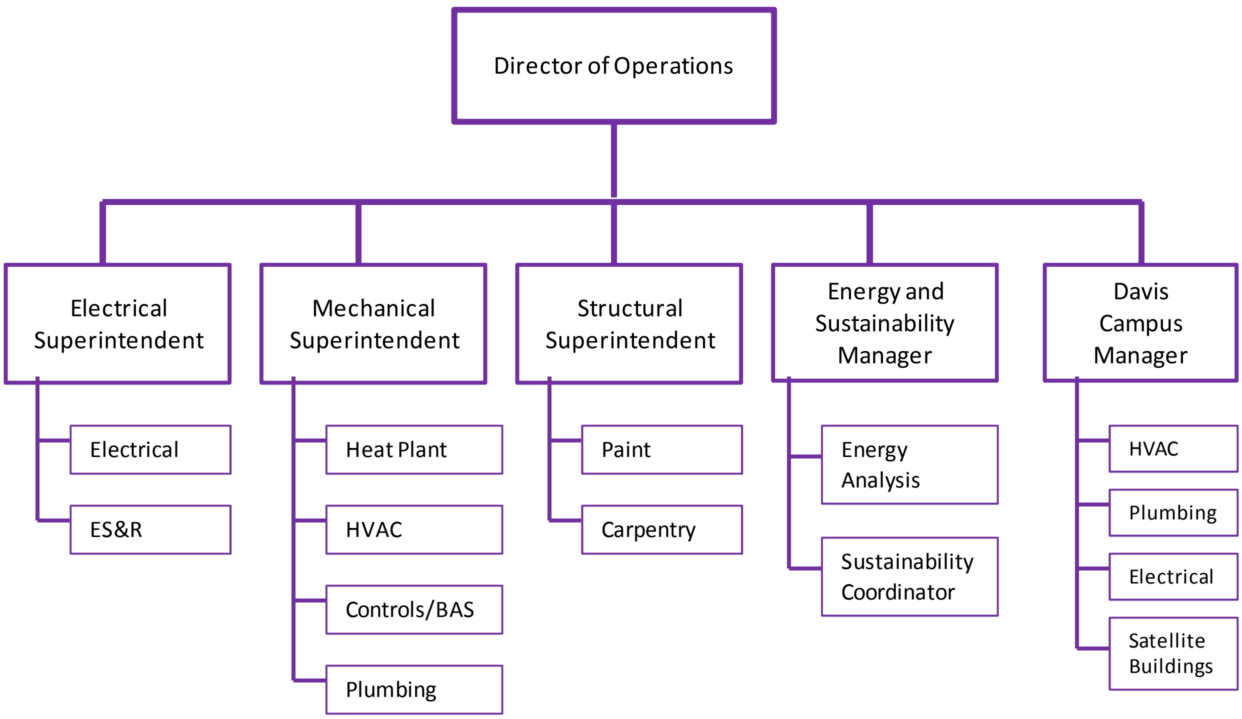


Figure 5-2 Facilities Management Operations Group Current Organization Chart

5.2.3 Project Flow Process

All projects related to buildings and campus infrastructure are the responsibility of Weber State Facilities Management. These generally fall into two major categories depending upon the driving force behind each project. The following discussion summarizes the project types and provides details on the process for projects originating in the Operations Group from the perspective of the ESIP II.

5.2.3.1 New Construction and Major Renovation

New construction and major building renovations projects are generally driven from the “top down”. That is, the impetus comes from the University President, Vice Presidents, Deans, major donors and the State. These projects typically flow through Campus Planning and Construction in an established process that the ESIP II will not attempt to include here. It is during that process however that the requirements discussed in Part 4 of ESIP II relative to the plan for carbon neutrality and the Mechanical Infrastructure Master Plan will be incorporated into the project requirements, design and construction.

5.2.3.2 Capital Improvement, Maintenance and Repair

These projects originate in the Operations Group and are generally empirical and data-driven through the Computerized Maintenance Management System (CMMS), Operations Group service or maintenance people, and reoccurring requests from building occupants. Projects that are justified by state-funded building condition assessments will also fall under this category.

The energy and water efficiency improvements, replacement of existing building systems with carbon neutral capable equipment, targeted building recommissioning, automation and controls upgrades, and other initiatives identified by the Operations Group will typically fall under the established process described in the following paragraphs.

All Operations Group projects start with a Work Request submitted by internal shops or customers within facilities. This includes projects using Capital Improvement funds.

The first step for the Work Request is a review and validation by the Facilities Management Business Office. This includes ensuring the project is appropriate for performance by Facilities Management, is within its legal authority, and that the necessary capabilities and resources are available. If there are issues in these areas, Facilities Management will go back to the shop or customer submitting the Work Request to explore options.

Once validated by the Business Office the project is sent to the appropriate Operations Superintendent(s) for review. If the Superintendent determines the project is within the capabilities of his area of responsibility the project is directed to the appropriate shop for execution.

Projects that the Superintendent determines are beyond the capabilities of Operations Group shops are forwarded to Campus Planning and Construction for evaluations of feasibility, development of cost estimates, contracting and implementation. Figure 5-3 illustrates a summary of this process.

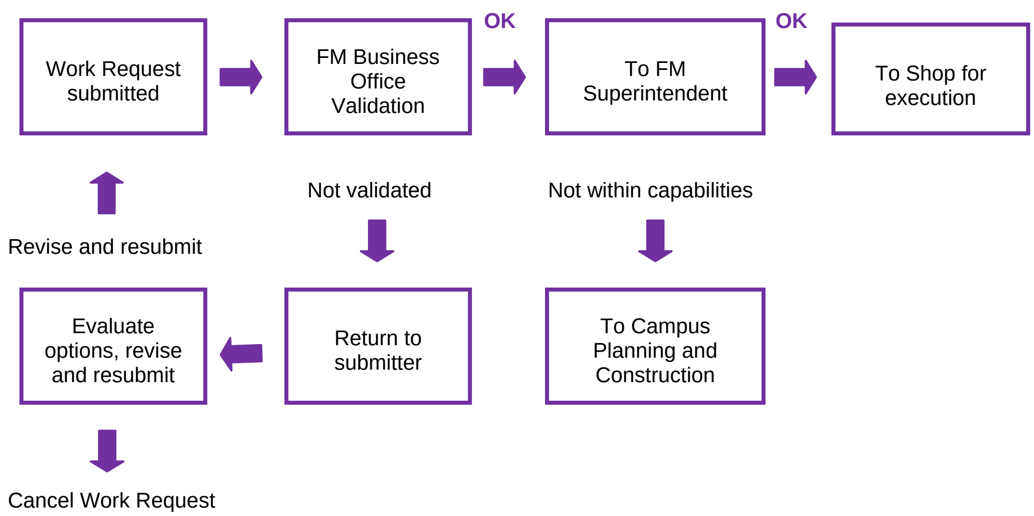


Figure 5-3 Operations Group Work Order Process

5.2.4 Energy & Sustainability Office (ESO)

The original ESIP recognized that effective management of energy and water in the over 2.8 million square feet of building space on the University's campuses requires a dedicated and continuous effort led by a highly qualified and motivated individual. Rather than assigning this responsibility as additional duties to a current Facilities Management staff member or spreading it across a number of people, the University approved creation of a new permanent position justified by the ESIP.

This position has evolved into an Energy and Sustainability Manager reporting directly to the Director of Operations, with an office staff dedicated to managing campus energy and water utilities, implementing technical improvements, tracking performance, evaluating the effectiveness of measures and initiatives, and developing energy and sustainability education, communication, and outreach programs. In addition, the Energy and Sustainability Manager is responsible for identifying and evaluating potential new energy or water conservation and sustainability projects and initiatives, including implementation of the Weber State Recommissioning Program. A part-time utility analyst provides support for data collection and analysis.

Work within the Energy and Sustainability Office includes monitoring progress and preparing the required reports associated with the American College and University Presidents Climate Commitment and a considerable amount of liaison work to assist University faculty with incorporating energy and sustainability subjects into curricula. In addition, the Energy and Sustainability Office has taken the lead to create and expand the highly successful Intermountain Sustainability Summit. The Summit, hosted by Weber State and the Utah Recycling Alliance with support from other local partners, recently completed its 5th annual session with Interior Secretary Sally Jewell as the keynote speaker.

As part of its responsibilities, the Energy and Sustainability Office has been implementing energy and water efficiency projects recommended in the original ESIP and the Investment Grade Audit performed by an Energy Services Company, along with upgrades to the steam infrastructure. These projects, described in more detail in Part 2 of the ESIP II, have been completed or are in progress using in-house personnel for the most part. Outside contractors have been engaged when needed for large projects such as the work on the steam system or when specialized expertise is needed, for example with solar equipment installations.

The Energy and Sustainability Office directly employs two electricians and one plumber and is managing their work in the campus-wide lighting retrofit, steam system repairs, water conservation, recommissioning, and several other projects. An additional two student interns are providing manual labor on a part-time basis for such work as cleaning mechanical spaces and minor replacement of pipe insulation on equipment. Larger projects involving outside contractors are typically managed by the Campus Planning and Construction Group, however the Energy and Sustainability Manager is actively involved in these as well.

A full-time Sustainability Coordinator and a student assistant are responsible for the activities related to sustainability such as Climate Commitment reporting, overall university sustainability planning, liaison with faculty, the recycling program, and coordination of two Weber State student Environmental Ambassadors for energy and sustainability awareness and outreach efforts.

A part-time person, with the assistance of the Sustainability Coordinator, has been dedicated to managing the annual Intermountain Sustainability Summit.

Funding mechanisms for the various positions described above are discussed in Part 7 of the ESIP II.

5.3 OPERATIONS GROUP ORGANIZATIONAL IMPROVEMENTS FOR ESIP II

The effort involved in developing the ESIP II was necessarily an extended one due to the magnitude of the endeavor and the need to develop a plan framework that would be viable over a twenty to thirty year time frame. This process has been evolutionary and that is expected to continue as the ESIP II is implemented.

An example of this evolutionary process in action is the recommendation early in ESIP II development that Weber State have an in-house controls specialist to facilitate standardization and optimization of controls strategies throughout the University's campuses. Facilities Management hired a qualified individual in the fall of 2013 to provide this team member. The controls specialist works under the Mechanical Superintendent and is responsible for addressing issues that arise with the building automation system and control strategies to ensure they are investigated and remedied in order to avoid having desired programming overridden in a reactionary manner and potentially left in that condition.

The controls specialist also assisted with the recommissioning effort at the Hurst Center for Lifelong Learning performed as part of Recommissioning Program development under the ESIP II. Going forward, this role will include supporting future recommissioning, monitoring based commissioning, and measurement and verification efforts to provide consistency and help for all of these efforts and ensuring development and implementation of optimized control strategies.

5.3.1 Summary of Recommendations

Facilities Management has implemented a number of structural improvements in recent years to place responsibility for results closer to where work is being accomplished, improve accountability, allow people to maximize their skills and abilities by concentrating on what they do best and ensure the span of control at different levels of management is appropriate and reasonable. The organizational enhancements to support the ESIP II discussed herein are intended to continue this philosophy and ensure the long term success of the plan and the people involved.

The ultimate success of the ESIP II and the University's efforts to achieve carbon neutrality will require three significant organizational improvements within the Operations Group. These are summarized here and discussed in detail in the sections that follow.

5.3.1.1 Deputy Director and Commissioning Agent

The success of the ESIP II will depend upon placing a great deal of importance on commissioning of new construction or renovation projects to ensure equipment and systems are operating properly, sustainability requirements are achieved, and that the University's interests are fully represented throughout projects. In addition, management and direction must be provided for implementation of the Weber State Recommissioning Program. The most effective way to accomplish this is to have an in-house commissioning agent as part of the University's Facilities Management staff.

This position must be have an appropriate degree of independence and be able to utilize the resources available in the Operations shops in order to efficiently and effectively accomplish the work required. This position will also work in a coordination function for construction and major renovation projects and must be at an equal level with the Project Managers. Therefore, the CxA position should be at the level of Deputy Director of Operations, reporting to the Director of Operations. This will also allow the Director to have a back-up when he is absent.

5.3.1.2 *Energy and Sustainability Office (ESO)*

The role of the ESO going forward will primarily be to provide a staff function to the Director and Deputy Director of Operations for planning, studies, analyses, reports and evaluation of new technologies. As part of this responsibility the ESO will continue to manage energy and water utilities, develop energy awareness outreach programs, provide communication related to energy and water efficiency improvements, and develop projects related to energy and water conservation, alternative energy, and sustainability.

The importance of the ESO for investigating the capabilities, performance and economics related to the equipment described in the Mechanical Infrastructure Master Plan will continue to grow along with research and development of heating and cooling operational improvements, more efficient sequences of operation, scheduling alternatives, and so on.

To permit the ESO to concentrate on these and other functions critical to achieving the University's sustainability goals, the personnel currently employed by the ESO for implementation of projects, and management of those projects, will need to transition to a new Construction and Renovation Shop. The ESO will continue to sponsor projects using the funding vehicles available, in effect becoming a "customer" of the rest of the Operations Group.

5.3.1.3 *Construction and Renovation Shop*

The current implementation of projects by the ESO with its own staff has, in effect, created a separate electrical and plumbing shop within the ESO. This should readily transition to become a separate Construction and Renovation Shop with trades people that already have experience with performing energy and sustainability projects forming its core.

The Construction and Renovation Shop will be led by a Manager and organized into Project Teams. This shop will assume responsibility for managing and completing ESO projects currently in progress or planned for existing buildings and the trades people working on them. This shop will also provide manpower and skills for future projects, recommissioning work and for minor space remodels or renovations for University Departments.

Projects performed by the Construction and Renovation Shop will generally be smaller in scope and cost with larger projects, and those involving outside contractors, continuing to be performed and managed through the Campus Planning and Construction Group.

The overall objective of these organizational improvements is to improve efficiencies and utilization of resources by having the ESO recommend "what" could be done and "why" it should be done, allowing the appropriate Superintendent and/or the Deputy Director/Commissioning Agent to determine "how" it will get done and manage the implementation process with resources from other appropriate shop(s).

While shifting responsibility and personnel for implementations of projects from the Energy and Sustainability Office to the new Construction and Renovation Shop increases the number of shops under the span of control of the Director of Operations, it is expected that the Deputy Director of Operations will provide management assistance and mitigate any impact. Figure 5-4 illustrates the proposed future organization of the Operations Group.

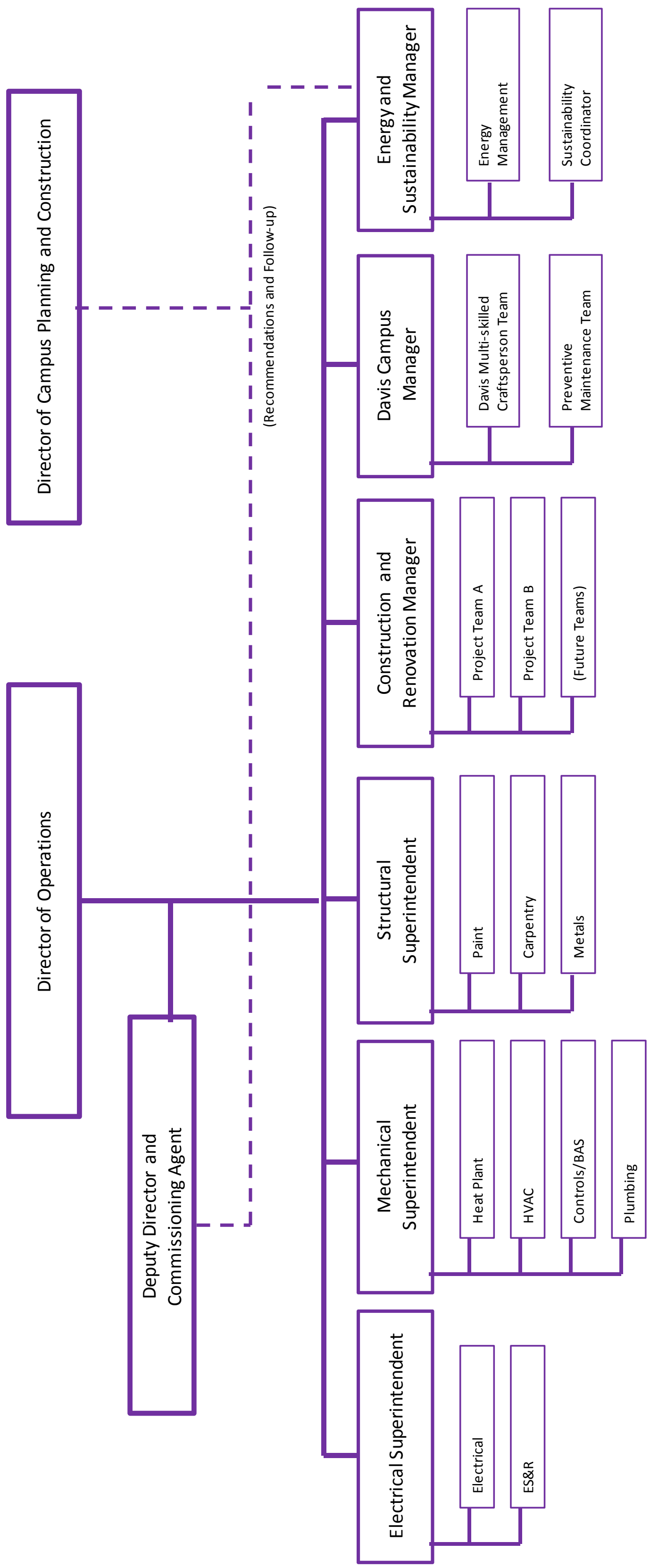


Figure 5-4 Facilities Management Operations Group Proposed Future Organization Chart

5.3.2 Project Flow Process

The process for Work Request for Capital Improvement, maintenance and repair projects will remain the same as described in Section 5.2.3.2 with the addition of responsibility for the Operations Group Deputy Director. Once validated by the Business Office the project will be sent to the appropriate Operations Superintendent(s) to determine which shop(s) will be assigned for execution.

Projects that the Superintendents determine are beyond the capabilities of Operations Group shops will be forwarded to the Deputy Director for review and recommissioning potential before they are transferred to Campus Planning and Construction for evaluations of feasibility, development of costs estimates, contracting and implementation. Figure 5-5 provides an updated flow diagram for this updated process.

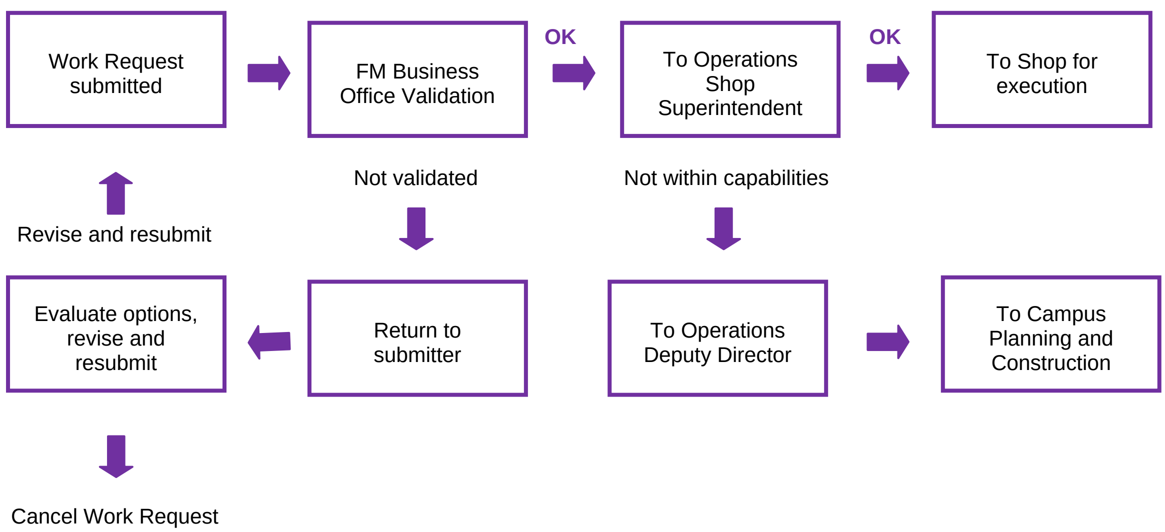


Figure 5-5 Updated Operations Group Work Order Process

5.3.3 Deputy Director of Operations and Commissioning Agent (CxA)

Weber State is committed to commissioning new buildings and major renovations in order to optimize buildings and their ancillary systems for meeting the requirements of LEED Silver Certification as discussed in Part 4. Further, the University intends to ensure that the requirements and efficiencies of certification are actually achieved. In addition, Facilities Management is embarking on the Recommissioning Program developed as part of the ESIP II.

As part of ESIP II development, the University examined the costs, benefits, and the value added to projects by a Commissioning Agent (CxA). The importance of commissioning on new construction or renovation projects, ensuring project requirements related to sustainability are achieved, and management of the Weber State Recommissioning Program to the success of the University's plan for carbon neutrality that is the core of the ESIP II cannot be overemphasized.

With that in mind, Facilities Management has determined that the most cost effective way to perform building and system commissioning on new construction, renovations, existing buildings, and other circumstances is to have an in-house commissioning agent as part of the University's Facilities Management staff.

This position in the Operations Group will be responsible for coordination of activities related to commissioning on new construction or renovation projects, implementation of the Weber State Recommissioning Program and for on-going monitoring based commissioning efforts. The CxA will coordinate with various Facilities Management shops for completion of this work and to provide training to shop personnel. Communication with University departments and outside entities, including utility companies, will also be necessary based upon individual project requirements.

The CxA must be in a position that provides an appropriate degree of independence and enables control over the resources available in the Operations shops in order to efficiently and effectively accomplish the work required. This position must also be at a level where the CxA routinely knows what is happening across all of the Operations Group shops and stays current on projects and activities in order to coordinate resources for commissioning and recommissioning projects as well as to help expedite repairs and operations improvements. Further, the CxA must be at an equal level with the Campus Planning and Construction Project Managers in a coordination function for construction and major renovation projects. Therefore, the CxA position should be at the level of Deputy Director of Operations, reporting to the Director of Operations.

5.3.3.1 Benefits

An in-house CxA would provide a valuable resource to Facilities Management. This person would ensure that Weber State's interests are fully represented in commissioning practices applied to all new construction and major renovation projects. In addition the CxA would manage Weber State's recommissioning and monitoring based commissioning efforts, and assist with measurement and verification of performance.

The addition of this position would help ensure that these services are available as needed and that commissioning best-practices are applied in a consistent and thorough manner on all Weber State projects. Several of the numerous potential benefits to be realized from having an in-house CxA are briefly described in the paragraphs that follow.

a) Direct representation of the University's interests

As a direct employee of Weber State the CxA is in the best position to ensure the University's interests are served and requirements are met. Familiarity with the daily operations and long range strategic planning and goals of Weber State will help ensure that designs, equipment installations and functional performance contribute to improved operation of buildings and achievement of the long term goals of ESIP II.

b) Reduced commissioning costs

Using a CxA on the Facilities Management staff working directly for Weber State on all projects, rather than hiring an outside commissioning agent for each project, will reduce overall costs to the state and the University on construction and renovation projects by eliminating the need and expense to separately contract with an outside commissioning firm for each project.

In every case now, whether a project is state sponsored, university sponsored, or funded by a third party, a separate contract is executed for commissioning agent services with the attendant contracting costs, overhead, and profit for the commissioning firm.

These costs, for an institution like Weber State University with a significant annual facility construction and remodel program, far exceed the cost of an employee on staff, including salary and benefits. For example, an outside CxA for the new Tracy Hall Science Center is estimated to cost nearly $600,000 in the current

Construction Budget Estimate; an amount that would be enough to fund an in-house CxA for five to seven years.

In addition, outside commissioning agents spend a significant amount of time driving and coordinating between different jobs, adding to the cost per hour for the time they are on site at an institution. An in-house CxA would not have those time requirements.

c) Comprehensive analysis on every project

An in-house CxA will make certain that all projects, even those that are minor remodels or reconfigurations of spaces, are examined and addressed to assure optimal systems performance and effectiveness. This will increase energy efficiency in all buildings on campus, and generate more energy and operations and maintenance savings through more efficient systems performance.

d) Improved energy efficiency

An in-house CxA will be more familiar with the operating practices of campus facilities. Thus this commissioning agent could "dial-in" the operation of building systems to match the needs of building occupants much better than an external agent.

e) Institutional familiarity

A significant portion of a commissioning agent's job is to represent the owner's needs during construction. To do this, commissioning agents generally must spend a considerable amount of time, at the owner's expense, getting to know those specific needs. An in-house CxA would be more intimately familiar with the University's needs and will be engaged in the early stages of project development. This would allow a commissioning agent that is part of Facilities Management staff to do more work for considerably less expense, resulting in an anticipated reduction in commissioning costs.

f) Better system operation and occupant comfort

Often, external commissioning agents have to make assumptions with regard to the systems installed and occupant needs which can result in incorrect system operation and poor occupant comfort. By being more familiar with campus operation, the commissioning agent could ensure that building systems are set up in a way that they operate better and provide better comfort.

g) Recommissioning and on-going commissioning

As with any mechanical system, tolerances and set points will drift over time and an occasional "tune up" is required to assure the best possible performance of the building systems. Weber State has developed a Recommissioning Program for campus buildings to systematically review and improve operation. Management and implementation of this program would more easily and cost-effectively be accomplished with an on-staff commissioning agent. An additional benefit is that continuous on-going commissioning would be possible in existing buildings to assure they are operating as efficiently as possible.

h) Coordination of controls and building automation

An in-house commissioning agent would work in close cooperation with the Operations Group controls programmer. Together, they can set up trends on building automation systems, perform data analysis, and regularly re-evaluate system operation and performance. Through these activities, they can continuously optimize system performance and ensure persistence of energy performance over time.

i) Reduced Maintenance

An in-house commissioning agent would become familiar with common maintenance practices at Weber State and would thus be able to provide valuable input on system selection and operation that will reduce negative impacts on maintenance budgets, operating procedures, preventive maintenance schedules, and other operations and maintenance issues.

j) Training for Facilities Management staff

The types of equipment and systems described in the Part 4 of the ESIP II will for the most part be new for Operations Group personnel and will evolve over time as the ESIP II unfolds. The CxA will be in an excellent position to provide “hands-on” training on the operation and maintenance of these systems for building operators and service people through their participation in the commissioning process.

k) Supplemental operations management support

As Deputy Director of Operations, the CxA will have intimate knowledge of the activities, schedules and personnel capabilities within the Operations Group. This will enable the CxA to provide management support to the Director of Operations and continuity in the event of planned or unplanned absences of the Director.

5.3.3.2 Commissioning Agent Responsibilities

The Deputy Director/Commissioning Agent is responsible for providing commissioning services for energy consuming systems installed on new construction and major renovation projects. These commissioning services will generally consist of providing a defined process for assurance and documented verification that these systems for a building or buildings meet Weber State standards for acceptability, are designed, installed and operating properly, and fulfill the functional and performance conditions of the University’s Project Requirements.

These services shall also include functional testing to verify and document proper operation and coordination with Campus Planning and Construction for scheduling and integration of commissioning activities into the overall project schedule.

This position shall also be responsible for implementing, monitoring and evaluating the effectiveness of the University's Recommissioning Program and the on-going monitoring based commissioning efforts described in Part 4 of the ESIP II.

In addition, the Deputy Director will participate as a member of the Weber State Standards Committee to help develop, research and establish construction standards for the campus to ensure that energy and sustainability goals are incorporated and become requirements for design and construction of all CD and CI projects.

As Deputy Director, the CxA will have the full resources of the Operations group available and will be responsible for coordinating their efforts. In addition, the CxA will have a "dotted line" responsibility to Campus Planning and Construction for recommendations, follow-up, scheduling and other aspects of construction or renovation projects. The CxA will be engaged early in the design process to join the Director of Campus Planning and Construction, the Director of Operations and the Energy and Sustainability Manager to complete the core internal Weber State project team.

The CxA responsibilities will include a number of elements as briefly described in the paragraphs that follow.

a) Equipment to be commissioned

In general, the following systems, including all components and controls, are to be commissioned:

1. Heating, Ventilation and Air Conditioning (HVAC) Equipment and Systems.
2. HVAC control systems and user interfaces.
3. Lighting and day-lighting controls.
4. Domestic water heating systems.
5. Specialty Systems.
6. Sub-metering and Measurement and Verification tools.

b) Commissioning on new construction and major renovation projects

There are several distinct phases in a new construction or major renovation project for which the CxA has responsibilities that are briefly described in the following paragraphs.

1. **Programming/Schematic Design Phase**
   - **i.** Assist with documentation of the University's requirements and initial design intent.
   - **ii.** Review the Basis of Design document.
   - **iii.** Identify and assign commissioning responsibilities.
   - **iv.** Begin development of Commissioning Plan detailing the roles, responsibilities and activities required to commission the facility.
2. **Design Development Phase**
   - **i.** Document evolution of the design intent.
   - **ii.** Continue development of Commissioning Plan.
   - **iii.** Review the design documentation at 50% or as otherwise prescribed for the project.
   - **iv.** Create and maintain a Design Phase Issues Log capturing items noted in the design that may have an impact on commissioning activities, when those issues are resolved and the action taken for resolution.
3. **Construction Document Phase**
   - **i.** Provide a focused review of the specifications and drawings at 90% or as otherwise prescribed for project to include design intent, basis of design, and sequences of operation for energy-efficiency and proper functioning. Advise the project team on any recommendations for enhanced performance or changes that may need to be made for successful commissioning.
   - **ii.** Finalize the commissioning plan including all activities and team member responsibilities for each activity. Include a list of specific equipment and systems to be commissioned, process to be

followed, communications and documentation protocols and estimated schedule.

iii. Prepare project-specific Pre-functional Checklist templates to be included in the bid document sections for mechanical, electrical, plumbing, and controls.

iv. Assist with coordination of project specifications to ensure support from contractors in all required Divisions is defined as it relates to functional performance testing.

v. Review contract documents for compliance with design intent.

vi. Provide final review of 100% Construction Documents before they are issued for bids to ensure comments and issues noted in the 90% review have been addressed.

vii. Review contractor bids on items relative to commissioning activities.

4. **Construction Phase**

i. Update the commissioning plan, Pre-functional Checklists, test procedures, and performance verification documentation as required for actual project conditions.

ii. Organize and conduct a commissioning coordination meeting with the Weber State Project Manager, general contractor and applicable subcontractors to review the commissioning plan, requirements, schedule, time estimates for completion of activities and milestones.

iii. Provide line items for commissioning activities, due dates for Pre-functional Checklists, commissioning meetings, and site visits to the Weber State Project Manager for insertion into the Project Schedule.

iv. Review revisions to the Project Schedule on a regular continuing basis for potential impacts on commissioning activities and communicate with the Weber State Project Manager to mitigate.

v. Review those contractor submittals that are critical to the commissioning process with special attention to substitutions or proposed deviations.

vi. Review any Change Order Requests that may impact the commissioning process and testing and provide comments as appropriate.

vii. Conduct periodic commissioning meetings.

viii. Perform periodic site visits and provide observation reports related to equipment, systems and activities that might affect performance verification activities.

ix. Observe selected construction, installation, startup, operation and Test & Balance of major mechanical equipment systems.

x. Create and maintain a Construction Issues Log capturing issues noted during site visits that may have an impact on performance assurance activities, when issues are resolved, and the action taken for resolution.

xi. Document completion of the pre-functional checklists and start up of equipment by mechanical, electrical, plumbing, and controls contractors in compliance with the specification and commissioning plan prior to functional performance testing.

xii. Perform and document Functional Performance Tests for each system and equipment to be commissioned to verify the proper control and operation of the mechanical systems and equipment.

xiii. Engage Weber State Facilities Management shops personnel in testing and verification activities to assist with training.

xiv. Assure systems operate as designed and are integrated properly and thoroughly to gain maximum synergies (for facility operation as a whole).

5. **Acceptance Phase**
   - **i.** Supervise and document seasonal or follow-up testing.
   - **ii.** Verify accuracy of final Test & Balance report.
   - **iii.** Review the Operation & Maintenance (O&M) documentation, project reports, and closeout documents submitted by contractors for completeness.
   - **iv.** Review and participate in training provided by contractor(s) and verify that it was completed.
   - **v.** Verify that there is a plan in place to resolve outstanding commissioning-related issues from the Design Issues Log and/or the Construction Issues Log.
   - **vi.** Perform a post-occupancy check 8-10 months after construction is complete to verify how the building is actually operating. Compile a list of issues or complaints noted by occupants or the Energy and Sustainability Manager.
   - **vii.** Prepare a Commissioning Report.
   - **viii.** Prepare a Systems Manual in accordance with the recommendations in ASHRAE *Guideline 1.4P Procedure for Preparing Facilities Systems Manuals* that is currently planned for publication in the fall of 2014.
   - **ix.** Develop a Building Operator's Manual as described in the Weber State Recommissioning Program Manual.

c) Commissioning on other upgrade and renovation projects

1. Perform commissioning on all projects with an effort appropriate to the scope of the project.
2. Utilize in-house Facilities Management resources as much as possible for cost effectiveness and training purposes.
3. Update affected documentation, including as appropriate:

i. Construction documents.
ii. As-builts.
iii. Operation and Maintenance Manuals.
iv. Systems Manual.
v. Building Operator's Manual.

d) Recommissioning (RCx) Program

1. Work with the Energy and Sustainability Manager and recommissioning committee to identify buildings for RCx.
2. Determine how targeted RCx will be performed.
3. Coordinate resources using Facilities Management personnel for cost effectiveness and training.
4. Manage the overall RCx process in accordance with the Weber State Recommissioning Program Manual.
5. Compile and update an Issues and Opportunities Log including actions taken for resolution of issues and implementation of improvements.
6. Prepare the Recommissioning Report per the Weber State Recommissioning Program Manual.
7. Develop or update the Building Operator's Manual as described in the Weber State Recommissioning Program Manual.

e) On-going monitoring based commissioning

1. Assist the Energy and Sustainability Manager with evaluation of data analyses.
2. Validate and implement recommendations from the Energy and Sustainability Manager.
3. Validate results of implementation.

f) Training for Facilities Management shops

1. Develop and provide oversight for an overall Operations Group training plan.

2. Coordinate with Superintendents to include commissioning and operation topics in shop meetings, safety meetings and toolbox talks.
3. Work with the Director of Campus Planning and Construction to ensure project managers and in-house engineers are included in training on new equipment, systems, commissioning, and so forth.
4. Provide updates and results from commissioning on new construction or renovation projects and recommissioning efforts on existing buildings.
5. Focus on how systems are supposed to work and impacts actions by operators or service people can have on overall system operation.
6. Ensure continuous training of building operators in proper maintenance best practices for equipment installed in new construction or renovations and for existing systems that have been recommissioned.

5.3.3.3 Deputy Director of Operations Responsibilities

As Deputy Director of Operations this position will also be responsible for the following:

- ***a)*** Acting with full authority of the Director of Operations when the Director is not available.
- ***b)*** Staying abreast of activities and events related to Operations.
- ***c)*** Developing performance metrics and accountability measures for Operations shops and personnel.
- ***d)*** Performing other duties as assigned.

5.3.3.4 Desired Qualifications

The Commissioning Agent (CxA) should have a minimum of five (5) full years in commissioning work and acted as the CxA for at least three (3) projects larger than 75,000 square feet. Extensive experience in the operation and troubleshooting of HVAC systems, HVAC controls and building automation systems, lighting controls systems, domestic water systems, and Computerized

Maintenance Management Systems (CMMS) is also required. In addition, the following qualifications are necessary:

a) Knowledge of test and balance of both air and water systems.
b) Experience in energy-efficient equipment design and control strategy optimization.
c) Direct experience in monitoring and analyzing system operation using energy management control system trending and stand-alone data logging equipment.
d) Excellent verbal and writing communication skills.
e) High degree of organization and ability to work with design professionals, the owner's project management personnel and trade contractors.
f) Experience in writing commissioning specifications.
g) Knowledge of building operation and maintenance
h) Practical experience with training for operations and maintenance personnel.
i) Certification: AGC CxA, NEBB, ASHRAE CxA, BCA CCP, or similar.

5.3.3.5 Funding

Funding for an in-house commissioning agent could come from a number of sources. These would include the capital development funds that are otherwise now spent on contracts for outside commissioning firms associated with construction and cost savings related to energy efficiency and recommissioning projects. Further discussion of funding sources is found in Part 7 of the ESIP II.

5.3.4 Energy and Sustainability Office (ESO)

Overall, the ESO of the future will include an energy management component and one focused on sustainability. The ESO will primarily provide a staff function to the Director and Deputy Director of Operations for planning, studies, analyses, reports and evaluation of new technologies. The ESO will assist with maintaining the larger vision of the ESIP II through participation with the Weber State project team in the design phase of construction and renovation projects and by interaction with University faculty on the education side.

As envisioned by the original ESIP, the Energy and Sustainability Office (ESO) has been the driving force for identifying, recommending, implementing, and verifying effectiveness on energy efficiency, recommissioning, renewable energy, and other sustainability projects. It is anticipated that these projects will continue to grow as the ESIP II moves forward, however responsibility for the actual implementation and management of projects will be transferred to other areas.

In addition, it is expected that the ESO will continue to manage energy and water utilities, develop energy awareness outreach programs, and provide communication related to energy and water efficiency improvements to various Facilities Management shops, University departments and outside entities, including utility companies. Development and management of a renewable energy portfolio will be a critical element to accomplish the University's carbon neutrality goals.

The ESO will also have a major role in developing the University's overall sustainability plan and the reporting that accompanies that effort. This will include continued participation in the Association for Advancement of Sustainability in Higher Education (AASHE) Sustainability Tracking Assessment and Rating System (STARS).

As part of its responsibility, the ESO will continue to be engaged in research and development of heating and cooling operational improvements, more efficient sequences of operation, scheduling alternatives, and the functional changes and communication required to enable major initiatives such as the successfully implemented shutdown of the main campus steam system for several summer months. The ESO will sponsor projects and manage the funding mechanisms available, in effect becoming a "customer" of the rest of the Operations Group and the Campus Planning and Construction Group.

The ESO will also expand its role in advising Campus Planning and Construction on energy and sustainability issues and the Mechanical Infrastructure Master Plan including investigating the capabilities, performance and economics related to the equipment described in that plan. The importance of this function will grow as available equipment and systems evolve and new technologies emerge beyond those described in Part 4 of the ESIP II.

5.3.4.1 Transition of Current Projects and Personnel

To permit the ESO to concentrate on the research, analysis, advisory, planning, utility management, energy education, and outreach functions critical to achieving the University's sustainability goals, implementation of projects currently performed by the ESO and personnel associated with those projects will need to transition to the Construction and Renovation Shop described in Section 5.3.5. This includes the energy project electricians and plumber that have been directly employed and managed by the ESO, along with any student interns or others providing manual labor on a part-time basis.

In addition, the effort required for coordination, promotion and operation of the Intermountain Sustainability Summit has grown to the point where it would be more appropriately handled by the academic side of the University. Therefore it is recommended that this responsibility, including the part-time Summit Coordinator currently in the ESO, be shifted to Academics.

5.3.4.2 Energy and Sustainability Manager

The Energy and Sustainability Manager has been reporting to the Director of Operations and will continue to do so in a staff and advisory function for the Director and Deputy Director to assure sufficient seniority in the position. In addition, the Energy and Sustainability Manager will have a "dotted line" responsibility to Campus Planning and Construction for the recommendations and follow-up integral to implementation of the Mechanical Infrastructure Master Plan. The Energy and Sustainability Manager will be a member of the core internal Weber State project team along with the Director of Campus Planning and Construction, the Director of Operations and the Deputy Director/CxA.

5.3.4.3 Sustainability Coordinator

The Sustainability Coordinator position is involved with all activities related to sustainability. These include the Green Department Certification Program, coordination of Weber State student Environmental Ambassadors for energy and sustainability awareness and outreach efforts, and several responsibilities that are beyond the scope of the ESIP II such as such as Climate Commitment reporting, overall university sustainability planning, liaison with faculty, recycling, and so forth. As part of the ESIP II evolutionary process this position was recently expanded to full-time. The use of one or more student assistant(s) should be continued.

5.3.4.4 Analysts

Integral to the functions of the Energy and Sustainability Office related to the various studies, research, planning, recommendations and reporting is the need for one or more analyst(s) to compile and organize the necessary data. Presently there is one part-time person in this role primarily engaged in utility data analysis including the individual building metering. This level of effort will need to continue in order to support the current evaluation of potential projects and reporting of results.

As the ESIP II progresses additional analyses will be needed for identification of targets for the recommissioning program or mechanical upgrades and savings calculations associated with those projects. This will likely grow to the point where addition of an analyst for existing buildings will be appropriate.

The need for additional analysts for systems or equipment associated with the Mechanical Infrastructure Master Plan, renewable energy, economics and other key areas may also be anticipated given the scope and duration of the ESIP II. In general these positions should initially be filled with internal hourly people or qualified student interns on a part-time basis that could be expanded to full-time as needs dictate and funding permits.

5.3.4.5 Responsibilities for the Scope of ESIP II

The focus of ESIP II is primarily on the Climate Commitment Scope 1 and Scope 2 emissions directly from sources that are owned or controlled by the University and those resulting from electricity generated off site that is purchased by the University. These include emissions from the Heat Plant, other direct or indirect emissions related to the Chilled Water Plant, building construction and operations, refrigerants and so on. The responsibilities of the Energy and Sustainability Office with regard to ESIP II and the mechanical infrastructure are briefly outlined in the paragraphs that follow.

a) Research

1. Perform research on equipment and systems available for inclusion in the Mechanical Infrastructure Master Plan.

2. Stay current on the evolution of equipment and systems and emerging technologies.
3. Prepare analyses and recommendations.
4. Identify and research new operational procedures, techniques and programs for adoption.

b) Data analysis

1. Utility usage
   - **i.** Ensure campus buildings have the hardware or meters to track consumption of steam, natural gas, chilled water, electricity, and domestic water.
   - **ii.** Develop metering and submetering plans.
   - **iii.** Review and analyze meter and equipment data.

2. Utility bill analysis
   - **i.** Review utility bills for errors.
   - **ii.** Track and analyze all utility costs and usage using spreadsheets and databases.
   - **iii.** Analyze impact of proposed utility rate increases.

3. Utility Database Management
   - **i.** Maintain and update the utility database as the primary source of information for all reporting and analysis.
   - **ii.** Perform frequent review of the database to ensure information is current and accurate.

c) Energy and water management

1. Establish Benchmarks
   - **i.** Develop utility use benchmarks for buildings.
   - **ii.** Perform building by building comparisons to identify opportunities for savings.
   - **iii.** Compile data and publish monthly reports.

2. Continue expansion of capabilities and use of the Lucid Dashboard.

3. Work with the CxA and controls specialist to establish key performance indicators, points to be monitored and monitoring interval and duration for monitoring based commissioning.
4. Review building and equipment operating schedules and provide recommendations for improvements.
5. Coordinate with Facilities Management shops, University Departments, and outside entities as required.

d) Energy and sustainability projects

1. Identify efficiency and operational issues and make recommendations for energy and water usage and cost saving measures and initiatives.
2. Evaluate technical and economic components, life cycle analysis, and calculated potential simple paybacks for energy and water conservation projects.
3. Sponsor projects to be performed providing technical support and appropriate funding sources.

e) Campus new construction and major renovation

1. Participate as a member of the Weber State Standards Committee to help develop, research and establish construction standards for the campus to ensure that energy and sustainability goals are incorporated and become requirements for design and construction of all CD and CI projects.
2. Provide assistance for LEED certification.

f) Recommissioning (RCx) Program

1. Participate as a member of the recommissioning committee for building selection.
2. Prepare utility analysis and benchmarking score for building to establish a pre-RCx baseline.

3. Participate in RCx project kickoff meeting and other RCx activities as needed.
4. Serve on the recommissioning team to help identify Energy Conservation Measures to implement that are consistent with the University's goals.
5. Assist with resolving issues and completing items identified in the Issues and Opportunities Log.
6. Compile data and perform calculations to quantify the energy savings of improvements implemented.
7. Assist with preparation of the Recommissioning Report.
8. Provide other assistance to the RCx team as needed.

g) On-going monitoring based commissioning

1. Provide trend and alarm points to controls specialist.
2. Prepare benchmarking, monitoring and reporting of building meter level data.
3. Perform analysis of change in usage patterns and data filtering for normalization.
4. Analyze trend data to identify operational issues.
5. Provide recommendations to Deputy Director/CxA for implementation.
6. Evaluate functionality of the current Lucid system and other available technologies to determine which could best serve as a Fault Detection and Diagnostic system.

h) Renewable resources

1. Identify and recommend sources for supply of electricity from on-site generation and off-site providers.
2. Develop and manage the renewable energy portfolio.
3. Investigate alternative technologies.
4. Conduct testing to evaluate potential renewable resources (i.e. wind, geothermal).

i) Sustainability

1. Prepare and submit reports associated with the University's Climate Commitment.
2. Coordinate and expand University's recycling program.
3. Assist with overall university sustainability planning.
4. Provide interaction with the University Environmental Issues Committee and other faculty to help develop sustainability courses on the academic side.
5. Participate in the Sustainability Center discussed in Part 6 of the ESIP II to assist with strategic planning.
6. Identify and recommend new or revised programs supporting university sustainability goals.

j) Measurement and verification

1. Develop and manage approaches for measuring energy and water use and cost savings.
2. Provide reports to management and University administration.

k) Emissions reporting

1. Maintain utility consumption and back-up generator and boiler operation data on a continual basis.
2. Coordinate with other University personnel, outside consultants, and Federal or State agencies as required to generate reports.
3. Review utility consumption and boiler operation data and prepare reports on emissions to support the University's climate commitment goals.

l) Energy awareness, education, and outreach

1. Develop and implement energy awareness programs and outreach activities on and off campus.
2. Participate on and provide support to energy and water teams.

3. Manage and expand the Green Department Certification Program.
4. Coordinate Weber State student Environmental Ambassadors for energy and sustainability awareness and outreach efforts.
5. Continue participation in AASHE STARS and pursuit of program initiatives.
6. Provide liaison with utility providers and political figures.

m) Financial management

1. Manage the energy project credit line established by the University including draws, payments and reconciliation with annual energy savings.
2. Utilize other energy and sustainability finding available from the University.
3. Prepare applications for utility incentive and other grant funds.
4. Provide tracking and reporting required for use of all funds.
5. Apply for all possible grants, rebates, cost sharing and other financial incentives.

n) Training for Facilities Management shops

1. Assist with development of overall Operations Group training plan providing energy and sustainability perspectives.
2. Work with Superintendents to include energy and sustainability topics in shop meetings, safety meetings and toolbox talks.
3. Provide updates on projects and initiatives.
4. Focus on the "why" for equipment choices, operation or schedule improvements, LEED requirements, and so forth.
5. Ensure continuous training of Facilities Management shops to maintain effectiveness.

5.3.4.6 Responsibilities Beyond the Scope of ESIP II

It is important to note that the responsibilities of the Energy and Sustainability Office extend beyond the Climate Commitment Scope 1 and Scope 2 emissions that are the emphasis of ESIP II. These include addressing Scope 1 and 2 emissions from sources such as the vehicle fleet and lawn chemicals along with Scope 3 emissions from commuting, university business travel and waste. In addition, there are some key target areas that are the responsibilities of the Energy and Sustainability Office that are listed below.

a) Water

1. Implement water efficiency measures and reduce water use:
   - **i.** Culinary water in new and existing buildings.
   - **ii.** Secondary water use in landscaping and processes.
2. Prepare analyses and recommendations.

b) Waste

1. Establish goals for reduction and diversion:
   - **i.** Ongoing consumables.
   - **ii.** Electronic equipment.
   - **iii.** Furniture.
   - **iv.** Construction and demolition waste.
   - **v.** Food and other green waste.
   - **vi.** Hazardous materials.
2. Prepare analyses and recommendations.

c) Indoor environment

1. Establish goals for use of low emitting materials for adhesives, sealants, paints, coatings, flooring systems, composite wood products, agrifibers and so forth.
2. Create and assist with implementation of an indoor air quality management plan.
3. Create and assist with implementation of a plan for green cleaning.

d) Sustainable sites and grounds

1. Develop and recommend strategies for heat island reduction for roof and non-roof areas.
2. Develop and recommend strategies for reduction of light pollution.
3. Continue involvement with Tree Campus USA.
4. Make recommendations and assist with creating plans for:
   - **i.** Storm water management.
   - **ii.** Integrated Pest Management.
   - **iii.** Sustainable snow and ice removal.

e) Food service and dining

1. Develop recommended goals and initiatives for:
   - **i.** Food purchasing that includes local sources, organic products, fair trade and so on.
   - **ii.** Vegetarian and vegan dining.
   - **iii.** Reusable food service and "to go" containers.
2. Investigate potential for farmers' markets and campus gardens.
3. Composting food waste.

f) Purchasing

1. Develop recommended sustainability goals for purchasing durable goods and ongoing consumables.
2. Assist with implementing sustainability goals in equipment, construction, and project management standards.

5.3.4.7 Funding

Funding for the Energy and Sustainability Office comes from a number of sources. The primary source currently is the funds generated by energy and water cost savings through implementation of efficiency improvement projects. Funding for the expansion of the Sustainability Coordinator to full-time will become available from transfer of the Intermountain Sustainability Summit Coordinator from the ESO to the academic side. Additional discussion of funding sources is found in Part 7 of the ESIP II.

5.3.5 Construction and Renovation Shop

As discussed previously, the current organization of the Operations Group is comprised of a number of trade shops grouped under superintendents in the major categories of electrical, mechanical and structural on the Ogden Campus. In addition the Davis Campus Manager supervises all trades personnel working on the Davis campus and satellite buildings. The principal responsibility of the trades people in these shops is the operation, maintenance and repair of existing buildings, equipment and systems. In addition these shops provide specific services when requested by University Departments.

The energy projects currently in progress and the recent recommissioning projects at the Hurst Center for Lifelong Learning and the Wildcat Center have been managed by the Energy and Sustainability Manager and performed with trades people working directly for the ESO. Additional personnel from other shops have been utilized where needed for particular expertise or to supplement ESO staff, requiring coordination with the particular superintendent and consideration of the workload for normal required services in the shop(s) affected.

The ESIP II plan for carbon neutrality in campus buildings discussed in Part 4 includes specific efforts identified for existing buildings. These include completion of the existing energy and water conservation measures, implementation of new projects recommended by the ESO, upgrades to building automation and controls systems, targeted recommissioning of building systems and other deep retrofit measures.

In its advisory role the ESO will be recommending improvements to be implemented and sponsoring projects with its available funding sources. The ESO will essentially be recommending “what” should be done and providing “why” based upon the research and analyses performed. To maximize this core competency of the ESO, and allow ESO staff to perform the other critical functions described in Section 5.3.4, it will be necessary to transfer responsibility for determining “how” a project will be implemented and performing the actual construction or renovation work to others.

The current arrangement with the ESO physically implementing projects with its own staff has, in effect, created a separate electrical and plumbing shop within the ESO for construction and renovations related to those energy projects. This should readily transition to become a separate Construction and Renovation Shop with trades people that already have experience with performing energy and sustainability projects forming its core.

5.3.5.1 Responsibilities

The Construction and Renovation Shop will continue the work on projects currently in progress or planned for existing buildings including the lighting retrofits, steam system repairs, water conservation, and so on. In addition, this shop will provide manpower and skills for performing recommissioning work under the direction of the CxA.

Facilities Management also performs work for University Departments such as minor space remodels or renovations and so forth. It is expected that the Construction and Renovation Shop will be the lead organization for implementing these projects, coordinating with other Operations Group Shops to obtain manpower and skills as needed.

It is anticipated that projects performed by the Construction and Renovation Shop will generally be limited to energy projects and those small projects that can be readily accomplished to meet customer requirements within a cost ceiling of $25,000 per project. Larger projects, and those involving outside contractors, will typically be performed and managed through the Campus Planning and Construction Group.

5.3.5.2 Construction and Renovation Manager

The Construction and Renovation Shop will be led by a Manager in a position equivalent to the other Operations Group Superintendents and reporting to the Director of Operations. This will ensure the ability for this shop to have the full resources of the Operations Group available and for coordinating their efforts.

5.3.5.3 Project Teams

The Construction and Renovation Shop will be organized into teams of individuals with skills in the different trades necessary to complete projects assigned. To form the first Project Team, the electricians and plumber that are currently directly employed and managed by the ESO will transfer to the Construction and Renovation Shop. Their roles will be expanded to include electrical and plumbing/mechanical work associated with any projects undertaken by this shop.

As the ESIP II is implemented and the Construction and Renovation Shop expands its role in accomplishing projects, additional people with complementary trade skills, for example structural, will be added to the team(s). Since they are part of the Operations Group these teams will also be available as a resource for the Director of Operations or the Deputy Director/CxA to use for flexibility and manpower to help accomplish work by other shops

a) Construction and renovation electricians

The electricians originally brought on board to work under the Energy and Sustainability Manager have been dedicated to performing electrical work related to the energy efficiency projects being implemented at Weber State. To date these individuals have been performing the lighting retrofit projects and are about forty percent (40%) complete. It is expected that this will be the focus of their work the next few years along with some other mechanical upgrade projects. For example, they have also been engaged with the installation of point-of-use electric water heaters.

b) Construction and renovation plumbers/technicians

The energy project plumber(s) originally under the Energy and Sustainability Manager will continue working to perform the mechanical work related to energy efficiency projects. This position has filled a key role in the comprehensive steam system upgrade and repair work over the past three years.

Going forward, this position will continue installing building submeters, performing retrofits for domestic water conservation, assisting with recommissioning, performing mechanical work associated with any projects undertaken by the Construction and Renovation Shop and working to maintain the steam system and keep it running efficiently until the eventual phase-out.

c) Other construction and renovation trades

In addition to the electrical and plumber/technician positions described in the paragraphs above, the Construction and Renovation Shop is envisioned to eventually include dedicated structural people such as carpenters, painters and metal trades.

d) Part-time opportunities for students

Student interns are currently providing manual labor for projects under the ESO on a part-time basis. These projects include such work as cleaning mechanical rooms, minor insulation replacement, paint touchup and so forth. Use of this ready labor source can also contribute to a student's overall education and should be considered whenever practicable.

5.3.5.4 Funding

The Construction and Renovation Shop, like the separate electrical and plumbing shop previously within the ESO should essentially be self-funding through cost savings from projects sponsored by the ESO or compensation for work done for University Departments. Equipment and building automation or controls upgrades may utilize Capital Improvement funds when appropriate. Additional discussion of funding sources is found in Part 7 of the ESIP II.

5.4 FUTURE SKILLS AND TRAINING NEEDS

Success of the ESIP II and achievement of the University's carbon neutrality goals with regard to the built environment entails a shift away from the legacy HVAC systems, boiler plant and steam infrastructure currently in place. The carbon neutral capable and renewable energy systems described in the Mechanical Infrastructure Master Plan will require expansion of some skills already available in Facilities Management front-line people along with a somewhat different skill set to deal with new technologies.

Overall the University will be moving toward smaller HVAC systems within buildings, more sophisticated controls and strategies, improved management of electrical systems, and renewable energy systems such as solar photovoltaic generation, solar thermal installation and the use of geothermal heat sources/sinks that is the key to the overall plan for carbon neutrality.

All of these will present opportunities and challenges that will require a well trained and up to date staff for operation, maintenance and repairs. Training plans therefore must be a continuous, organized ongoing effort that includes updated training for existing people within Facilities Management, and for new people coming on board on the new technologies and equipment being employed at Weber State. The objective will be to ensure an ongoing effort to train staff, particularly those on the front line, before buildings are constructed or renovated and turned over to the Operations Group with these new systems, equipment types and technologies installed.

To provide a greater perspective and coordinate training across the entire Operations Group, the Deputy Director/CxA should have overall responsibility for developing, implementing and continuously updating the training plan. The ESO will need to assist in these efforts with the energy and sustainability perspective to ensure everyone understands why particular systems, technologies and strategies are used along with the potential impact actions by technicians and operators can have.

It is also critical for front line people in Campus Planning and Construction, particularly Project Managers and others who have a role in reviewing designs and construction, to also be included in training on these new and emerging systems and technologies. The Operations Group Deputy Director/CxA will already be working with the Director of Campus Planning and Construction and Project Managers for design reviews, commissioning work, and other activities associated with construction and major renovation, so coordination of the training effort to include Campus Planning and Construction staff is a natural extension of Deputy Director/CxA responsibility for the overall training plan.

Major areas of emphasis for skills needed and training requirements are discussed in the paragraphs that follow. Much of this relates to the skills and training needed as new equipment and technologies are installed through building construction and renovation projects and upgrades through the Capital Improvement Program. The training program should build on this to provide training for new personnel and ongoing training for current staff. As time passes, newer more efficient technologies will likely emerge and these will need to be considered in future training plans.

5.4.1 Building Systems and Equipment

The campus wide Mechanical Infrastructure Master Plan uses all electric systems and a fluid heat exchange loop within each building. The preferred equipment types for buildings consist of variable-refrigerant flow (VRF) heat pump systems, heat recovery ventilation systems and heat pump chillers with chilled beam units or small air handling equipment. These systems will require an increased emphasis on skills and training for refrigeration and controls associated with systems that are smaller, but more numerous, than the whole building central station air handling, chilled water and steam/hot water systems used previously.

The initial training effort will be dependent to a large degree on the complexity of the systems installed and the capabilities of Facilities Management personnel. In general for building construction or major renovations a combination of classroom sessions and observing functional performance tests with the Operations Group CxA should be used to provide training on these new systems.

Training requirements should be included in project requirements for contractors to include specific topics and descriptions of the kind of training sessions to be provided for each type of equipment or system installed. Simple walk-through familiarization or observation of equipment startup by contractors shall not be acceptable.

Consideration should be given to requiring that this training be provided in separate sessions to allow onsite training of one group of people while other staff remains available to respond to normal work requests. A requirement that operation and maintenance manuals along with written sequences of operations shall be provided to each attendee at training sessions is strongly recommended also.

The training requirements should also include hands-on training once systems are tested and operational, and refresher training at about the 6-month point of the 12-month project warranty period.

5.4.2 Campus Cooling and Heating Infrastructure

As the Mechanical Infrastructure Master Plan moves forward, the campus chilled water system will be converted to a campus wide Ground Source Heat Pump (GSHP) system, connecting all building VRF or heat pump systems, geothermal wells, pumping systems, and the cooling towers, that are phased in over time. The planned addition of ground exchange with wells will ultimately be the primary source for heating or cooling needed within the campus water loop.

Eventually this will allow the large boilers in the Heat Plant and chillers in the Chilled Water Plant to be phased out at the end of their useful service lives. The skill sets currently in place for these boilers and chillers will still be needed during this transition, and a certain amount of competence will be required for operating and maintaining the smaller condensing-type hot water boilers that will provide supplemental heat to the campus water loop during the heating season. However, skills and training needs will shift toward operation and maintenance of geothermal systems.

5.4.3 Commissioning and Recommissioning

The participation of Operations Group technicians and operators in the commissioning process is an invaluable tool for learning about the systems or equipment installed and its proper operation. It also has the benefit of providing manpower to the Operations Group Deputy Director/CxA for accomplishing the commissioning work. Training for each specific project should be prepared and conducted by the CxA prior to the start of commissioning on new construction, renovation, or capital improvement projects.

In addition, the University will have Standards developed for materials, construction, piping support and pressure testing related to refrigerant systems and a refrigerant leak detection and management plan will be established for each project. The Weber State Project Manager should provide training for Operations Group personnel on the plan for each project.

The Weber State Recommissioning Program is based upon using Operations Group staff, under the direction of the Deputy Director/CxA, to perform the work needed in those projects. The CxA, with the assistance of the ESO will conduct training on recommissioning for each project to include why the building was selected, what needs to be done and the expected outcome of the work. This will generally be part of the project kickoff meeting.

5.4.4 Renewable Energy Systems

In addition to the geothermal systems described in the Mechanical Infrastructure Master Plan Weber State will be installing solar photovoltaic (PV) systems for generating electricity and exploring other alternative sources such as wind power. These will require new skills sets particularly in the electrical field, for operation and maintenance and appropriate training must be incorporated in the training plan.

The ESO is successfully implementing campus wide lighting retrofit and other energy efficiency projects using the electricians who will be transferring to the Construction and Renovation Shop as described in Section 5.3.5. Training these and other Operations Group electricians on solar installations to the point where they become certified solar installers would allow the Construction and Renovation Shop to self-perform solar PV installations following the model used for the lighting retrofit projects.

Implementing solar projects through the Construction and Renovation Shop will result in simplifying purchasing and reduced costs from better equipment pricing and elimination of contractor mark-ups. The Construction and Renovation Shop will be in a position to start installing solar power on a larger scale once the lighting retrofit projects are completed.

(THIS PAGE INTENTIONALLY BLANK)

PART 6
COMMUNICATION, EDUCATION AND OUTREACH TO SUPPORT THE PLAN

6.1 OVERVIEW

The efforts of Facilities Management in implementing the original ESIP have resulted in a culture of sustainability that is developing campus-wide. Increased awareness of these efforts and their positive impacts, throughout the whole university community has also resulted in increased support from all stakeholders. The challenge as the ESIP II moves forward will be to build upon this momentum to keep administration, faculty and students engaged and informed to ensure the success of the plan.

Assimilation of the different organizations and individuals at Weber State, along with other local and state entities, into the Facilities Management carbon-neutrality plan and other sustainability efforts will be critical to their success. This will require a combination of good communication internally and externally, education efforts and various levels of targeted outreach.

This part of the ESIP II begins with discussion of the methodology and results of a survey performed as part of plan development to assess the attitudes and perceptions of Facilities Management personnel toward energy and water efficiency. A similar survey was performed during the original ESIP several years ago offering an opportunity to evaluate the effectiveness over time of communication, education and outreach related to the improvements implemented under that plan. The results provide considerable insight and form the basis for improvement recommendations in these areas.

Several other ideas for communication, education and outreach with respect to the ESIP II are introduced for the university as a whole and for the greater community beyond the campuses with which interaction on the larger scale university sustainability plan will be needed. While the ESIP II is centered primarily upon carbon neutrality efforts for campus buildings, it is intended to complement and supplement the overall sustainability and carbon-neutrality plan being developed by the University. These recommendations are presented here for further investigation and potential incorporation in that overall plan.

6.2 ASSESSING ATTITUDES AND PERCEPTIONS

Learning about attitudes and perceptions with regard to energy, sustainability and related issues is critical for determining previous successes and uncovering areas for emphasis in order to develop communication, education and outreach initiatives. A good way to do this is to perform a survey with questions designed to elicit the insight desired from the target group(s). The results can often be considerably different from what was assumed and this provides valuable direction for creating a plan to improve awareness, understanding and support.

As part of ESIP II development, an on-line survey process directed toward Facilities Management personnel was completed. The results of this survey and comparisons with the previous one performed for the original ESIP are presented in the section that follows. It is highly recommended that a similar approach be used with University administration, faculty and student community as a whole with survey questions tailored to each of these major groups.

6.2.1 ESIP II Facilities Management Employee Survey

This survey included responses from the employees' perspectives on job responsibilities, the importance of sustainability and energy conservation both at work and personally, current savings practices, suggested improvements, desired training, and potential barriers they see. Finally open-ended questions provided a wealth of interesting ideas and comments.

The survey used same methodology and questions used in the one performed when developing the original ESIP. This permitted an ability to compare the results of the new survey to that previous one in an effort to gauge changes over time in perception and attitudes toward the efficiency upgrades, education and outreach activities of Facilities Management since the original ESIP. Some additional questions were included to gain further insight along with separation of sections for energy and water efficiency.

The survey was set up in an anonymous "on-line" format to encourage participation and candid responses. The following groups within Facilities Management were included in the survey:

Senior Management	Business Center
Campus Planning & Construction	Energy & Sustainability
Fire Marshall	HVAC (including Heat Plant and Davis)
Carpentry	Custodial

Electrical	Electronic Systems and Repair
Plumbing	Utility
Paint	Systems Support
Key and Lock	Vehicle Repair
Shuttle Bus/Fleet	

It is estimated that there are up to 250 people in the Facilities Management target groups and responses were received from 85 people for very good response rate of 34%. Responses came from individuals in all of the targeted groups and the highest participation among those that identified where they were assigned was again Custodial at 29 % of the total followed by HVAC (including the Heat Plant and Davis) at 16% and Project Management with 13%.

Analysis of survey results can be used to evaluate progress and identify initiatives that are working and where additional attention needs to be paid. Specific plans for improving on the success of programs implemented from the original ESIP and for new programs under ESIP II can then be developed going forward.

6.2.1.1 Analysis of Survey Responses

Although participation on a percentage of total personnel basis was slightly lower than the previous survey, the overall number of people responding was considerably higher. This represented a good cross section of personnel and responsibilities in Facilities Management allowing a high confidence level in analysis of the results.

From the responses provided by all of those who participated in the survey there are a number if interesting points that are helpful in developing communication improvements, education initiatives and outreach strategies. These are summarized as described in the following paragraphs with comparisons to the original survey results for reference. A complete summary of the survey results, details on responses, and a full compilation of all participant comments in “raw” form is included in Appendix D.

a) Time on current job

The majority of respondents (72.8%) indicated they have been with the University for at least two years. Those that have been in their current job for more than five years comprised 46.9% percent of the total indicating some attrition of experienced staff since the original survey. This group has been in place for the majority of time since the original ESIP and can provide the best insight.

b) Position classification

Most respondents (58.5%) indicated they were "Classified" followed by "Professional" (26.8%) and "Hourly" (14.6%). This represents a considerable change over the previous survey where "Classified" represented 47.5% of the total with the balance almost evenly split between "Professional" and "Hourly". This is most likely due to the expansion of Facilities Management groups included in the survey and the larger number of participants.

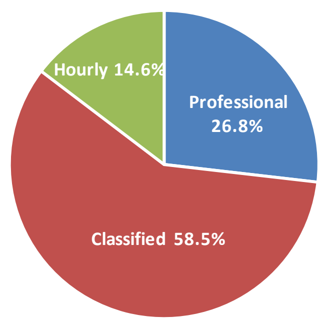


Figure 6-1 Participants by Classification

c) Role in energy efficiency

The questions in this section provided insight into the perceptions of the individual responding relative to authority to make decisions, having materials and equipment needed to do a job well, making energy saving suggestions, and the responsiveness of supervisors to those suggestions, all with regard to energy efficiency.

1. Nearly 41% indicated that they were "frequently" given enough authority to make the decisions they need to make with regard to energy efficiency, a 13% increase over the previous survey. Another 38%, about 10% more than previously, said this occurred "occasionally". The balance

of the responses indicated this was "rarely" or "never" the case, however these were decreases of 10% and 51% respectively showing progress has been made in this area.

2. Over 45% of those responding said they "frequently" had the materials and equipment needed to do their jobs well and 37% indicated they had these "occasionally". This is a slight increase over the previous survey where these responses respectively represented 43% and 34.5% of the total.

3. The responders that noted they "frequently" made energy saving suggestions in their job decreased from 33% in the previous survey to 30%, however an additional 44% said they did this "occasionally", an increase from 28% previously.

4. On the question related to perception of supervisor responsiveness to these suggestions 55.7% indicated their supervisor was "frequently" responsive. While this is still slightly over half of the respondents it does not indicate a significant change from the previous survey where 54% gave this response. A similar situation was noted for those noting this happened "occasionally" (31.4% vs. 28%). There were slight decreases in the percentage of responses indicated this was "rarely" or "never" the case, however.

d) Importance of energy efficiency

The purpose of this series of questions in this section was to gauge the respondents' perceptions of the importance of energy efficiency in their jobs at the University and see how that relates to the importance it has to them personally. The results were then compared to the survey for the original ESIP.

Importance to respondents personally has increased to nearly 80% and their perception of how important energy efficiency is in their jobs also showed a significant increase with over two thirds now thinking it is important in their job as well. This indicates success in communication in Facilities Management and an increased desire to bring these practices to the job.

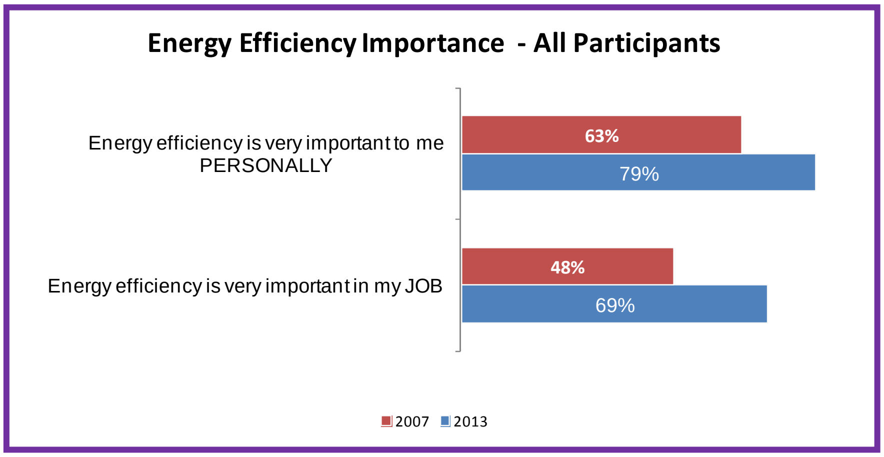


Figure 6-2 Importance of Energy Efficiency

e) Current energy efficiency practices

This series of questions explored each employee's view of energy efficiency as a part of their job, whether they were on an energy team, and if they felt they had the training needed to reduce energy use. Figure 6-3 illustrates the changes in percentages of those who answered "yes" to these questions.

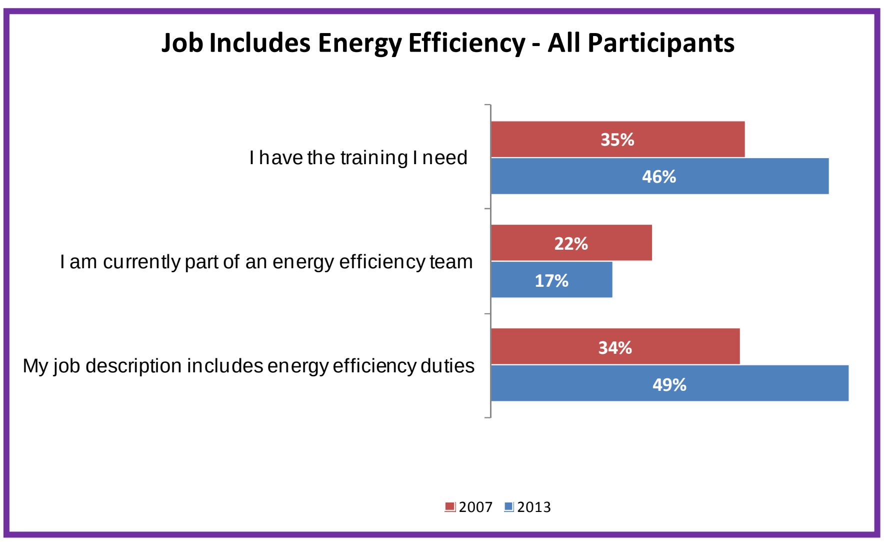


Figure 6-3 Energy Efficiency Practices

f) Energy efficiency at Weber State

This question asked participants how efficient they believed Weber State is in terms of energy usage. It was added since the previous survey to assess the overall impression Facilities Management employees have and gauge the effectiveness of efforts to communicate efficiency improvements. There are no previous results for comparison however 31.9% of respondents said Weber was “very efficient” with another 66.7% believing the university was “somewhat efficient.

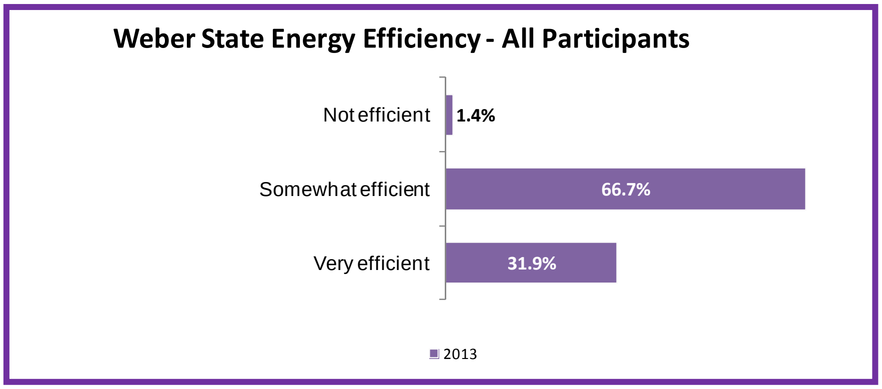


Figure 6-4 Energy Efficiency at Weber State

g) Improvement recommendations

The next three sections of the survey each listed a number of potential improvements in three major areas: operation and maintenance; organizational; and new construction or building remodel. For each of the improvement suggestions listed, respondents were asked their opinion whether each should be “highly recommended”, “somewhat recommended” or “not recommended”.

1. **Operation and Maintenance Practices**
   Of the 85 total people participating in the survey, 65 responded to the items for improvements in operation and maintenance practices. An overwhelming majority (70% and higher) indicated that the items related to policy, training and awareness were “highly recommended”.

2. **Organizational Improvements**
   Sixty three participants provided responses to this section for the possible improvements listed which included some policy and communication items and a number of suggestions related to job requirements. The results indicate that those items that do not appear to affect employees personally were generally "highly recommended" at 57% and higher while those related directly to their work requirements and evaluations were not as well received.

3. **New Construction and Building Renovation**
   This section listed a number of improvement suggestions directed toward sustainability in construction and major renovation of campus buildings. The sixty five people responding to this section demonstrated overwhelming support for these with the majority indicating they were "highly recommended" or "somewhat recommended".

   The suggestion receiving the most support was "*More flexible buildings that will adapt better to future uses*" which was "highly recommended" by 78.5% and "somewhat recommended" by the remaining 21.5%. This was also the only improvement for which no one said it was "not recommended".

   Immediately following were two recommendations related to design: "*Better lighting controls to balance electric lighting with natural lighting*" and "*Improved comfort levels to eliminate space heaters and opening windows*." These received identical support with responses of 75.8% "highly recommended", 21.5% "somewhat recommended" and only 1.6% "not recommended".

   Only two, "*Green power contracts such as Blue Sky purchases*" and "*Install co-generation boiler at Heat Plant*" fell below 50% support in both categories. While co-generation is no longer relevant because it does not support the plan for carbon neutrality, the first is interesting since there is considerable support for other suggestions in the list for renewable energy.

h) Manager/Supervisor help to manage or reduce energy use

This open-ended question asked how each person's manager or supervisor could help them manage or reduce energy use. Twenty two participants responded to this effort to determine what organizational or communication improvements could be considered.

A majority of the comments received relate to aspects of communication, including training, and provide valuable insight since they are likely to be shared by a larger number of people than just those who responded.

i) Training to help with energy efficiency

The purpose of this question was to get each participant's perspective on what training is needed for improved understanding of how energy efficiency is related to their individual job. Of the twenty five people responding to this question, twenty one had suggestions, one person thought current training was sufficient, another said any training was welcome and three indicated they were not sure. Again, it can probably be assumed that a larger number of people have similar needs.

j) Water efficiency questions

The questions in this part of the survey addressed the same issues as described above only with a focus on water. The results were nearly identical to the previous survey and they were higher than the energy section responses for those who answered "no" for job description including water saving duties (63.8% - up from 57.6%) and being part of a water efficiency team (84.7% - up from 77.6%). 54.6% (up from 48.3%) said they did not have the needed training. Figures 6-5 and 6-6 illustrate comparisons with the original survey.

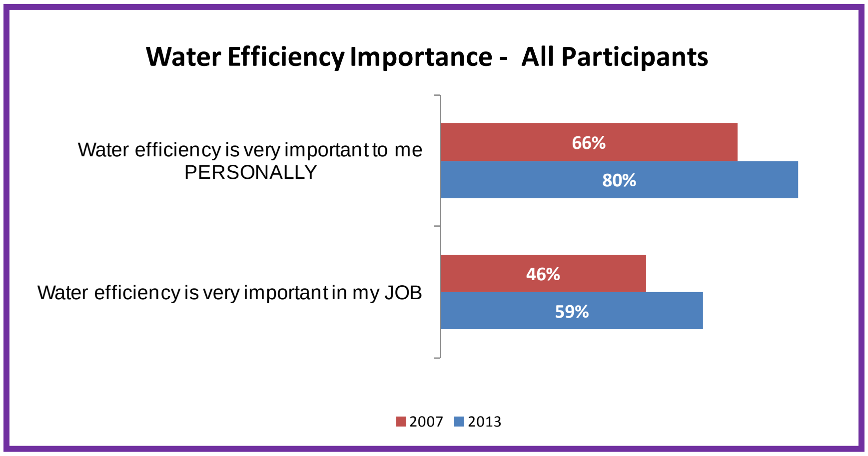


Figure 6-5 Importance of Water Efficiency

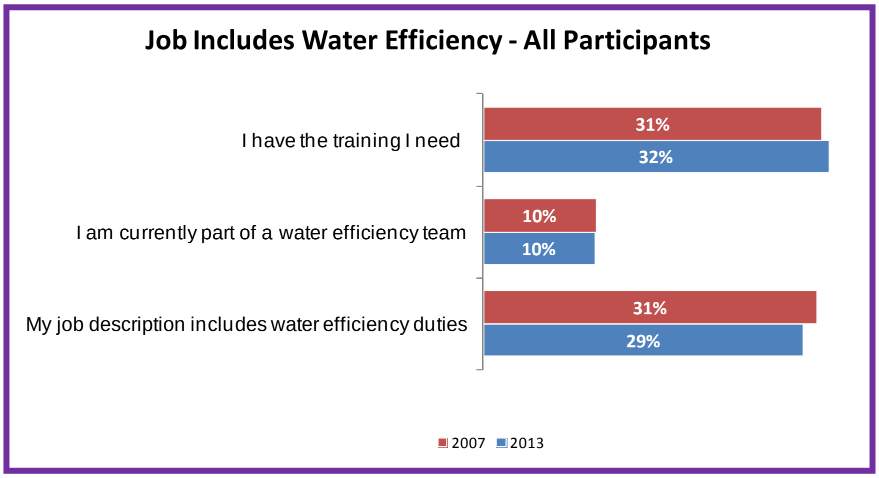


Figure 6-6 Water Efficiency Practices

Figure 6-7 shows the perception relative to water efficiency at Weber State.

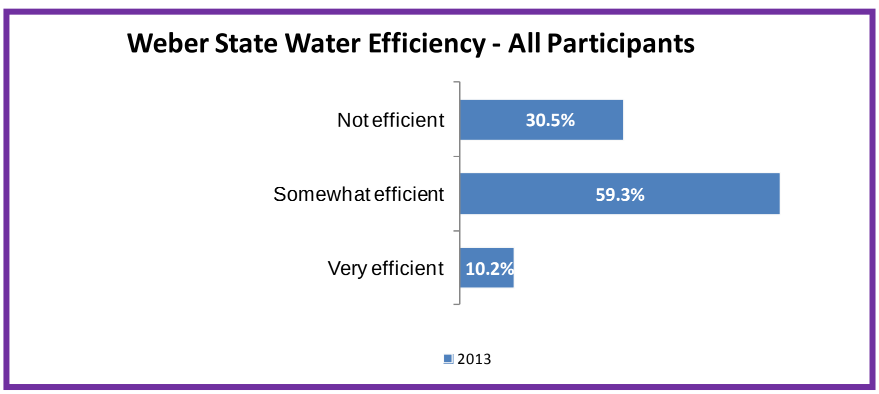


Figure 6-7 Water Efficiency at Weber State

The improvement recommendation sections provided similar participant opinions on which items listed in the survey should be "highly recommended", "somewhat recommended" or "not recommended".

Fifty eight participants responded to both the improvements to reduce water use section and the one for organizational improvements. Of the suggestions listed for reducing water use, "highly recommended" responses were heavily weighted toward the exterior environment and landscape with "*Identify and stop over watering*" the highest at 89.7%. A close second at 87.9% was "*Reduce risk of unintentionally breaking pipes*". For recommended organizational improvements, communication and training were emphasized while policy and requirements directly affecting job performance were again not popular.

For improvements in new construction and renovation of buildings an open ended request for recommendations was employed. Only fifteen people chose to respond to this; however there were several good suggestions for improvements in communications, standards, equipment and landscape water use.

Training needs were similar to those expressed for energy efficiency including how people could do more for water conservation in their jobs, updated savings measures, University standards, and performance of water audits.

k) Manager/Supervisor perception of training needs

Managers and supervisors participating in the survey were given an opportunity to express their recommendations on training for their people through this open ended question. The overall responses supported regular training on energy and water savings, the importance to the University, why Weber State is implementing conservation and sustainability initiatives, up-to-date methods and practices, and so forth.

l) Open-ended questions

The majority of the questions in the survey provided free space for respondents to provide additional information, expanded comments and add recommendations with regard to energy and water efficiency practices on campus, improvements in the specific areas of operation and maintenance practices, the new construction or building remodel planning process, and organizational improvements related to energy and water. Open-ended questions about supervisor help in managing or reducing use, and training allowed participants to provide their own unique response.

This format and the anonymity of the survey resulted in remarkable candor in the responses to these questions. Common threads throughout these remarks were the need for better communication, more training and being kept up to date on Facilities Management initiatives for efficiency and sustainability as well as their own performance.

6.2.1.2 Conclusions

Overall the results of the survey are valuable for improving communications within Facilities Management and developing education programs for staff. Participation came from all organizations within Facilities Management including every Operations Shop. From the responses and comments it seems clear that people now have more awareness of Weber State's initiatives and know more about energy and water efficiency or at least "know what they don't know" and are eager to have more training in this area.

Along with an increase in the percentage of people who place a high level of importance on conservation personally, the importance of energy and water conservation on the job has grown substantially. This demonstrates that communication of the importance of conservation to the University has improved and that people are likely to willingly embrace the direction of the ESIP II. Communication improvements will play a crucial role in this.

The marked increase in responses indicating employees are given enough authority with regard to energy and water conservation frequently or at least occasionally indicate success on the part of management in this area and continued improvement will be critical to ensure employee ownership in the program. Although slightly fewer employees said they frequently made suggestions in their job, the percentage of those saying they did this occasionally increased considerably indicating more engagement in this area.

Of some concern however are the responses for having the materials and equipment needed to do their jobs well which only showed a slight increase over the previous survey. In addition, the perception of supervisor responsiveness to suggestions was essentially unchanged which will have a detrimental effect on the willingness of people to make suggestions if not investigated and addressed.

Nearly all of the people responding to the survey think Weber State is at least somewhat energy efficient with nearly one third saying the University is very efficient in this area. On the water side, the results are not as positive with 30% responding that practices were not efficient indicating a need for improvement in this area.

Suggested areas for improvement in operation and maintenance, organizational improvements, and construction and renovation showed a high degree of agreement with many of the items listed and this was supported by the additional comments in this section. The list contained many ideas that are being incorporated into the ESIP II so the responses indicate there is likely to be an eagerness to implement the plan.

On the management side there still appears to be a need for better communication of expectations, improvement of energy and water efficiency practices in people's daily work, and responsiveness to suggestions. As may be expected, survey respondents are somewhat wary of suggestions that are related directly to their work requirements and performance evaluations.

People are also eager to receive as much training as possible. The suggestions for training could be grouped into one or more of the following general categories listed in no particular order.

- Conservation and personal impacts.
- Building performance, schedules, problem areas on campus.

- Updates on advances in technologies, equipment, strategies.
- WSU Standards for materials, equipment, and construction practices.
- Technical including commissioning, proper maintenance practices, solar and geothermal.

Based upon the results of the survey, a substantial number of Facilities Management people are engaged, willing to offer suggestions, and ready to help the University move forward to accomplish the goals of the ESIP II. There are some opportunities for improvements with regard to communication, education and outreach for these people that are described in the sections that follow.

These recommendations will need to be developed further to become an integral part of implementing the ESIP II to continue developing a culture of efficiency for all employees and assure long-term support for the plan.

6.2.2 University-wide Assessment

The next effort should be to survey the University community as a whole with customized survey questions for major groups such as administration, faculty and students. The content and direction of this survey would probably be different from the one for Facilities Management and that group may be included in the second survey as well.

In addition to attempting to gauge the perception and attitudes toward energy and water efficiency in the overall University community, the survey should include open ended questions and the ability for respondents to provide confidential anonymous answers. It should be focused specifically on uncovering what impact efficiency upgrades, outreach and education activities of Facilities Management have had on each of the survey target groups. This will help provide a better understanding of existing conditions and satisfaction with improvements under the first ESIP and the University's energy and sustainability programs.

6.3 COMMUNICATION - ENSURING SUCCESSFUL PLAN IMPLEMENTATION

The University has accomplished many of the goals and objectives of the original ESIP for energy efficiency and sustainability including better communication within Facilities Management, within entire University community, and with the broader community beyond campus. The ESIP II presents a much longer view and considerable changes in the facilities infrastructure at Weber State over that time. The success of this plan will ultimately depend on how well it is understood, supported and promoted by all of the different organizations at the University.

To build this understanding and support to ensure the goals of the ESIP II, and ultimately the University's Carbon Commitment, are achieved, a high level of communication will be needed with Facilities Management personnel, the University community on campus and to some extent the community outside of Weber State.

The approaches to each will be different due to their nature and each presents its own challenges for communication of goals, plans and successes. For example, Facilities Management people are part of a well-defined organization with essentially a full-time presence on campus and intimate knowledge of its infrastructure. On the other hand, Weber State is a commuter campus for faculty and students who are in buildings for classes, preparation and some study but are away the rest of the time.

This section provides a summary of current communication activities and efforts with regard to Facilities Management, the campus community and the broader community outside of the University and includes recommendations for communication improvements specific to each that should be investigated and developed further as the plan progresses.

6.3.1 Facilities Management

6.3.1.1 Current Activities and Efforts

The Energy and Sustainability Office has initiated a number of communication activities specific to the people within Facilities Management including:

a) Incorporating energy and sustainability updates in the Facilities Management newsletter.

b) Creating and maintaining a sustainability website (www.weber.edu/sustainability).

c) Providing an opportunity for anyone in Facilities Management to submit green ideas to the Energy and Sustainability Office via the sustainability website.

d) Establishing Facebook and Twitter accounts.

e) Using the Lucid Dashboard to make real-time energy and water consumption data available via the web at www.buildingdashboard.net/weber.

f) Participating in new employee orientation to talk about the University's programs and offer assistance (Energy and Sustainability Manager or his designee).

g) Implementing the Green Ideas Spot Award Program within Facilities Management to recognize employees that identify ways the University can become more energy efficient and sustainable. Ideas are submitted via an application and are reviewed by the Energy Strategic Action Team. Good ideas are rewarded with gift cards.

6.3.1.2 Improvement Opportunities

The goal of the communication effort within Facilities Management is to foster understanding and acceptance of the ESIP II by ensuring expectations are understood, results are widely shared, and everyone understands the importance of their role and the impacts they can have on the success of the plan.

Based upon the results of the survey, Facilities Management has made significant improvements in communication of these vital elements and there is a high level of importance to people personally and in their jobs with regard to better use of energy and water. These results also supply important insight and provide direction for developing recommendations for areas where improvements can be made.

Survey responses and comments also confirm that communication improvements within Facilities Management as they relate to the ESIP II should include:

- Explaining the goals objectives and strategies for plan elements.

- Ensuring the expectations within individual job requirements with regard to the plan, including employees' decision-making empowerment, are understood.

- Responding to suggestions for improvement.

- Providing up to date results of initiatives and measures implemented.

Some recommendations are provided in the paragraphs that follow and each of the above should be examined in detail to determine how best to improve communication in these areas. It is important to remember that how new requirements, procedures, policies, and so forth related to the plan are presented is critical. It must be done with great care so that the people involved have a sense of ownership and passion to do their part to achieve the goals of the plan. The overriding consideration for communication should be to emphasize the "*why*" behind anything that can be seen as a change.

a) Expectations for new employees

One of the first things that should be described for new hires and even short-term employees is the ESIP II, its goals and their role in the plan's success. The orientation package should contain printed materials, such as the brochure on sustainability created by Geography students and one produced by the Energy and Sustainability Office. These should be used to facilitate discussion and for future reference but should not be solely relied on to convey the message about the importance of the University's plan and climate goals.

The goals of the University, ESIP II plans and progress, and expectations for new employees, must be discussed and emphasized as part of orientation.

b) Expectations for current employees

One of the most effective ways of developing a culture of sustainability, and assure the long-term success of the ESIP II, is to make it an integral part of each employee's job expectations and performance review.

The original ESIP recommended additions to job description and performance review formats to include energy and water efficiency. Facilities Management Human Resources should work with managers and supervisors to evaluate where enhancements are needed to further the ESIP II and then assure updated requirements reach all affected employees.

c) Goals, results, updates and other information

Facilities Management has a structure in place for regular meetings at various levels including Senior Staff meetings, Project Management Meetings, Shop Meetings, and so forth. This meeting structure facilitates communication at all levels and was discussed as a means to improve communications in the original ESIP as well.

Scheduling a brief presentation during any of these meetings on a particular topic related to the ESIP II and sustainability with regard to design, construction, operations, maintenance, and so forth is highly recommended. Finally, these regular meetings are an opportunity for management to promote the good work being done by the University to be sure everyone is aware of it.

Inclusion of energy and sustainability topics in these meetings has been adopted to some extent. These topics should be added to the existing meeting structure rather than take up time in new meetings. The Energy and Sustainability Office will help with this. Starting from the Senior Staff meetings, pertinent information should be distributed through the individual shops to their respective employees.

Each meeting type presents an opportunity for including follow-up on suggestions, discussing results for actions taken as part of the plan, and providing updates on other issues. Their importance will be emphasized as the ESIP II moves forward.

1. **Project Management Meetings**
   Project Management Meetings give Shop Superintendents the opportunity to get updates on new construction and building renovation planned or in progress on campus. It is also an appropriate forum for these managers to provide input to the project design and management team with regard to energy and water efficiency as well as any service or maintenance issues that may be of concern.

2. **Superintendent and Manager Meetings**
   Meetings that Superintendents and Managers hold regularly with their employees present an ideal opportunity to pass on information from Senior Staff meetings as well as to encourage discussion on ESIP II issues specific to their shop. They are also an excellent venue to set goals, monitor progress and encourage energy champions within each shop.

   In addition, one or more team members could discuss topics such as why quality assurance in employees' work is critical to the ESIP II, benchmarks for energy reduction goals and progress toward achievement, or simply have a question and answer session.

3. **Shop Meetings**
   An energy or water saving piece could also be readily added to Shop Meetings. For example, at each meeting a different employee could discuss an energy or water efficiency item. The Electrical Shop has been successful this approach with safety topics as part of its regular meetings.

4. **Monthly performance reviews**
   These meetings conducted by the Associate Vice President for Facilities and Campus Planning provide an opportunity to discuss progress on expectations related to sustainability.

5. **Weekly Group Staff Meetings**
   Potential impacts on the success of the ESIP II that may arise and corrective actions needed should be part of the management issues discussed during these staff meetings within each Facilities Management Group.

6. **Weekly Scheduling Meetings**
   Managers, Superintendents and Shop Leads participate in these regular meeting creating an excellent opportunity to identify and address issues related to sustainability and the ESIP II that may develop at these levels.

d) Green Shop Certification Program

The Energy and Sustainability Office is currently working to create a Green Shop Certification Program. Similar to the Green Department Program described in section 6.3.2.2, this program is specific to how Facilities Management operates and the significant impact it has on Scope 1 and 2 emissions. It is based on educating Facilities Management personnel and incentivizing desired behaviors.

Two green team committees have been created with a representative from each shop. The first committee is responsible for developing the program energy/sustainability goals and the second committee is responsible for conducting shop audits and determining the rewards/incentives for achieving the goals agreed upon.

Once the program goals are set, each shop will have the opportunity to pursue and achieve their goals. Points will be awarded for successfully achieving designated goals and once a certain number of points are acquired the shop will be certified as bronze, silver, gold, and ultimately green.

e) Facilities Management Website

The Facilities Management website provides opportunities to keep employees abreast of what is happening and engaged in the ESIP II. Enhancement of the website with more timely and attention getting news flashes, updates, tips, planned efforts and accomplishments should be investigated. In addition, a link to the sustainability website (www.weber.edu/sustainability) should be prominently displayed on the Facilities Management website.

6.3.2 Campus Community

Generally speaking, unless there is a problem with function or comfort, the mechanical and electrical infrastructure is invisible to most occupants of buildings, including those on a university campus. With the possible exception of individuals in some engineering or similar technical disciplines, the majority of people using a building will probably not know the differences between various heating and cooling system types or their relative impacts on energy consumption and carbon footprint.

The goal of the communication effort with regard to ESIP II is to heighten awareness of objectives and progress in order to promote the plan and build support for it within the larger University community. One of the challenges in doing this is the fact that Weber State is largely “commuter campus” with faculty and students at the University for activities related to classes and away the rest of the time. The key to success is to reach students and faculty *where* they are on campus *when* they are there.

The Energy and Sustainability Office has found that one of the most effective ways to reach this audience is to personally get in front of students with presentations and giving them problems to solve. The Energy and Sustainability Office has also been working closely with faculty to promote the overall carbon neutrality effort. All of this has had the effect of getting students and faculty engaged and talking about energy and sustainability projects and this practice should be expanded.

6.3.2.1 Current Activities and Efforts

Several ideas were discussed in the original ESIP for communication and outreach activities to engage the campus as a whole. The Energy and Sustainability Office has initiated a number of these and more including:

a) Training and managing the student Environmental Ambassadors Program for energy and sustainability awareness and outreach efforts. Students in this program, under the auspices of the Energy and Sustainability Office, run several events throughout the year and a booth at campus-wide events such as Block Party, Major Fest, and so on to communicate plan goals and progress.

b) Publishing at least one, and often several, sustainability-related articles in the campus Signpost newspaper each semester. The Signpost editor has also assigned a reporter to the "sustainability beat".

c) Developing a "Green Department" program to encourage faculty and student energy efficiency and sustainability champions.

d) Competing in the Campus Conservation Nationals, a competition each spring to encourage reduced energy consumption. The Lucid Dashboard system is used to facilitate this competition.

e) Publishing the Green Link Newsletter directed toward energy and sustainability once or twice per semester and available on line through the Weber website (www.weber.edu/environment/Newsletter.htm).

f) Attending every staff and faculty new employee orientation to discuss energy/sustainability goals and progress.

g) Participating in faculty retreats, particularly the faculty sustainability retreat which is a teaching and learning forum.

h) Assisting faculty with incorporating sustainability into curricula.

i) Having two representatives on the Faculty Senate Environmental Issues Committee.

j) Working with the student environmental clubs.

k) Representing the Energy & Sustainability Office at all student government meetings to advance energy and sustainability goals and communicate progress.

l) Working with construction management students, engineering students, etc. and involve them in energy and sustainability projects, especially research on renewable alternatives.

m) Providing education for decision makers on the costs and savings of energy efficiency and sustainability.

n) Providing an opportunity for students and faculty to submit green ideas to the Energy and Sustainability Office via the sustainability website.

o) Using the Lucid Dashboard to make real-time energy and water consumption data available via the web at www.buildingdashboard.net/weber.

6.3.2.2 Improvement Opportunities

a) Expanding the Green Department Certification Program

In the fall of 2014, the Energy and Sustainability Office launched the Green Department Certification Program. Beginning with pilot projects in the Geography and English Departments and Housing this program provides recognition and rewards for helping the University achieve its energy and sustainability goals.

The program is based upon establishing a Green Team organized by and within a department or office to support sustainability in that department. The goal is for these teams to form a nucleus of people throughout the campus community that shares a mutual objective to help the University achieve its sustainability and carbon neutrality goals.

The program awards points for various sustainability criteria in areas such as recycling, efficient use of energy, waste management transportation and purchasing. Bonus and innovation points are also available. Points earn different levels of certification and departments or offices can work toward higher degrees of achievement.

The Energy and Sustainability Office provides details and resources on the program through the sustainability website (www.weber.edu/sustainability/GreenDept.html) and works directly with Green Teams to achieve sustainability points with the overall goal of certification as a Green Department or Office.

This program will be instrumental in the success of the ESIP II and should be expanded to as many departments and offices as possible.

b) Enhancing faculty and staff engagement

There are a number of other possible avenues to explore to improve the engagement of faculty and staff in the University's sustainability efforts. These include:

1. Creating a faculty and staff version of the Environmental Ambassadors to ensure that communication is happening regularly at the faculty and staff levels.

2. Institutionalizing the recent efforts of the Energy and Sustainability Office for attending Department and Dean's Council meetings to provide a report on Weber State's progress and extend that to include President's Council and the general campus community.

3. Offering an annual State of Sustainability address to President's Council, the Faculty Senate, Student Government and a general public session.

c) Connecting with students

To address the challenges of communicating with students when the majority are commuters, efforts need to be directed toward reaching them when they are on campus. These should include:

1. Incorporating Weber State's energy and sustainability goals prominently into new student orientation.

2. Expanding the use of the energy dashboards to promote energy awareness.

3. Creating a "greening" blog for student photos, videos and stories related to sustainability.

d) Publicizing accomplishments

Building and maintaining support throughout the campus community goes beyond ensuring the University's sustainability goals are communicated. It is also important to promote Weber State's own good work as it is completed.

While people can see some of the improvements such as lighting, rooftop solar installations and so forth first hand, it should not be assumed that this is sufficient for a broad audience.

As the ESIP II moves forward some approaches for publicizing success will include:

1. Highlighting the best of projects, their contribution to achieving the University's sustainability goals and the people responsible for them. For example, the LED lighting upgrade at the Dee Events Center designed and implemented by the Energy and Sustainability Office generated a lot of interest in the press and at other institutions, providing great exposure.

2. Improving the existing website to add timely publication of planned efforts and accomplishments.

3. Investigating how to customize the energy dashboards to include project highlights and other information campus wide.

4. Creating a robust communication strategy that reaches needed audiences through social media Facebook, Twitter, LinkedIn, and so on).

5. Publishing the annual report on the Climate Action Plan on a central clearinghouse for wider distribution and to be more available to the local community. Outline plans and progress, publicize successes and demonstrate leadership.

6.3.3 Broader Community

6.3.3.1 DFCM, Architects, Engineers, and Contractors

The University has published *Design and Construction Standards for Architects, Engineers and Contractors* to familiarize Design Professionals and contractors with the standards of Weber State University for building construction and renovation. The manual provides information on University policies and procedures that affect the design and construction of a project. General design considerations and a Specification Guide are also included.

In addition, Facilities Management has made an extensive effort to review and update standards for materials and equipment to identify what is acceptable for use in University buildings to support efficiency and sustainability goals.

As part of this, Weber State has performed considerable research into such things as lighting color, mechanical systems, and revisions to commonplace designs that are encouraging the engineering community to move beyond traditional practices and embrace the Mechanical Infrastructure Master Plan described in Part 4.

This has created more effective communication with design professionals and acceptance is growing. At the State level, the positive effect has been similar to what the university saw previously with its energy performance contract program and the subsequent self-performed projects.

6.3.3.2 Other Communication Efforts

The Energy and Sustainability Office has been involved in a number of initiatives to improve communication such as:

a) Creating and managing the highly successful Intermountain Sustainability Summit.

b) Generating press releases about three times per year.

c) Meeting with the Ogden City Mayor a number of times to talk about energy and sustainability goals and issues.

6.3.3.3 Improvement Opportunities

The ESIP II presents some opportunities to improve communication with the community beyond campus on a global scale. Some areas that will directly impact communication for the ESIP II include:

a) Making campus standards readily accessible, easily understood and straightforward to follow.

b) Setting up the new Sustainability Practices and Research Center (SPARC) discuss in section 6.4.2.2 that follows.

6.4 EDUCATION AND OUTREACH - SHARING PROGRESS AND BUILDING SUPPORT

Facilities Management has been engaged in education and outreach with regard to energy and sustainability internally and with the campus and broader communities with good success. In his role as Energy and Sustainability Manager Jacob Cain participates in various activities and fairs. Associate Vice President Kevin Hansen has made a presentation to the Ogden City Council and there have been several press releases describing Weber State's efforts.

Ongoing outreach strategies should involve promotion of the campus' carbon neutrality efforts and showcase the successful energy-efficiency, renewable energy and other projects in progress, completed and proposed relative to the ESIP II. Easily accessible media such as websites, newsletters, and campus newspaper should be utilized along with public presentations and participation in larger events.

Similarly, the measurement and verification efforts in the Energy and Sustainability Office provide quantitative results that demonstrate current achievements of the carbon neutral efforts. Communicating these successes to constituents, stakeholders, and the general public will promote a supportive environment so that these efforts can continue in a robust and comprehensive manner toward achieving the University's ultimate carbon-neutrality goal.

In this section current activities and efforts with regard to Facilities Management, the campus community and the broader community beyond the University are summarized and some recommendations for improvements specific to each that are in progress or should be developed are provided.

6.4.1 Facilities Management

The ESIP II has aggressive goals for reduction of the carbon imprint from the University's buildings with infrastructure requirements that represent a significant departure from typical design practices to date. These are also intended to evolve with improvements in available technologies over time and will necessitate an on-going education effort for everyone involved.

A robust education program within Facilities Management, particularly for "front-line" employees is essential to the success of the plan and long-term sustainability of the savings generated. Education efforts should include the training needs discussed in Part 5 especially on the new equipment types required by the Mechanical Infrastructure Master Plan for people in the shops who will be responsible for the new equipment.

Education for sustainability awareness as it relates to the ESIP II must also be incorporated and will encompass all members of the Facilities Management organization because they are directly involved in sustainability on a daily basis throughout the campus. These efforts should be specific to the shops involved and as previously mentioned, focus on the "why" so that it can be understood from person to person and shop to shop. The overall objective of sustainability awareness programs will be to foster the belief in employees that they are stewards for the University.

6.4.1.1 Current Activities and Efforts

The Energy and Sustainability Office has been developing energy and sustainability awareness and outreach programs for the people in Facilities Management over the last several years. These combined with the establishment of energy teams and increased communication through the methods described previously have contributed to an increased awareness of energy efficiency and sustainability as illustrated by the results of the employee survey.

In addition to serving as a vehicle to create change and communicate progress, the Green Shop Certification Program described in section 6.3.1.2 provides a means to educate Facilities Management staff on how to operate the University's infrastructure in a more energy-efficient and sustainable manner.

Facilities Management people are also encouraged to participate in the Intermountain Sustainability Summit.

6.4.1.2 Improvement Opportunities

The Energy and Sustainability Office is developing classes that can be offered through Weber State's Training Tracker for Facilities Management employees. In addition to sustainability awareness, available training should include familiarization on the new equipment and systems in the Mechanical Infrastructure Master Plan, how those systems contribute to the ESIP II, and what impacts actions by people in the shops and buildings can have on operation and performance.

Sustainability education should be aimed at changing the behavior of people in order to achieve the goals of the ESIP II and support the University's climate commitment. Programs must consider what motivates people to change their behavior so that when people are trained on the need to use resources efficiently, how sustainability is important to the University, and how they can help, they will willingly adopt the desired sustainability practices.

These practices must also be easy to get started on, convenient to incorporate into daily activities, relevant to people's job functions, and desirable from a social perspective. Some considerations for developing a successful awareness program were discussed in Section 8 of the original ESIP published in January of 2008.

6.4.2 Campus Community

The Energy and Sustainability Office and the Environment Issues Committee of the Faculty Senate have developed a mutually beneficial partnership over the last several years and this has provided an opportunity for communication of plans progress and successes to date. To effectively reach the students, faculty and staff in a challenging "commuter campus" environment this very productive relationship must continue to grow as the ESIP II moves forward.

6.4.2.1 Current Activities and Efforts

Both the Energy and Sustainability Office and the Environment Issues Committee have been involved in a number of initiatives including:

a) One of the most significant results of this partnership has been organizing and hosting the Intermountain Sustainability Summit. This annual event held each spring has been growing over the last five years and has brought statewide and national recognition of Weber State's leadership in sustainability.

b) The Energy and Sustainability Office conducts multiple class visits and campus tours throughout the academic year to a variety of classes.

c) The Energy and Sustainability Office has partnered with a number of professors and classes on campus on projects that benefit Facilities Management and provide students with a hands-on learning experience using the campus as a living learning lab.

d) The Student Environmental Ambassadors Program managed by the Energy and Sustainability Office is dedicated to outreach and provides Weber State students with a number of educational resources and opportunities.

e) The Environmental Issues Committee hosts a number of speakers and has co-sponsored Weber State's Engaged Learning Series focused on the topics of air, water, and food over the last several years.

f) The Environmental Issues Committee hosts Teaching and Learning Forum sessions and an annual faculty retreat to help faculty incorporate energy and sustainability issues into the curriculum. The Energy and Sustainability Office has assisted in these activities.

g) The Energy and Sustainability Office is now working to develop classes that can be offered to University faculty and staff through Weber State's Training Tracker.

6.4.2.2 Improvement Opportunities

Weber State's sustainability program is based on the Association for Advancement of Sustainability in Higher Education (AASHE) Sustainability Tracking Assessment and Rating System (STARS). This system incorporates four major elements: Academics, Engagement, Operations, and Planning and Administration.

The focus of the ESIP II is on the first element and part of the second with strategic planning for operations developed by Facilities Management. Engagement on the academic side will be critical to the success of the ESIP II and a bridge is needed between the strategic planning done for academics and that of operations.

To accomplish this, the University should move forward with the proposal to establish a "Sustainability Practices and Research Center (SPARC)" composed of representatives from Academics, Administration and Facilities Management. The new SPARC will work closely with the Energy and Sustainability Office and the Environment Issues Committee to facilitate further curriculum development, research and community engagement.

From the ESIP II perspective, members from both Academics and Facilities Management will be providing outreach as part of the mission for this center.

This will allow close coordination of outreach efforts, help create buy-in for the plan, and measure its success.

6.4.3 Broader Community

6.4.3.1 Current Activities and Efforts

The Intermountain Sustainability Summit is the premier event for Weber State's current outreach efforts beyond the University. This conference has become well-known and enjoys excellent attendance each year. Now in its fifth year, the conference provides an opportunity for sustainability professionals, businesses, educators, students and members of the community to meet, interact and explore new strategies for sustainability. This responsibility has now been transferred to Academics with assistance still to be provided by the Energy and Sustainability Office.

Additional efforts have included participation in various City activities meeting with the Ogden City Mayor, making presentations to the Ogden City Council and providing press releases to publicize Weber State's plans and successes.

6.4.3.2 Improvement Opportunities

Ongoing outreach with regard to the ESIP II should include strategies to promote successful energy-efficiency, renewable energy and other sustainability projects and their contribution to University's carbon neutrality goals. Some recommendations for further development include:

a) The existing website could be better publicized and improved to add timely dissemination of planned efforts and accomplishments. This would also provide a readily accessible location for publishing the annual reports for the Climate Action Plan so they are more available to the local community.

b) The Continuing Education Department and the Sustainability Practices and Research Center could create energy and sustainability related classes and programs reaching the general public.

c) Other outreach activities of the Sustainability Practices and Research Center should include:

1. Continuing to organize and host the Intermountain Sustainability Summit.

2. Facilitating most of the communication with the broader community and general public.

3. Sponsoring guest speakers on sustainability-related topics that focus on issues important to the larger community.

4. Building other community partnerships and offer the University's expertise and experience to help other organizations with sustainability initiatives.

PART 7
FUNDING STRUCTURE
TO SUPPORT THE PLAN

7.1 OVERVIEW

An undertaking the scope of the Mechanical Infrastructure Master Plan and the other elements described in the ESIP II to support the University's overarching carbon neutrality goal will need to have adequate funding available to assure success. Fortunately there are a number of funding mechanisms already in place that have been utilized to implement improvements identified in the original ESIP and other initiatives.

The return on the University's investment of funding for energy efficiency and sustainability has been well beyond the expectations of the original ESIP and subsequent investment grade energy audit. This return is expected to grow exponentially going forward with the potential of amounting to millions of dollars over the timeframe of ESIP II. The positive cash flow generated will primarily be used to finance plan elements, however it is important to note that it will continue to be generated after debts has been repaid. This means that there will be a point where additional funds could be available for the Administration to redirect to other areas.

The current funding sources are described in this part of ESIP II to provide a basis for discussion of the funding structure needed to support the plan over the long term and accomplish the University's objectives. The manner in which these funding sources are currently used for energy and sustainability projects and the staff needed to implement them through the Energy and Sustainability Office is also discussed for reference.

Some of the current opportunities are dependent upon variable sources of funding such as rebates, grants and student fees and are at risk should those sources be reduced or cease to be available and alternative sources must also be considered to ensure long-term viability.

Fundamental to the success of energy efficiency and carbon neutrality efforts of the ESIP II is continuing the current funding sources used to support these efforts. This will necessarily include funding for implementing the Mechanical Infrastructure Master Plan, energy and water efficiency projects, ongoing recommissioning, renewable energy installations, and the organizational changes described in Part 5.

The principle behind the funding structure described in this part of the ESIP II is that the efficiency, carbon neutrality and even personnel elements continue to pay for themselves as much as possible through energy and water cost savings, allocation of existing funding sources and revenue generation.

The majority of funding for debt service and additional projects will continue to come from savings in the amounts allocated for the University's utility budgets. To assure savings are available for repayment on the line of credit in order to continue this funding stream it is imperative that the University's utility budgets be maintained at present levels with incremental increases for expansion of overall campus building square footage, as well as in proportion to utility rate increases with respect to the established 2006-2009 baseline.

Proper maintenance of existing funding sources, with increases in funding amounts where appropriate, and allocation of funds from other existing sources as described in the discussion that follows are crucial to guarantee that Weber State's leadership in carbon neutrality efforts continues. This will allow the efforts to achieve the University's goals to proceed without interruption or loss of momentum, resulting in attainment of carbon neutrality in or before the year 2050.

7.2 FACILITIES MANAGEMENT FUNDING SOURCES

7.2.1 Appropriations from State Legislature

The principal source of all funding for Weber State Facilities Management is through appropriation by the Utah State Legislature. The types of funding provided generally fall into one of the categories described in the following paragraphs. It is important to note that allowable uses of the funding in each of these categories are specific as defined in the individual appropriation and Utah State Statute.

7.2.1.1 Education and General Fund (E&G)

This category of funding from legislative appropriation provides a significant portion of the operating capital for the entire University each year. Allocations of Education and General Fund amounts are requested by the various University Vice Presidents and academic department heads and approved by the President's Council.

Facilities Management receives about $3 million per year (exclusive of salaries) from the University's E&G Fund through the Weber State Vice President for Administrative Services. Use of these funds by Facilities Management is restricted to the operations, maintenance, and repairs of the existing infrastructure, including part-time hourly employee costs, to maintain facilities in the condition to which they were built and this funding source cannot be used outside of this confine.

The chart in Figure 7-1 illustrates the approximate distribution of E&G funds each year. These are divided into four major classes as follows:

a) ***Preventive Maintenance:*** Regularly scheduled activities and tasks necessary to maintain existing infrastructure throughout its useful life including structural elements, mechanical, electrical, and electronics systems and so forth.

b) ***Planned Maintenance:*** Scheduled and budgeted equipment replacement.

c) ***Corrective Maintenance:*** The emergency repairs of breakdowns typical in any large infrastructure.

d) ***Operations:*** All of the activities and services not listed above that are needed to operate the physical plant to create and maintain the learning environment including comfort, landscaping, buildings, roads, infrastructure, and a clean and inviting setting.

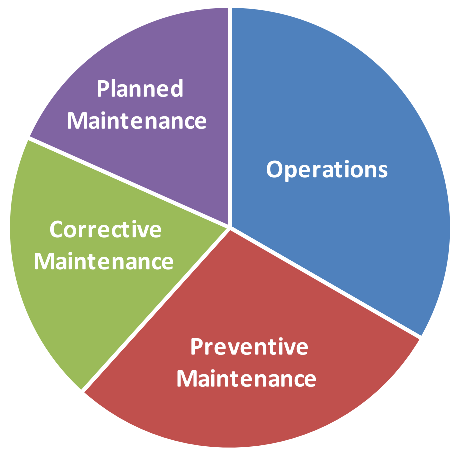


Figure 7-1 Typical FM Annual E&G Funds Distribution

7.2.1.2 Capital Development Program (CD)

Appropriations from the State Legislature under the Capital Development (CD) Program are directed specifically and solely to large facility projects including building construction and major renovations. These funds can only be used for the project or purpose to which they are specified and are primarily administered by the State Division of Facilities Construction and Management (DFCM) with a university project manager assigned from the Campus Planning and Construction group within Facilities Management.

CD funding is used for State-funded projects valued at over $2.5 million per year and there is approximately $200 million of work currently in progress. Projects under the Capital Development Program may also include infusion of funds from donors for specific projects but these would likely be used for more "visible" elements of the building.

7.2.1.3 Capital improvement Program (CI)

Each year the University receives Capital improvement Program (CI) funding from legislative appropriation for major facilities maintenance and repair projects in existing buildings. These funds are allocated by the State Building Board from the appropriation provided by the Legislature. CI projects are initiated by the Facilities Management Operations Group. Projects are managed by DFCM with a university project manager assigned by the Campus Planning and Construction Group.

Available CI funding has been up to about $4.5 million per year and sometimes less depending upon economic conditions in Utah. There is currently about $8-10 million of work currently in progress which has included equipment replacement, building controls and automation upgrades, and some of the other energy efficiency measures described in Part 2 of the ESIP II.

7.2.2 University Internal Funding

7.2.2.1 Funding for Facilities Management Provided by University Administration

Weber State University Administration and the various Departments provide a significant amount of funding for renovations, upgrades and new construction of buildings. This can be highly variable year to year because it is based on enrollment, grants, donations and so forth.

These funds are directed toward specific projects and those projects are managed similarly to CI projects and with the same level of care, attention and expertise. Individual project size is less than $250,000 and as such they can be fully managed by the University.

7.2.2.2 Energy Project Revolving Line of Credit

Following the original ESIP and the delivery of an Investment Grade Audit performed by an energy services contractor, the University determined its interests would be best served through self-performing the recommended energy and water efficiency improvements. Rather than borrow money from outside sources for these projects, the Vice President for Administrative Services presented a plan for the University to fund improvements internally that was approved by the President and Board of Trustees.

This resulted in the current $5 million revolving line of credit established through the office of the Vice President for Administrative Services from the University’s cash management investment pool. This line of credit is dedicated to implementing energy efficiency, water conservation and other sustainability projects related to the University's utility consumption.

The annual savings generated by projects are validated through a defined measurement and verification effort and used for repayment on the line of credit, with interest, each year. In this way, funds are replenished so they are available for projects to be implemented in the following year.

The vehicle for this repayment is based upon an agreement with the Vice President for Administrative Services that allows Facilities Management to retain utility cost savings resulting from energy projects implemented. As initially conceived, this agreement would return 75% of these cost savings to Facilities Management for allocation to future projects.

In practice, Facilities Management has actually been allowed to use 100% of those savings, which has benefitted the University by increasing the amount of improvements that can be achieved. It is vital to the success of the ESIP II that this practice is allowed to continue.

Administration, allocation of funds received, measurement and verification of savings and reporting is the responsibility of the Energy and Sustainability Manager.

7.2.2.3 Vice Presidents' Carbon Offset Account

As part of Weber State's overall commitment to carbon neutrality an effort is being made to address emissions associated with travel by upper level management on University business. A common practice for this is to purchase carbon "offsets", usually from a third party provider. Rather than pay for carbon offsets to a third party, a vehicle was established by University Administration to pay carbon offsets to an internal account that makes those funds available and dedicated to help pay for carbon offset initiatives such as renewable energy and energy efficiency at Weber State.

The funds paid into the Carbon Offset Account are based upon estimated air travel for the year and the avoided cost of payments to a third party. Fiscal Year 2013 was the first year for this account and approximately $60,000 was made available that year. This amount increased to about $80,000 in fiscal year 2014, and is expected to level off at $100,000 for each year going forward. Management of funds received and reporting is the responsibility of the Energy and Sustainability Manager.

7.2.2.4 Student Fees

A flat fee of $16,000 per year is provided to Facilities Management for the Energy and Sustainability Office through the Student Fee Recommendation Committee. Management of funds received and reporting of the students' activities each year is the responsibility of the Energy and Sustainability Manager. Stipulations on use of these funds include requirements to send one student to the AASHE conference per year and have one student sustainability technician on staff.

7.2.2.5 Student Affairs

Funds to help offset the costs of using students for outreach, energy related issues, the recycling program, and so on are provided by Student Affairs to Facilities Management for the Energy and Sustainability Office. This amount is currently $5,000 for each student working with the Energy and Sustainability Office and the manager is responsible for administration of funds received and reporting of the students' activities.

7.2.2.6 University Department-Funded Services

As discussed in preceding sections, the appropriated funds received by Facilities Management are essentially restricted to operation, maintenance and repair of state-funded University facilities as they were originally built, particular major maintenance and repair projects in existing buildings, and specific projects for new building construction and major renovations.

The qualifications and abilities of Facilities Management people for those activities are also available to University Departments for performing Department-specific tasks and upgrades at the request of Deans, Department Chairs, and so forth. These typically include installation, maintenance and repair of Department-owned equipment.

In addition, Facilities Management provides services to auxiliary buildings such as the Union Building, Bookstore, Food Services and Concessions, Residence Halls, Student Health Services and the Stadium Sky Suites.

Further, Facilities Management provides services for all special events, and the President's residence, and handles all requests for building remodeling or alteration for Departments, and maintenance, repair or replacement of equipment and building components not original to the building's construction. All of these services are billed to the customer Departments and auxiliaries.

7.2.3 Rebates and Grants

Rebate programs offered by Rocky Mountain Power, and to an extent by Questar, have been an important source of funding for the Energy and Sustainability Office. Lighting retrofits and other qualifying conservation measures have generated dozens of rebates in varying amounts for a total of over $912,000 in the course of the past five years.

The American Recovery and Reinvestment Act of 2009 (ARRA) provided an opportunity to accomplish several major projects funded by grants from the US Department of Energy through the Utah State Energy Office. These projects and the grant funds applied to each of them included:

- $750,000 for the new high efficiency chillers used in the replacement of the old inefficient chiller plant at the Dee Events Center.
- $250,000 toward the solar photovoltaic system installed at the Shepherd Union.
- $250,000 used to install a solar thermal system for the pool at the Swenson Gym.
- $125,000 for lighting upgrades at the Ice Sheet and Swenson volleyball courts.
- $75,000 for the initial solar photovoltaic system at the Davis 02 Building.

Two additional grants of $75,000 each from the Blue Sky Program have been used for increasing the solar photovoltaic installation at the Davis 02 Building. Administration and allocation of rebate and grant funds received and required reporting is the responsibility of the Energy and Sustainability Manager.

7.3 CURRENT ENERGY AND SUSTAINABILITY OFFICE FUNDING STRUCTURE

The current composition of the Energy and Sustainability Office (ESO) consists of the Energy and Sustainability Manager, full-time energy project tradespeople, a full-time Sustainability Coordinator, several other part-time employees and some student interns. The manager is funded from the Facilities Management Education and General Fund allocation, and the other office staff positions, along with the energy and sustainability projects implemented by the ESO, are funded from various sources as described in the paragraphs that follow. In general the concept is to implement energy and sustainability projects to capture cost savings and rebates that will then fund further projects and ESO staff so the overall effect is an operation that is "self-funding".

7.3.1 Energy and Sustainability Projects

The primary source of funding for the projects completed and in progress under the Energy and Sustainability Office is the revolving line of credit described in the preceding section which is dedicated to energy efficiency efforts across the Weber State campuses. These funds are used to pay for the equipment and materials needed for individual projects, the personnel costs for the electrical and plumbing tradespeople currently employed by the ESO for project implementation, and the cost of any outside contractors used. In some cases, funds from the ARRA, rebates and grants have been used to supplement the funding for individual projects.

.

This revolving line of credit has also been used in conjunction with Capital Improvement Program (CI) funds to enhance the positive impact of these projects on energy use and/or sustainability. While this arrangement helps the University toward the overall goal of carbon neutrality it is complicated to quantify because in most cases the CI projects principally addressed maintenance or repair issues with the addition of some energy efficiency improvements. The $60,000 power factor correction at the Dee Events Center in fiscal year 2013 was one CI project directly related to energy.

The energy savings and rebates realized from these projects are used to service the debt including interest payments on the revolving line of credit and to fund further efficiency and sustainability projects, recommissioning efforts, the campus sub-metering and dashboards, enhancements to CI projects and ESO staff.

Figure 7-2 summarizes the expenditures from the line of credit in each of the five fiscal years since it was established along with the calculated energy cost savings and rebates realized in each year. Note that the expenditures shown are only from the line of credit and do not include ARRA funds, other grants, reinvestment of rebates into projects or use of CI funds. The expenditure amounts are also only a close approximation due to the nature of accounting with regard to encumbrance and actual expenditures.

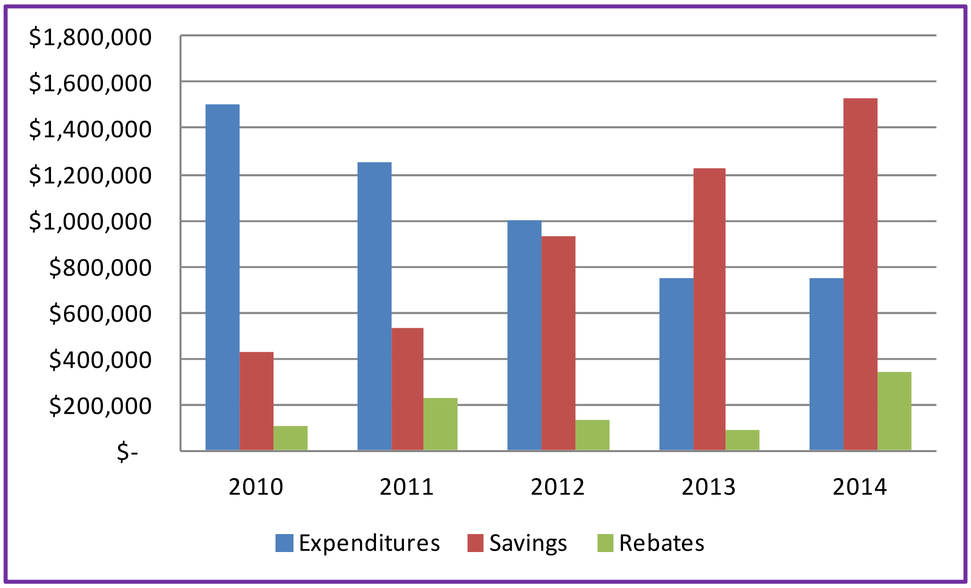


Figure 7-2 FY 2010-2014 Line of Credit Expenditures, Cost Savings and Rebates

7.3.2 Energy and Sustainability Office Staff

As previously noted, the Energy and Sustainability Manager is currently the only position in the ESO that is supported from the Education and General Fund. The remainder of the people involved with the energy and sustainability efforts are funded from several other sources as follows:

- **Utility Analyst:** This part-time position is funded with rebates from electric and gas utilities for energy conservation measures implemented.
- **Energy Project Electrical and Plumbing Tradespeople:** These full-time positions are paid from the revolving line of credit that is serviced by the energy cost savings resulting from projects implemented.

- **Energy Project Manual Labor:** These student positions primarily perform insulation repairs, mechanical room cleanup and so on. They are funded from energy cost savings at a total of about $10,000 per year.

- **Sustainability Coordinator:** This position is funded with rebates from electric and gas utilities and the funding made available with the transfer of the Sustainability Conference Coordinator to Academics.

- **Sustainability Assistant:** The Sustainability Coordinator has a part-time student assistant with 50% of the costs paid from student fees and the balance from energy cost savings or rebates.

- **Environmental Ambassadors:** Student Affairs currently provides about 50% of funding for these three part-time student positions supervised by the Sustainability Coordinator with the balance funded from electric and gas utility rebates.

- **Sustainability Conference Coordinator:** This half-time position working with the Sustainability Coordinator has been funded by the conference and will be transferred to Academics.

7.4 FUNDING STRUCTURE FOR ESIP II

To accomplish the objectives and sustain the efforts of the ESIP II and ultimately achieve the University's goal of carbon neutrality, it is critically important that the existing funding mechanisms described in Sections 7.2.1 and 7.2.2 remain in place. The majority of funding will still come from the line of credit established for energy efficiency and sustainability projects and this source must be protected for the duration of the plan.

To assure savings are available for repayment on the line of credit and for subsequent projects, the University's utility budget must be maintained at present levels with appropriate increases for additional square footage or utility rate increases with respect to the established 2006-2009 baseline. Further, Facilities Management must have the ability to direct the maximum amount of cost savings from energy efficiency and on-site renewable generation projects into further projects.

Other opportunities such as grants, rebates, subsidies, and so on will be pursued by the Energy and Sustainability Office to supplement these funding sources as much as possible. These tend to be more variable however, and will not necessarily be relied upon for planning or budgeting purposes.

The funding structure needed to ensure the success of the ESIP II and attaining the University's goals must address the key areas of implementing the Mechanical Infrastructure Master Plan in new construction, major building renovation, and upgrades for mechanical and controls systems in existing buildings. In addition, ongoing recommissioning, energy and water efficiency projects, and renewable energy installations will need to be funded. The ESIP II also includes new or modified staff positions and a shop within the Operations Group dedicated to efficiently implementing improvements.

Strategies for each of these elements are discussed in the paragraphs that follow. The overall intent is that they pay for themselves as much as possible through energy and water cost savings, allocation of existing funding sources and revenue generation.

7.4.1 New Construction and Major Building Renovation (CD)

The University has a Standards Committee on which the Energy and Sustainability Office has a major role in research, development and establishment of construction standards for the campus. This ensures that energy and sustainability goals are incorporated globally on campus and become requirements for design and construction of all Capital Development (CD) and Capital Improvement (CI) projects. This role will continue to expand as the ESIP II is implemented and will add the expertise of the Deputy Director of Operations/Commissioning Agent.

In new construction and major renovation of existing buildings the need to convert existing mechanical systems to carbon neutral capability is typically eliminated because these systems will be replaced, but the new building or renovation must include the new systems and equipment with carbon neutral capability required by the Mechanical Infrastructure Master Plan.

It is anticipated that the Capital Development Program will incorporate the requirements of the Mechanical Infrastructure Master Plan and will provide funding for the carbon neutral capable equipment to maximum extent. In some cases, support for incremental costs of the carbon neutrality components may be provided by the ESO from savings generated by other energy efficiency projects. The need for this sponsorship from the ESO will be determined by the Weber State Project Team on a case-by-case basis.

The Energy and Sustainability Office will provide recommendations for CD projects being partially funded by the energy efficiency budget, directing contributions toward implementing the Mechanical Infrastructure Master Plan and/or improved energy performance to ensure higher overall value for Weber State is realized and discourage the exercise commonly referred to as "value engineering".

7.4.2 Existing Building Mechanical and Controls Upgrades (CI)

For existing buildings the intent of the ESIP II is to use $1.25 million to $1.5 million of Capital Improvement funds each year for upgrades to mechanical systems for conversion to carbon neutrality capability in accordance with the Mechanical Infrastructure Master Plan. Modernization of controls and building automation systems will be part of this work.

This will allow the University to improve an existing building not planned for major renovation in the near future about every two years and gradually retrofit systems to variable refrigerant flow and/or chiller heat pump systems over the twenty to thirty year period envisioned to get all of the buildings converted. Again, projects will be evaluated on a case by case basis for any supplemental funding from the ESO.

7.4.3 Recommissioning and Efficiency Projects

The primary source of funding for recommissioning efforts and energy or water efficiency projects outside of the CD and CI programs will continue to be the energy project revolving line of credit replenished from energy and water cost savings, previously described in paragraph 7.2.2.1. Rebates and grants will also be used to supplement the line of credit as much as possible.

It is expected that the principal use of this fund over the next four to five years will be for completion of the energy projects currently planned or in progress and repayment on the line of credit for the monies used to fund them. A portion of the available funds will be budgeted for the Recommissioning Program to accomplish these efforts on about four existing buildings per year.

Following the repayment period for current projects, the energy and water cost savings realized from them will be available to accelerate building conversions to carbon neutral mechanical systems, controls and building automation upgrades, recommissioning efforts, and potentially increase funding participation in CD or CI projects.

7.4.4 Renewable Energy Projects

Installations of renewable energy systems to date have been funded for the most part by grants and this is expected to continue for the short term. The ESO will continue to apply for these grants, which may be supplemented with University internal funding, to maintain momentum. Renewable energy projects are also expected to accelerate using the revolving line of credit once repayment of that line for the loans to implement the original energy projects is completed.

7.4.5 Organizational Structure Improvements

The ultimate success of the ESIP II and the University's efforts to achieve carbon neutrality will require three significant organizational improvements within the Operations Group. Part 5 of the ESIP II describes these recommended improvements in structure, responsibilities and staffing within the Operations Group to support the plan.

These enhancements provide resources vital to implementation of the ESIP II and allow the Energy and Sustainability Office to concentrate on functions that are critical to achieving the University's sustainability goals. Included in those functions are indentifying projects and sponsoring them with funding from the appropriate available source(s). Administration and allocation funds under his control along with required reporting remains the responsibility of the Energy and Sustainability Manager.

7.4.5.1 Deputy Director/Commissioning Agent

Funding for an in-house commissioning agent would come from several sources depending upon the type of project. One source will be the Capital Development funds that are otherwise now spent on contracts for outside commissioning firms associated with construction. In this case, it is proposed that the funds budgeted for commissioning on the CD project would be turned over to the University to fund the Facilities Management commissioning agent. Once received, these funds will need to be protected internally to be sure money is available when there are large gaps in time between CD projects.

A similar situation will occur when commissioning is needed for Capital Improvement projects. In this case the Director of Operations will need to include the cost of the commissioning agent in the overall CI project budget and account for these funds internally.

For other energy and water efficiency projects, recommissioning efforts and installations of renewable energy systems, the costs for the in-house commissioning agent would ultimately be paid from the funding provided through the ESO for those projects. Again this will need to be accounted for internally, however it should be similar to the current situation with paying the costs of the energy project tradespeople which could serve as a model.

Finally, the commissioning agent would also hold the position of Deputy Director of Operations and will be providing management support to the Director of Operations for operations, maintenance, and repairs to the existing infrastructure. This part of his duties meets the requirements for use of E&G funds and a commensurate allocation of those funds should be used to partially fund the position.

7.4.5.2 Energy and Sustainability Office (ESO)

The ESO will provide a staff function to the Director and Deputy Director of Operations for planning, studies, analyses, reports and evaluation of new technologies. Management of energy and water utilities, development of energy awareness outreach programs, and providing communication related to energy and water efficiency will also be part of the responsibilities of the ESO.

In this role the ESO staff is closely connected to the operations, maintenance, and repairs to the existing infrastructure indicating that support for the ESO from E&G funds should be expanded to include the costs for the Sustainability Coordinator and analyst(s) instead of using rebate money as is the case under the current model.

This will also help accomplish a key objective of the ESIP II to maximize the amount of cost savings from energy efficiency and on-site renewable generation projects that can be directed into supporting the Mechanical Infrastructure Master Plan and funding further projects to ensure the University's carbon neutrality goal is achieved on or before the target date.

The ESO will sponsor projects using the energy and sustainability funding sources available to pay for implementation by the Construction and Renovation Shop, commissioning agent, the Campus Planning and Construction Group and others. Expenses for the energy project tradespeople and students providing part-time hourly labor will transfer to the Construction and Renovation Shop where they will continue to be supported from project economics.

Funding for student interns from Student Fees and Student Affairs will need to be preserved in order for the ESO to continue offering those opportunities. A reduction in expenses will be realized from transfer of the Intermountain Sustainability Summit Coordinator from the ESO to the academic side.

7.4.5.3 Construction and Renovation Shop

The Construction and Renovation Shop will absorb the electrical and plumbing tradespeople that were previously under the ESO and assume responsibility for managing and completing ESO projects currently in progress or planned for existing buildings. This shop will also implement future projects, assist with recommissioning work and perform minor space remodels or renovations for University Departments.

All of this work will either be sponsored financially by the ESO, be part of projects funded by the CI program, or be billed to University Departments. Therefore it is anticipated that the Construction and Renovation Shop will essentially be self-funding without the need for infusion of funding from E&G or other sources.

7.4.6 Utility Usage Cost Allocation

In addition to ensuring the funding sources described to achieve the goals of the ESIP II are in place and maintained, it will be important to make certain that the costs for energy usage are appropriately allocated to buildings, departments and activities.

The objective of a cost allocation system is to accurately account for utility usage by the consumer components on campus so the costs can be distributed appropriately and recovered by university administration as part of managing the overall utility budget.

The benefits to this approach are two-fold. First, from the energy and sustainability perspective, it removes a common disconnect that can exist in large organizations between those who use energy and those who actually pay the bills for it. The result is that energy users are more cognizant of their impact which can serve as an incentive to join in the conservation and sustainability efforts of Facilities Management.

The other benefit is that unanticipated or excessive usage of energy can be documented with costs assigned to the responsible Departments or activities so the utility budget is not subsidizing overruns at the expense of sustainability and carbon neutrality efforts or other functions.

With some minor exceptions, electrical energy is delivered to the main campus through a single substation and then distributed to individual buildings. This results in a single point from which the entire campus usage and demand charges are billed by Rocky Mountain Power. With a few exceptions, the same is true for natural gas which is principally provided by Questar for operation of the Heat Plant. In addition, Facilities Management operates steam and chilled water district systems with the Heat Plant and Chilled Water Plant respectively.

This in effect puts Facilities Management in the position of being an internal utility provider for all of these services on the main campus. A similar condition is developing with the growth of the Davis campus and inclusion of a district heating and cooling approach there. Beyond that, the Dee Events Center and other satellite buildings have their own heating and cooling systems and utility meters for electricity usage and demand and natural gas consumption, simplifying cost and usage allocation for those facilities.

Weber State already has a number of tools and processes in place to measure and collect utility usage for individual buildings. The best tool for any cost allocation program is the electric, gas, steam, and chilled water submeters that have been installed on buildings through one of the original energy projects. This primary source for data would provide a credible basis for cost or usage allocations to assess fees for energy use by buildings, Departments or activities that would be billed to the appropriate entity.

Installation of building dashboards, which take data from the submeters, provides a public representation of each building's energy consumption. Continued expansion of this program is vital to stimulate engagement of users and the attainment of the University's sustainability and carbon neutrality goals.

Implementation of an accurate process to charge utility use to buildings, Departments and activities involves both energy management and accounting components. Care must be taken to prevent the process from becoming unwieldy, rendering it unworkable over time. This includes ensuring the process is flexible enough for a comprehensive system, accurately allocates all types of energy expenses (including for example electrical demand charges), and is transparent and readily understandable to the Departments or activities involved.

The best way to accomplish this is to investigate and invest in a software package for energy management with a utility billing function that can be integrated with the Facility Management accounting system. Ultimately information should be published via the web so end users can view their accounts as they would with any outside utility. This process is important for auxiliary facilities that are not eligible for E&G funding and must pay their own way.

APPENDIX A
CAMPUS MAP AND BUILDING LIST

Building Directory

NAME	LOCATION	CODE
Browning Center	C4	BC
Campus Services	A3	CS
Davidson Track Locker Rooms	C2	TR
Dee Events Center	D1	DC
Elizabeth Hall	B3	EH
Engineering Technology	B3	ET
Facilities Management	A1	FM
Heat Plant	A3	HP
Hurst Center for Lifelong Learning	D5	HC
Information Booth	C5	IN
Kimball Visual Arts Center	C4	KA
Lampros Hall	C3	LP
Lind Lecture	B2	LL
Lindquist Alumni Center	E5	AL
Marriott Health	C3	MH
McKay Education	B4	ED
Miller Administration	B4	MA
Portable Classrooms	A3, B2, B3	M1-4
Public Safety	A5	PS
Receiving and Distribution Services	A1	RD
Residence Hall I	E4	R1
Residence Hall III	E4	R3
Science Lab	B2	SL
Shepherd Union	C4	SU
Social Science	B4	SS
Stewart Bell Tower	B3	ST
Stewart Library	C3	LI
Stewart Stadium Sky Suites	C2	SK
Stewart Wasatch Hall	E4	R2
Stromberg Stadium Offices	C2	SD
Stromberg Strength Training	C2	WR
Student Services Center	B4	SC
Swenson Building	C3	SW
Technical Education	B3	TE
University Village	E2	V1-5
Village Community Center	E2	VC
Wattis Business	B4	WB
Wildcat Center for Health Education and Wellness	C3	WI
Wildcat Village	E4	R1-3

Annex Directory

Athletics	D-2	A13
Fatigue Studies Lab	A-3	A02
Outdoor Program	D-2	A09
Upward Bound	A-3	A03
Veteran's Services	D-4	A05
ROTC	A-4	A11
Veteran's Upward Bound	A-4	A12

Non-campus Buildings

Weber County Sports Complex The Ice Sheet Marquardt Field House	D-2	WC
Newman Center	A-4	NC
Ogden LDS Institute	A-4	OI
Weber State Credit Union	E-5	CU

Parking Lots

A1-A14	Permits as Designated
A1, A2, A7	Visitor Meters
DC	Dee Center A,W and R Permits *(Shuttle Available)*
PPL	Public Pay Lot
R1-R4	Residence Halls/RW and A Permits
S1	Children's School Permit
S3-S4	Special Use Permits
W1-10	W, R/W and A Permits

m Motorcycle Parking

ADA Access

AED (*Automated External Defibrillator*)
*Latest known AED locations

Ride the Wildcat Express Shuttle.

All Weber State University parking is by permit only. You can buy a $25 pass and always find a place to park in one of the 3,000 available spaces at the Dee Events Center. The shuttle runs from the Dee Events Center to the bus stop in the loop south of the Stewart Library and back to the Dee Events Center.

The shuttle operates from 6:30 AM to 8:30 PM. The shuttle runs at 5-minute intervals from 7:45 AM to 1:30 PM and every 15 minutes outside of this time frame.

Questions? 801-626-7220 or 801-626-6294

Updated 8/14

WEBER STATE UNIVERSITY

Ogden Campus
3848 Harrison Blvd.
Ogden, UT 84408
801-626-6000

weber.edu

WEBER STATE UNIVERSITY
MASTER BUILDING LIST

December 2014

STATE BLD #	2 LTR ID	OFFICIAL BUILDING NAME	WSU BLD #	ABBREV	GSF	YR CONST	YR REMD	E&G or non	Type: Main Supp	STREET ADDRESS
17601	A01	Annex 1 (Residence)	67	ANNEX1	1,368	1956		E&G	M	3675 Birch Ave.
05392	A02	Annex 2 (Fatique Studies Lab)	21	ANNEX2	3,654	1956		E&G	M	3684 Birch Ave.
19005	A03	Annex 3 (Upward Bound)	65	ANNEX3	3,972	1966	2014	E&G	M	3660 Birch Ave.
17602	A04	Annex 4 (Residence)	68	ANNEX4	2,455	1956		E&G	M	3659 Birch Ave.
00765	A05	Annex No. 5 (Veterans Services/Acad Affairs)	49	ANNEX5	3,763	1956		E&G	M	1352 Village Drive
02254	A09	Annex 9 (Wilderness Recreation Center)	62	ANNEX9	3,135	1957	2006	non	M	4022 Stadium Way
06686	A11	Annex No. 11 (ROTC)	66	ANEX11	4,375	1956		E&G	M	3741 Custer Avenue
05395	A12	Annex 12 (Veterans Upward Bound)	69	ANEX12	3,164	1955		E&G	M	1342 Edvalson Street
02253	A13	Annex 13 (Athletics)	61	ANEX13	2,815	1955		E&G	M	4008 Stadium Way
13112	A20	Annex 20 (Visiting Professors)	95	ANEX20	5,248	1986		non	M	1380 E. 4225 S., Ogden
14271	A21	Annex 21 (Dell Brown Residence)	96	ANEX21	2,475	1993		non	M	1375 E. 4225 S., Ogden
15792	A22	1350 Country Hills House	97	ANEX22	2,351	1954		non	M	1350 Country Hills Drive, Ogden
17140	A23	Annex 23 (Henrie)	98	ANEX23	3,437	1960		non		1360 E. 4225 S.
00764	AX4	Annex No. X4 (Vacant)	48	ANNXX4	2,536	1956		E&G	M	1364 Village Drive
07050	AL	John A. & Telitha E. Lindquist Weber State University	63	ALUMNI	11,419	1992		E&G	M	1235 Village Drive
02242	BC	Val A. Browning Center for the Performing Arts	38	BRNCTR	177,429	64 (I); 1966	1999	E&G	M	3950 West Campus Drive
04020	C2	Concession Building No. 2	53B	CNCSS2	140	1965		non	S	3870 Stadium Way
04021	C3	Concession Building No. 3	53C	CNCSS3	140	1965		non	S	3870 Stadium Way
10868	CL	Chilled Water	9	CHLLWT	4,607	2008		E&G	S	1593 Edvalson Street
00756	CS	Campus Services	20	CMPSER	16,871	1956	002/201	E&G	M	1410 Edvalson Street
09317	CT	Cooling Towers	8	COOTWR	5,877	2001		E&G	S	3755 Skyline Parkway
02259	DC	Dee Events Center	100	DEVCTR	161,969	1977		E&G	M	4444 Events Center Drive
12771	DE	East Dugout	103	EASDUG	518	2009		non	S	4388 Event Center Drive
02260	DM	Dee Events Center Marquis	101	DECMRQ	562	1979		non	S	4444 Events Center Drive
12772	DS	South Dugout	102	SOUDUG	718	2009		non	S	4388 Event Center Drive
12601	EB	East Box (Command & Control Center)	52A	EASTBX	379	1953		non	S	
00755	ED	David O. McKay Education	16	EDUCBG	67,377	1973		E&G	M	1351 Edvalson Street
10866	EH	Elizabeth Hall	17	ELZBHL	94,751	2008		E&G	M	1395 Edvalson Street
13550	EL	Electrical Vault	71A	ELCVLT	532	1964	2012	E&G	S	
17483	ER	East Stadium Rest Rooms	52B	EASTRR	1,121	2014		non	S	3870 Stadium Way
02237	ES	David O. McKay Education Storage	16A	EDSTOR	166	1977	2004	E&G	S	1351 Edvalson Street
02240	ET	Engineering Technology	23	ENGTEC	74,886	1977		E&G	M	1447 Edvalson Street
10328	EV	Environmental Storage	32	ENVSTO	168	1999		E&G	S	
15595	FE	FM Equipment Storage	25	FMEQUP	4,256	2012		E&G	S	
00758	FM	Facilities Management	26	FACMAN	26,325	1974	2000	E&G	M	3700 Skyline Parkway
07928	FP	Fuel Pump	20A	FUELPM	24	1990	1995	E&G	S	1410 Edvalson Street
12773	FS	Field Storage	104	FLDSTO	368	2009		non	S	4388 Event Center Drive
12774	GS	Golf Cart Storage	41	GLFSTO	176	2009		non	S	3885 West Campus Drive
10867	HC	Hurst Center	77	HRSTCT	41,933	2009		E&G	M	1265 Village Drive
09465	HM	Ham Communications	60	HAMCOM	128	1952		E&G	S	
02238	HP	Heating Plant	18	HEATPL	10,520	52 (I); 1971	1994	E&G	M	1402 Edvalson Street
09464	HW	Hazardous Waste	30	HZDWST	241	1996		E&G	S	
15100	IN	Information Booth	13	INFORM	340	2009		E&G	M	3902 Dixon Parkway
09357	KA	Ethel Wattis Kimball Visual Arts	40	KIMART	74,420	2001		E&G	M	3964 West Campus Drive
00762	LI	Stewart Library	37	STWLBD	159,062	65 (I); 1975	2005	E&G	M	3921 Central Campus Drive
06682	LL	John G. Lind Lecture Hall	7	LINDLH	46,737	1970		E&G	M	3748 North Campus Drive
00763	LP	Jack D. Lampros Hall for Teaching, Learning and Tech	39	LAMPRO	21,892	1966	2003	E&G	M	3939 Central Campus Drive
17484	M1	Portable Modular 1	1	PMOD-1	1,440	2014		E&G	S	1465 Edvalson Street
17485	M2	Portable Modular 2	2	PMOD-2	1,440	2014		E&G	S	3772 North Campus Drive
17486	M3	Portable Modular 3	3	PMOD-3	1,440	2014		E&G	S	3772 North Campus Drive
17487	M4	Portable Modular 4	4	PMOD-4	1,440	2014		E&G	S	3772 North Campus Drive
00753	MA	William P. Miller Administration Building	10	MILADM	43,094	1970		E&G	M	3950 Dixon Parkway
13897	MF	WSU Marquardt Field House (in Weber County Sports	110	MRQFHS	36,545	1994	2013	non	M	4415 Event Center Drive
04018	MH	J. Willard Marriott Allied Health Sciences	34	MARAHS	89,796	87 (I); 1990 (II)		E&G	M	3875(No.)/3891(So.) Stadium Way
03955	MS	Engineering Technology Metal Storage	23A	MTLSTR	759	1985		E&G	S	1447 Edvalson Street
09503	OB	Observatory	24	OBSERV	301	1999		E&G	S	
13113	PB	Pay-lot Booth	42	PAYBTH	40	2011		non	S	
04017	PC	Power Control Center	29	PWRCTR	419	1952		E&G	S	
10327	PF	Fountain Pump House	11	PUMPFT	247	1988		E&G	S	
02241	PI	Irrigation Pump House	28	PUMPIR	486	1952		E&G	S	
13551	PR	Press Box - Women's Softball Field	105	PRSBOX	151	2010		non	S	4388 Event Center Drive
15801	PS	Public Safety	12	PUBSAF	10,103	2014		E&G	M	3734 Dixon Parkway

WEBER STATE UNIVERSITY
MASTER BUILDING LIST

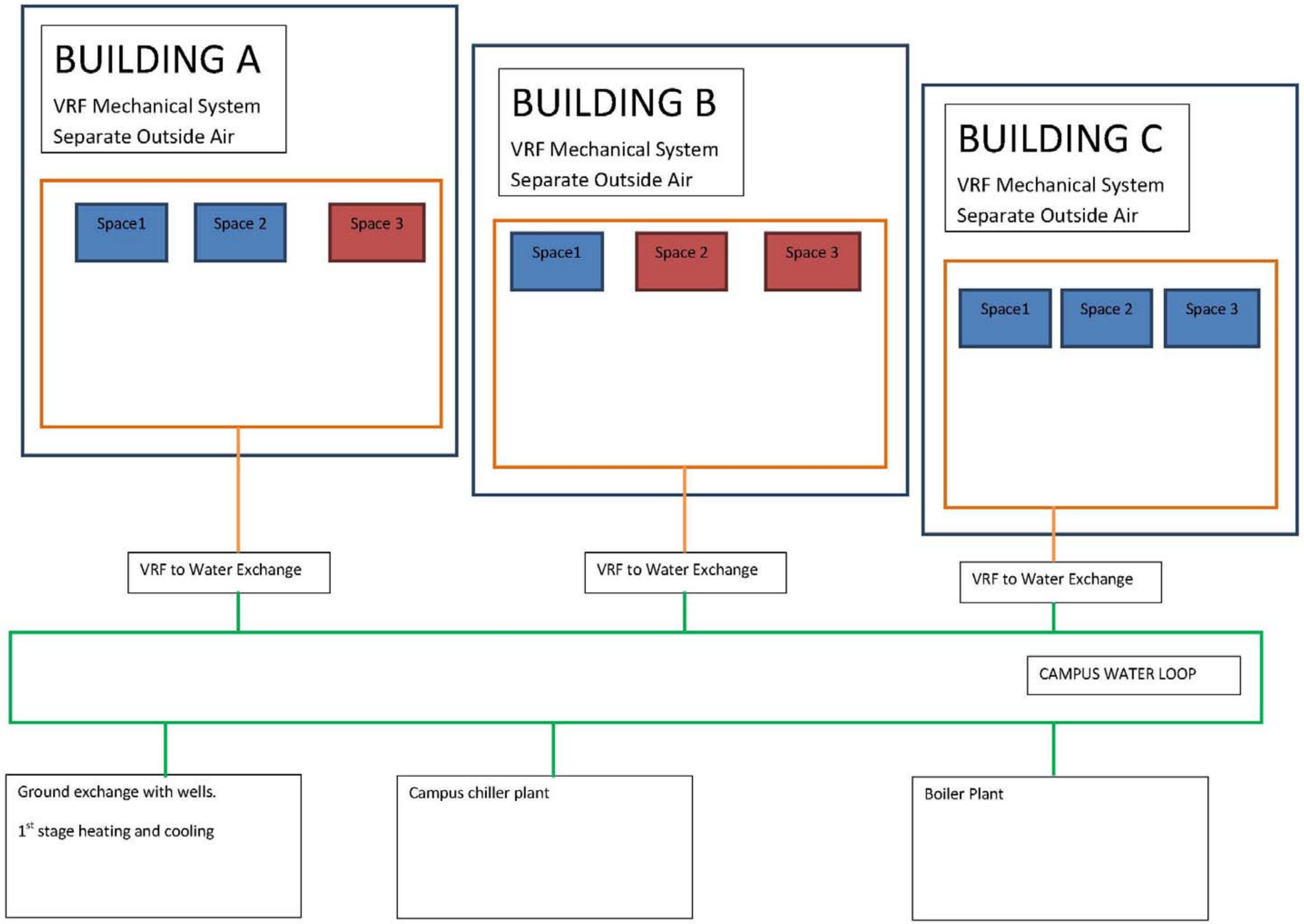
December 2014

13072	R1	Residence Hall 1	73	RESHL1	52,034	2011		non	M	1375 Village Loop Road
14272	R2	Stewart-Wasatch Residence Hall 2	71	STEWAS	88,480	2012		non	M	1375 Village Loop Road
15810	R3	Residence Hall 3	72	RESHL3	35,465	2013		non	M	1375 Village Loop Road
04016	RD	Receiving and Distribution Services	27	RECDIS	23,823	1982	2007	E&G	M	3730 Skyline Parkway
12600	RR	Stadium Rest Room	52D	STADRR	733	1953		non	S	3870 Stadium Way
15811	RS	ROTC Storage	66A	ROTCST	1,800	2012		E&G	S	3741 Custer Avenue
09504	SA	Salt Storage	26A	SALTST	1,500	2002		E&G	S	3700 Skyline Parkway
08118	SC	Student Service Center	35	SRVBLD	84,346	1995		E&G	M	3885 West Campus Drive
10324	SD	C. William & Bernice C. Stromberg Athletic Office Com	52	STADHS	22,101	1967		non	M	
12599	SF	Stadium Storage Shed F	52F	SSTORF	72	2002		non	S	
06687	SJ	Stewart Stadium Storage Shed J	52J	SSTORJ	1,455	1990		non	S	
10325	SK	Elizabeth Dee Shaw Stewart Sky suites and Press Box	55	STWSKY	39,788	2001		E&G	M	3870 Stadium Way
00752	SL	Science Lab	6	SCILAB	109,263	1971		E&G	M	3772 North Campus Drive
00751	SP	Underground Science Shop	5	SCISHP	2,514	1977		E&G	S	
00754	SS	Social Science	14	SOCSCI	106,322	1971		E&G	M	1299 Edvalson Street
00760	ST	Stewart Bell Tower	31	STWTWR	534	1972		E&G	M	
00761	SU	J. Farrell Shepherd Union	36	SHEPUB	186,840	61 (I); 1969	2008	non	M	3910 West Campus Drive
00766	SW	Swenson Building	50	SWNSON	94,082	1962	2006	E&G	M	1435 Village Drive
02247	TC	Ticket Booth C	52C	TKBTHC	69	1965		non	S	
00757	TE	Technical Education	22	TECHNI	87,976	1957		E&G	M	1465 Edvalson Street
02251	TG	Ticket Booth G	52G	TKBTHG	130	1965		non	S	
02252	TH	Ticket Booth H	52H	TKBTHH	164	1965		non	S	
10331	TK	Ticket Booth K	52K	TKBTHK	86	1965		non	S	
10326	TR	Tom & Nancy Davidson Track Locker Rooms	56	TRACKL	4,390	2005		non	M	
02243	TS	Tennis Court Storage	50A	TESTOR	201	1985	2002	non	S	
13866	TY	Tracy Hall Science Center	19	TRAHAL				E&G	S	
10318	V1	University Village Building One	111	VILLA1	30,531	2002		non	M	1321 E. 4600 S.
10319	V2	University Village Building Two	112	VILLA2	30,531	2002		non	M	1321 E. 4600 S.
10320	V3	University Village Building Three	113	VILLA3	30,531	2002		non	M	1321 E. 4600 S.
10321	V4	University Village Building Four	114	VILLA4	30,531	2002		non	M	1321 E. 4600 S.
10322	V5	University Village Building Five	115	VILLA5	30,531	2002		non	M	1321 E. 4600 S.
09358	VC	University Village Community Center	110	VILCOM	13,234	2002		non	M	1321 E. 4600 S.
10323	VS	University Village Shop	116	VILSTO	1,209	2004		non	S	
03954	WB	Edmund Orson Wattis Business	15	WATBUS	53,855	1983		E&G	M	1337 Edvalson Street
06683	WI	Wildcat Center for Health Education and Wellness	51	WLDCAT	122,054	1990	2013	E&G	M	
02244	WR	C. William & Bernice C. Stromberg Strength Training F	54	WEIGHT	4,891	1966	1998	non	M	
		WSU-DAVIS CAMPUS (200 SERIES)								
14165	CCE	Center for Continuing Education	210	CEDAVS	16,643	2000	2012	non	M	775 S.University Park Blvd., Clearfield 84015
09639	D02	Davis Building 2	202	DAVIS2	113,580	2003		E&G	M	2750 University Park Blvd., Layton 84041-9099
15809	D03	Davis Building 3	203	DAVIS3	120,956	2013		E&G	M	2750 University Park Blvd., Layton 84041-9099
13753	D04	Central Plant	204	CNTPNT	4,482	2013		E&G	S	2750 University Park Blvd., Layton 84041-9099
15850	D13	D13 - 875 South	213	DAVD13	27,319	2001		non	M	875 S. University Park Blvd., Clearfield 84015
		OFF-SITE LOCATIONS								
15851	CM	Community Education Center	363	CMPROG	4,521	1963 (?)	1996	non	M	2955 Harrison Blvd., Ogden
14270	UF	UCAID Farmington	362	UCAIDF	18,857	1992		non	M	218 S. 200 W., Farmington 84025
13899	WD	Weber State Downtown	363	WSUDWN	27,009	1920's (?)	2013	non	M	2314 Washington Blvd., Ogden
10055	WW	West Center	361	WSUWST	7,556	2002	2005	E&G	M	5627 S. 3500 W., Roy 84067

APPENDIX B
STEAM SYSTEM MAP


LL
SL
A3
CW
PH
C2
RR
TC
WR
SD
SK
TR
C3
TH
TH
MR
SJ
TG
A5
TE
A2
MS
ET
MH
A4
SW
A2
B5
FP
B4
A1
LI
SB
B3
CS
B4
B1
B2
HP
BC1
EH
ST
LP
B3
STEAM:
LEGEND:
RISE/DROP
ANCHOR
ISOLATION VALVE
HPS EXPANSION JOINTS
BALL JOINTS
PHASE 1
PHASE 2
PHASE 3
PHASE 4
ASBESTOS ABATEMENT AREAS
ANCHOR TO BE REPLACED
ISOLATION VALVE TO BE REPLACED
VENT LOCATION [APPROX.]
REPAIR LINE LEAK
REPAIR BENT/ ALTERED PIPE
NOTE:
REPLACEMENT FOR VALVES & JOINTS ONLY, UNLESS OTHERWISE NOTED
SCALE: 1/64"=1'-0"
ED
C2
SU
BC
C1
X1
X2
WB
C4
CS
SC
C3
C5
SS
MA
KA

APPENDIX C
MECHANICAL INFRASTRUCTURE
MASTER PLAN DIAGRAM



Optional Mechanical Systems
1. VRF
2. Heatpump
3. Heatpump chiller
4. Any system that can exchange heating and cooling with 45-65 degree water.

Considerations
1. Campus water loop is already in place, the chilled water pipe can be used.
2. Ground source wells will serve as a third plant, and since it can use the chilled water pipe there are many options for locations.
3. VRF systems typically struggle with low air temperatures, but this system will use a water exchange with a water minimum temp of 45 degrees.
4. Using the hybrid groundsource, 50% capacity will cover 90% consumption as renewable.
5. The groundsource and chilled water loop could be used as thermal storage for load shifting.
6. The system would allow for phasing through CI and CD projects and would not require major upfront funding.
7. We would still be able to use infrastructure that we have invested in and allow life-cycle phase-out of equipment (e.g. boiler 1)

APPENDIX D
FM PERSONNEL SURVEY

APPENDIX D
FACILITIES MANAGEMENT EMPLOYEE SURVEY DATA

Weber State University
ESIP II FM Employee Survey

1. Which Facilities Management (FM) Shop are you assigned to?

	Response Percent	Response Count
Business Center	11.6%	8
Carpentry	7.2%	5
Custodial	**29.0%**	**20**
Electrical	5.8%	4
Electronic Systems and Repair	4.3%	3
Fire Marshall	1.4%	1
Landscape	7.2%	5
Plumbing	4.3%	3
Project Management	13.0%	9
Shuttle Bus/Fleet	4.3%	3
Systems Support	1.4%	1
Utility	7.2%	5
Vehicle Repair	2.9%	2
Other (please specify)		15
answered question		**69**
skipped question		**16**

2. What is your job title in Facilities Management (FM)?

	Response Count
	79
answered question	79
skipped question	6

3. How long have you worked in your current job?

	Response Percent	Response Count
Less than one year	12.3%	10
One to two years	14.8%	12
Two to five years	25.9%	21
More than five years	**46.9%**	**38**
answered question		81
skipped question		4

4. What age group are you in?

	Response Percent	Response Count
Under 20	2.5%	2
20-29	8.8%	7
30-39	25.0%	20
40-49	20.0%	16
50-59	**26.3%**	**21**
60 or greater	17.5%	14
answered question		80
skipped question		5

5. What is your position classification?

	Response Percent	Response Count
Professional	26.8%	22
Classified	**58.5%**	**48**
Hourly	14.6%	12
	answered question	**82**
	skipped question	**3**

6. Your Role in Energy Efficiency

	Frequently	Occasionally	Rarely	Never	Rating Count
I am given enough authority to make decisions I need to make with regards to energy efficiency	**40.8% (29)**	38.0% (27)	14.1% (10)	7.0% (5)	71
I have the materials and equipment I need to do my job well with regards to energy efficiency	**45.7% (32)**	37.1% (26)	17.1% (12)	0.0% (0)	70
I make energy saving improvement suggestions in my job . . .	30.0% (21)	**44.3% (31)**	20.0% (14)	5.7% (4)	70
My supervisor or manager is responsive to my suggestions . . .	**55.7% (39)**	31.4% (22)	10.0% (7)	2.9% (2)	70
				answered question	**71**
				skipped question	**14**

7. Importance of energy efficincy

	Very important	Somewhat important	Not too important	Not important at all	Rating Count
How important is energy conservation to you in your assigned role within FM?	**68.5% (50)**	26.0% (19)	5.5% (4)	0.0% (0)	73
How important is energy conservation to you personally?	**79.2% (57)**	19.4% (14)	1.4% (1)	0.0% (0)	72
				Your comments	6
				answered question	**73**
				skipped question	**12**

Page 2, Q7. Importance of energy efficincy

1	Steam trap leakage happens frequently but the plumbers are constantly tasked with other jobs. It seems that only when water hammer is threatening piping damage is trap repair given priority. Our new "this trap is blowing by" monitoring system at the UB is constantly ignored.	Apr 15, 2013 12:34 AM
2	still in the learning process as a HP tech.	Apr 13, 2013 3:03 AM
3	I have had the opportunity to help out the energy and sustainability department for 3 months when they were short handed, and was able to see the big picture of what kind of energy changes are possible at Weber State.	Apr 12, 2013 7:48 PM
4	Use, use, use. Eventually we deplete even the most abundant resources. Not the best plan.	Apr 12, 2013 4:28 PM
5	Saving energy is beneficial to everyone and most importantly to future generations.	Apr 5, 2013 9:48 PM
6	Conserving energy in every way possible is very important, because you effort will benefit future generations.	Apr 4, 2013 9:58 PM

8. Current Energy Saving Practices

	Yes	No	Not Sure	Rating Count
My job description includes energy saving duties	**48.6% (35)**	40.3% (29)	12.5% (9)	72
I am currently part of an energy efficiency team	16.7% (12)	**77.8% (56)**	5.6% (4)	72
I have the training I need to reduce energy use	**45.8% (33)**	38.9% (28)	18.1% (13)	72
			Comment	7
			answered question	**72**
			skipped question	**13**

Page 2, Q8. Current Energy Saving Practices

1	I recently received an opportunity to attend training for this position and have applied for a FM grant	Apr 13, 2013 3:03 AM
2	All Facilities Management employees should be doing their best to limit fiscal waste. All other practices are not sustainable.	Apr 12, 2013 4:28 PM
3	About all we can do is make sure lights are turned off and heaters that our occupants leave on, we turn off as much for safety as for energy savings.	Apr 12, 2013 4:18 PM
4	It will be very helpful to receive the latest training in regards to energy savings.	Apr 5, 2013 9:48 PM
5	More training in specific areas is always welcomed	Apr 5, 2013 11:35 AM
6	I feel the are better ways to do things and become more efficient in all things we are doing.	Apr 4, 2013 9:58 PM
7	I would love more information about how I personally can save energy at work.	Apr 4, 2013 3:59 PM

9. How efficient do you believe Weber State is in terms of energy usage?

	Response Percent	Response Count
Not efficient	1.4%	1
Somewhat efficient	**66.7%**	**48**
Very efficient	31.9%	23
answered question		**72**
skipped question		**13**

10. What improvements to energy operation and maintenance practices would you recommend to reduce energy use?

	Highly Recommended	Somewhat Recommended	Not Recommended	Rating Count
Immediately replace inefficient half burned out HID lights and strobing CFLs	**70.3% (45)**	28.1% (18)	1.6% (1)	64
Policy to standardize lamps as much as possible throughout the campus	**76.6% (49)**	20.3% (13)	3.1% (2)	64
Create awareness of the benefits of energy efficiency	**83.1% (54)**	10.8% (7)	6.2% (4)	65
Provide training to PM staff	**75.4% (49)**	24.6% (16)	0.0% (0)	65
Provide training to building users	**76.9% (50)**	21.5% (14)	1.5% (1)	65
Show the savings of turning off unused equipment	**83.1% (54)**	15.4% (10)	1.5% (1)	65
Tell people to wear different clothes if they are uncomfortable	27.7% (18)	33.8% (22)	**38.5% (25)**	65
Avoid brow-beating people who are uncomfortable - Instead quantify the issue and solve the problem	**67.7% (44)**	26.2% (17)	6.2% (4)	65
			Other (be specific)	6
			answered question	**65**
			skipped question	**20**

Page 3, Q10. What improvements to energy operation and maintenance practices would you recommend to reduce energy use?		
1	Get Questar and Rocky Mountain Power statistics on individual contributions that as a 'whole' = major savings.	Apr 13, 2013 3:16 AM
2	I don't believe it is our place as technicians to "tell" people to wear different clothes.	Apr 12, 2013 7:57 PM
3	We already have a policy in place that standardizes lamps on campus. We are replacing HID lights in general all over campus. Training for PM staff and building users is greatly needed.	Apr 8, 2013 12:18 PM
4	Teach people at every level to be energy efficient minded. If you work in a office and are leaving for the day, turn off all electronics.	Apr 5, 2013 9:50 PM
5	Recommissioning of buildings, quicker response to problem areas ie: fan systems locked on 24/7, making contractors more responsible for wasting energy ie: Dee Events Center lighting is on 24/7 "due to the construction of new Ice Sheet" We need more than one person fully trained in Metasys.	Apr 5, 2013 11:37 AM
6	I think there are several more ways to improve in our energy efficiency. 1) be proactive in the things we doing, always look for better ways on doing things, like equipment usage there are better energy efficiency equipment.	Apr 4, 2013 10:12 PM

11. What organizational improvements would you recommend to improve energy efficiency?

	Highly Recommended	Somewhat Recommended	Not Recommended	Rating Count
Stay informed of policies, changes to help reduce energy use	**71.0% (44)**	29.0% (18)	0.0% (0)	62
Communicate the consequences of wasting energy	**63.5% (40)**	34.9% (22)	1.6% (1)	63
Adjust work schedules to improve efficiency	36.5% (23)	**52.4% (33)**	11.1% (7)	63
Policy for cleaning staff to reduce lighting	**44.4% (28)**	39.7% (25)	15.9% (10)	63
Organize energy teams for each facility	33.3% (21)	**54.0% (34)**	12.7% (8)	63
Energy saving as part of job description	33.3% (21)	**50.8% (32)**	15.9% (10)	63
Energy efficiency as part of job evaluation	23.8% (15)	**42.9% (27)**	33.3% (21)	63
Provide energy efficiency training for staff, faculty, students, and administration	**76.2% (48)**	22.2% (14)	1.6% (1)	63
Set temperature standards for comfort and efficiency	**63.5% (40)**	23.8% (15)	12.7% (8)	63
Policy for resolving comfort conflicts with energy efficiency	**57.1% (36)**	31.7% (20)	11.1% (7)	63
Cleaning crew policy to minimize lighting use - including job performance guidelines	38.1% (24)	**46.0% (29)**	15.9% (10)	63
			Other (be specific)	6
			answered question	**63**
			skipped question	**22**

Page 3, Q11. What organizational improvements would you recommend to improve energy efficiency?		
1	are not most lights on auto or getting that way	Apr 13, 2013 7:30 PM
2	There is a temp. standard in place, it's just not in forced.	Apr 12, 2013 5:49 PM
3	There are some really touchy subjects here, other than the fact that most cleaning crews only have the necessary lights on where they are working unless the building is open and being utilized by the faculty and students. It would be nice if a floor could be maintained during regular working hours (while classes are in) but due to the noise created by the machines and the unfortunate occurrence of people not reading signage and ruining new finish... this isn't efficient and it becomes costly in labor and product because the floor has to be taken down and new finish put down. Some comfort claims have legitimate reasons behind them. An administrator or professors office being 58 degrees when they come into work is very cold, especially in the winter and should probably be addressed instead of telling them to 'bundle up'.	Apr 12, 2013 5:28 PM
4	More policies aren't going to change the will of an individual. Try using common sense.	Apr 12, 2013 4:43 PM
5	Have a reward program for those areas or departments that are meeting the energy savings expectations.	Apr 5, 2013 9:50 PM
6	Not all buildings operate with the the same occupancy schedules. Setting a defined policy to clean a building at a certain time may not work across the board.	Apr 5, 2013 6:34 AM

12. What specific improvements in new construction or building remodel planning process would you recommend to reduce energy use?

	Highly Recommended	Somewhat Recommended	Not Recommended	Rating Count
Green power generated on-site	**63.5% (40)**	31.7% (20)	4.8% (3)	63
Green power contracts - such as "Blue Sky" purchases	**47.6% (30)**	46.0% (29)	6.3% (4)	63
Install co-generation boiler at heating plant	**44.3% (27)**	**44.3% (27)**	11.5% (7)	61
Use of photovoltaic electricity generation	**64.5% (40)**	29.0% (18)	6.5% (4)	62
Solar hot water heating	**64.6% (42)**	33.8% (22)	1.5% (1)	65
Use of natural lighting	**73.8% (48)**	26.2% (17)	0.0% (0)	65
LEED certification	**61.9% (39)**	36.5% (23)	1.6% (1)	63
Other green certification for buildings	**52.4% (33)**	44.4% (28)	3.2% (2)	63
Building commissioning	**64.5% (40)**	30.6% (19)	4.8% (3)	62
More use of natural and recycled building materials	**60.9% (39)**	37.5% (24)	1.6% (1)	64
More flexible buildings that will adapt better to future uses	**78.5% (51)**	21.5% (14)	0.0% (0)	65
Incorporate alternative transportation	**54.7% (35)**	40.6% (26)	4.7% (3)	64
Life cycle cost as the basis for evaluating and selecting options	**61.7% (37)**	35.0% (21)	3.3% (2)	60
Lighter interior colors to reduce lighting needs	**66.1% (41)**	32.3% (20)	1.6% (1)	62
Better lighting controls to balance electric lighting with natural lighting	**75.8% (47)**	22.6% (14)	1.6% (1)	62
Improved comfort levels to eliminate space heaters and opening windows	**75.8% (47)**	22.6% (14)	1.6% (1)	62

More energy monitoring and sub-metering to help manage energy use	**68.3% (41)**	25.0% (15)	6.7% (4)	60
			Other (be specific)	11
			answered question	**65**
			skipped question	**20**

Page 3, Q12. What specific improvements in new construction or building remodel planning process would you recommend to reduce energy use?

1	Use of high R value insulative materials while building new structures to help reduce the amount of energy needed for heating and cooling.	Apr 16, 2013 6:23 AM
2	Our steam load is too low for co-generation. If we could sell heating steam to nearby facilities it might become feasible but McKay Dee has moved too far away.	Apr 15, 2013 12:45 AM
3	Better building designs	Apr 13, 2013 2:11 PM
4	Any green power would be a step in the right direction, but many of the options for green power are extremely expensive.	Apr 12, 2013 7:57 PM
5	Utilize ground sore heating and cooling in a heatpump application to reduce gas heating and power in chiller water use.	Apr 12, 2013 5:49 PM
6	Consider a boiler that operates on certain waste. Saving money on waste removal, with heating possibilities. Create jobs on campus. Compact pellet formed waste fuel cells that can be consumed by the boiler.	Apr 12, 2013 4:43 PM
7	I see a lot of cars idling with their windows down, just to play their radio. Also, the campus "beautification" efforts that waste energy are not beautiful to me. Why do we heat the outdoors at the union?	Apr 5, 2013 11:37 AM
8	We are doing most ot these things already!!!	Apr 5, 2013 11:37 AM
9	I have no idea what "Blue Sky" contracts are....	Apr 5, 2013 8:46 AM
10	Some of our classroom equipment such as Extron controllers and speakers are constantly on when they don't need to be. The units do not have an on/off switch and teaching consoles ought to have a means of turning them off such as putting them on a circuit with a switch. Also, the units have auto power off features that are not being utilized due to lack of training and familiarity with the technology.	Apr 5, 2013 8:02 AM
11	I am highly recommend to use or research for more natural gas vehicles which in turn save more and energy to the University. Smaller size vehicles also will be beneficial.	Apr 4, 2013 10:12 PM

13. How could your manager or supervisor help you in managing or reducing energy use?

	Response Count
	22
answered question	22
skipped question	63

Page 3, Q13. How could your manager or supervisor help you in managing or reducing energy use?

1	we police our selves we dont need more rules to be written up over	Apr 22, 2013 7:58 AM
2	Planing projects a little better	Apr 17, 2013 12:24 PM
3	My manager is very helpful he stays on top of all issues	Apr 16, 2013 9:37 AM
4	Not sure	Apr 16, 2013 7:04 AM
5	keep us up to date of new policies and procedures	Apr 15, 2013 4:33 PM
6	Training and information given is sufficient.	Apr 15, 2013 8:31 AM
7	Have bad lights fixed sooner.	Apr 14, 2013 11:09 PM
8	Training	Apr 14, 2013 7:24 AM
9	push for getting our lighting upgraded	Apr 13, 2013 2:11 PM
10	List the energy saving suggestions and up date us frequenlly on what is being done with our suggestions.	Apr 12, 2013 5:49 PM
11	The purchase of equipment that takes less energy or water than the standard 'status quo' of regular operations. Naturally this kind of equipment is expensive to purchase with the cost savings accrued in the usage.	Apr 12, 2013 5:28 PM
12	Encourage reduce/reuse.	Apr 12, 2013 4:43 PM
13	By purchasing newer energy efficient equipment to replace older equipment.	Apr 12, 2013 4:25 PM
14	He is already very supportive.	Apr 12, 2013 4:18 PM
15	Give me advice on how to do this.	Apr 9, 2013 2:32 PM
16	Distribute flyers with energy reports of specific facilities to the ocupants of those facilities to show them theyr energy usage and what we have done and are doing to make it more efficiant and how they can contribute by theyr energy saving practices.	Apr 8, 2013 6:49 AM
17	Better communication of what needs to be done, and what is within my control. If work were better coordinated, a lot less waste would happen of efforts, money, and energy. I wish managers and techs were more pro-active in paying attention, and helping each other to work as a team. It does not feel like there is a greater common goal, the PRIDE initiative has fizzled out, and the three pillars are not very unifying.	Apr 5, 2013 11:37 AM

Page 3, Q13. How could your manager or supervisor help you in managing or reducing energy use?

18	Help identify ways that our department is failing and succeeding. Create a forum for improvement ideas.	Apr 5, 2013 8:46 AM
19	Learn and provide training for energy conservation. Collaboratively formulate standard practices to conserve energy. Provide necessary materials/tools to promote energy conservation.	Apr 5, 2013 8:02 AM
20	Pass on suggestions to proper people. Try to facilitate an energy efficient view.	Apr 5, 2013 6:41 AM
21	We could talk about what all of the energy reducing options are (I think we all need a better understanding of our options). Then we would would have more buy-in and ownership.	Apr 4, 2013 4:24 PM
22	listen, pay attention, take others ideas into consideration	Apr 4, 2013 3:56 PM

14. What specific training would help you with energy efficiency in your job?

	Response Count
	25
answered question	25
skipped question	60

Page 3, Q14. What specific training would help you with energy efficiency in your job?		
1	just show us per building what it was before and now what we are saving	Apr 22, 2013 7:58 AM
2	Energy conservation	Apr 17, 2013 12:24 PM
3	light ordering	Apr 16, 2013 9:37 AM
4	Not sure	Apr 16, 2013 7:04 AM
5	I'm interested in any and all training to help reduce energy consumption.	Apr 15, 2013 12:57 PM
6	Training and information given is sufficient.	Apr 15, 2013 8:31 AM
7	How to save energy more.	Apr 14, 2013 11:09 PM
8	planned meeting one or more	Apr 13, 2013 7:30 PM
9	un known	Apr 13, 2013 2:11 PM
10	Bt101 basic steam boiler operator training will help give me more insight and I can share that information.	Apr 13, 2013 3:16 AM
11	Solar Instillation and maintenance training would be good.	Apr 12, 2013 7:57 PM
12	Building schedule training. Training on what are the trouble areas on camup.	Apr 12, 2013 5:49 PM
13	More information on the advances that are taking place within the arena of energy conservation. For my job, I think I keep fairly abreast of the new technologies, strategies, and techniques to keep costs down and productivity and quality high.	Apr 12, 2013 5:28 PM
14	I have no idea.	Apr 12, 2013 4:25 PM
15	Geothermal Training or experience would open new avenues to uses on campus.	Apr 12, 2013 4:18 PM
16	When I design project for the PMs. I don't know all the standards for lighting energy and plumbing fixture. I will like to be in the same training as the PMs for I know what to used.	Apr 8, 2013 7:51 AM
17	Periodic updates of new materials or equipment that we could impliment in our energy upgrade projects.	Apr 8, 2013 6:49 AM
18	If managers work to eliminate just one or two meetings a week and were available to help their staff for that period of time, SOOOO much more would get done. On the job training is valuable, however it requires managers to actually be available to mentor and manage.	Apr 5, 2013 11:37 AM
19	Building commissioning, Better understanding of Metasys	Apr 5, 2013 11:37 AM
20	Provide a specific standards training on Energy Conservation (and recycling) within the new construction and remodeling area.	Apr 5, 2013 8:46 AM
21	Probably a general overview to start with.	Apr 5, 2013 8:02 AM
22	Water conservation, proper IPM practices, and other training that might help my job functions.	Apr 5, 2013 6:41 AM
23	Training, updating with new information as it becomes available and making recomendations.	Apr 4, 2013 10:12 PM
24	I need to understand what my impact is now. I already turn my computer off at night. We use less lights in the office than we used to. I don't let the water run when I wash my hands. I take the golf cart rather than run a gas vehicle. I would like a trash audit....I am not always sure about what I can recycle. I know we use WAY too much paper around here. I would still like to try taking the printer away for a few days and get a feel for what REALLY needs to be printed or if it could be scanned and saved. Thank you for all of the amazing work your group is doing!	Apr 4, 2013 4:24 PM
25	any	Apr 4, 2013 3:56 PM

15. Your Role in Water Efficiency

	Frequently	Occasionally	Rarely	Never	Rating Count
I am given enough authority to make decisions I need to make with regards to water efficiency	**36.8% (21)**	35.1% (20)	15.8% (9)	12.3% (7)	57
I have the materials and equipment I need to do my job well with regards to water efficiency	**35.7% (20)**	33.9% (19)	14.3% (8)	16.1% (9)	56
I make water saving improvement suggestions in my job . . .	24.6% (14)	**29.8% (17)**	**29.8% (17)**	15.8% (9)	57
My supervisor or manager is responsive to my suggestions . . .	**52.6% (30)**	26.3% (15)	10.5% (6)	10.5% (6)	57
				answered question	**57**
				skipped question	**28**

16. Importance of Water Conservation

	Very important	Somewhat important	Not too important	Not important at all	Rating Count
How important is water conservation to you in your assigned role within FM?	**58.6% (34)**	25.9% (15)	12.1% (7)	3.4% (2)	58
How important is water conservation to you personally?	**79.7% (47)**	20.3% (12)	0.0% (0)	0.0% (0)	59
				Comments (be specific)	3
				answered question	**59**
				skipped question	**26**

Page 4, Q16. Importance of Water Conservation

1	currently don't have water in area	Apr 13, 2013 2:12 PM
2	I do not deal with water too much in my role within FM	Apr 12, 2013 7:59 PM
3	I see leaks all the time, and have no control over them. I see daytime irrigation all the time, and the landscape dept. pretends that it does not occur. What am I supposed to do about this? The admin. puts in water features that I think are wasteful, what materials or decisions do I have to control this?	Apr 5, 2013 11:48 AM

17. Current Water Saving Practices

	Yes	No	Not Sure	Rating Count
My job description includes water saving duties	29.3% (17)	**63.8% (37)**	6.9% (4)	58
I am currently part of an water efficiency team	10.2% (6)	**84.7% (50)**	5.1% (3)	59
I have the training I need to reduce water use	31.6% (18)	**52.6% (30)**	17.5% (10)	57
			Comments (be specific)	4
			answered question	**59**
			skipped question	**26**

Page 4, Q17. Current Water Saving Practices

1	i have the training but not the money	Apr 17, 2013 6:58 AM
2	More training in irrigation water audits would be helpful	Apr 16, 2013 7:06 AM
3	Considering that nobody is well informed or equipped to detect or deal with a water main break, maybe we should start there.	Apr 5, 2013 11:48 AM
4	more training on latest trends can always help	Apr 5, 2013 6:42 AM

18. How efficient do you believe Weber State is in terms of water usage?

	Response Percent	Response Count
Not efficient	30.5%	18
Somewhat efficient	**59.3%**	**35**
Very efficient	10.2%	6
Comments (be specific)		4
answered question		**59**
skipped question		**26**

Page 4, Q18. How efficient do you believe Weber State is in terms of water usage?

1	too much watering in the spring and fall when the weather will suffice.	Apr 16, 2013 6:24 AM
2	There definitely has been an improvement in the last eight years noticeably in landscape. There is less street/sidewalk watering I've noticed	Apr 13, 2013 3:22 AM
3	As a whole there can be improvements with regards to water conservation	Apr 12, 2013 5:28 PM
4	I have heard that the storm water re-use system does not actually function.	Apr 5, 2013 11:48 AM

19. What improvements would you recommend to reduce water use?

	Highly Recommended	Somewhat Recommended	Not Recommended	Rating Count
Continuous training for personnel on benefits of fixing steam/water leaks	**72.4% (42)**	25.9% (15)	1.7% (1)	58
Training on drip irrigation systems	**63.8% (37)**	31.0% (18)	5.2% (3)	58
Select water efficient landscaping	**84.5% (49)**	15.5% (9)	0.0% (0)	58
Locating and map water lines	**79.3% (46)**	19.0% (11)	1.7% (1)	58
Reduce risk of unintentionally breaking pipes	**87.9% (51)**	10.3% (6)	1.7% (1)	58
Drought tolerant landscaping	**81.0% (47)**	15.5% (9)	3.4% (2)	58
Water meters on buildings	**60.3% (35)**	39.7% (23)	0.0% (0)	58
Water meters on irrigation systems	**72.4% (42)**	27.6% (16)	0.0% (0)	58
Low flow toilets, urinals, sinks	**65.5% (38)**	31.0% (18)	3.4% (2)	58
Recapture water and use for irrigation	**69.0% (40)**	27.6% (16)	3.4% (2)	58
Better timing of watering to reduce waste	**86.2% (50)**	13.8% (8)	0.0% (0)	58
Use of more hardscape - lava, bark, rock, etc.	**55.2% (32)**	39.7% (23)	5.2% (3)	58
Alternative water sources	**56.9% (33)**	43.1% (25)	0.0% (0)	58
Identify and stop over watering	**89.7% (52)**	10.3% (6)	0.0% (0)	58
			Other (be specific)	6
			answered question	**58**
			skipped question	**27**

Page 5, Q19. What improvements would you recommend to reduce water use?		
1	We are a teaching campus. Watering times have to be balanced against the needs of the students for a learning environment. This does not mean that irrigation systems could not be turned on for operational testing to see if sprinkler heads are clogged or missing on days when students are absent.	Apr 15, 2013 12:54 AM
2	The watering of parking lots has always been an issue at campus (over watering to the point that the water is running off the grass and onto asphalt). Custodial also needs to look at water conservative equipment in regards to auto-scrubbers, carpet extractors, and kyvacs (restroom cleaning machines) which use a lot of water. The first step of course for carpet cleaning is to have better vacuums to pull the dirt out of the carpets with a brush and suction rather than water and soap.	Apr 12, 2013 5:40 PM
3	Develop water catch basins for rainfall that can be used for watering.	Apr 12, 2013 4:50 PM
4	Many of the above we are already doing...	Apr 8, 2013 12:20 PM
5	We sure water a lot of lawn in wide open spaces that could be improved with shade trees or a drought tolerant landscape.	Apr 5, 2013 8:54 AM
6	Better care for sprinkler system to avoid watering the concrete.	Apr 5, 2013 8:09 AM

20. What organizational improvements would you recommend to improve water efficiency?

	Highly Recommended	Somewhat Recommended	Not Recommended	Rating Count
Stay informed of policies, changes to help reduce water use	**68.4% (39)**	29.8% (17)	1.8% (1)	57
Policy to immediately fix water leaks	**75.9% (44)**	20.7% (12)	3.4% (2)	58
Policy to only purchase water efficient fixtures and irrigation equipment	**69.0% (40)**	24.1% (14)	6.9% (4)	58
Communicate the consequences of wasting water	**69.0% (40)**	25.9% (15)	5.2% (3)	58
Adjust work schedules to improve efficiency	44.8% (26)	**46.6% (27)**	8.6% (5)	58
Policy for cleaning staff to reduce water use	39.7% (23)	**50.0% (29)**	10.3% (6)	58
Organize water saving teams for each facility	34.5% (20)	**48.3% (28)**	17.2% (10)	58
Water saving as part of job description	32.8% (19)	**43.1% (25)**	24.1% (14)	58
Water efficiency as part of job evaluation	28.1% (16)	**42.1% (24)**	29.8% (17)	57
Provide water efficiency training for staff, faculty, students, and administration	**72.4% (42)**	22.4% (13)	5.2% (3)	58
			Other (be specific)	4
			answered question	**58**
			skipped question	**27**

Page 5, Q20. What organizational improvements would you recommend to improve water efficiency?

1	we dont need more rules to be written up over	Apr 22, 2013 8:05 AM
2	cleaning staff wasting water-your lucky if the mop water is changed every day, your wastage is leakage and over watering.	Apr 13, 2013 7:48 PM
3	I'll admit first that I don't see how changing someone's shift would improve efficiency. It seems that they'd use the same amount of water for the task they were doing regardless of the time they were doing it at. You could put it on their job description but how would you evaluate whether they were being conservative or wasteful... unless you found them with a hose letting the water run down a drain or something.	Apr 12, 2013 5:40 PM
4	Water efficiency starts with design. If you don't put grass on slopes, you wont have to pay later to rip it out and replace it. Or to water and mow it until you realize it was a bad idea to begin with. When the sunbathing frisbee playing students you were hoping for never actually appear, maybe then you will realize how wasteful grass really is. I think most of the students and workforce have very little to do with water use. People could not flush toilets for a month, and one water main break will waste way more in a few seconds.	Apr 5, 2013 12:00 PM

21. What improvements in new construction or building remodel planning process would you recommend to reduce water use?

		Response Count
		15
	answered question	15
	skipped question	70

Page 5, Q21. What improvements in new construction or building remodel planning process would you recommend to reduce water use?

1	Water efficient faucets in sinks	Apr 17, 2013 12:40 PM
2	more trees less turf in the new landscapes	Apr 17, 2013 7:01 AM
3	better shower heads , get ride of the battery sinks	Apr 16, 2013 9:41 AM
4	Need to be more in the communication loop to make recommendations.	Apr 16, 2013 7:09 AM
5	Recommend that information about energy and water cost saving measures always be discussed as part of planning and construction and development of any building or construction on campus.	Apr 15, 2013 8:44 AM
6	unknown	Apr 13, 2013 2:16 PM
7	Zero scaping, and reduce make up water in building by fixing leaks in water line and steam lines.	Apr 12, 2013 6:00 PM
8	I'd recommend waterless urinals to start with. Students and guests can't flush paper towels down them to clog the drains or cause flooding. It would mean a bit of training for everyone that had to deal with them from the users to the cleaners. I'd hate to get rid of windows, but they do require cleaning which requires a lot of water if your not using a microfiber system (scaffold & squeegee). Poles that spray water on a window to clean it aren't water conservative.	Apr 12, 2013 5:40 PM
9	Standardization of parts, equipment.	Apr 12, 2013 4:50 PM
10	Do not impliment water features that require the use of a pump, or potable water	Apr 8, 2013 6:56 AM
11	Standardization of materials.	Apr 5, 2013 11:42 AM
12	drought tolerant landscaping and better timing on automatic sink fixtures that reduce the amount of over flow	Apr 5, 2013 8:54 AM
13	Use fixtures that are reliably water efficient such as hand sensor taps. Some bad examples are the sinks in the art building bathrooms.	Apr 5, 2013 8:09 AM
14	Good design on water saving features. Waterless urinals.	Apr 5, 2013 6:45 AM
15	set water standards	Apr 4, 2013 3:58 PM

22. What specific training would help you with water efficiency in your job?

		Response Count
		13
	answered question	13
	skipped question	72

Page 5, Q22. What specific training would help you with water efficiency in your job?

1	Don't know	Apr 17, 2013 12:40 PM
2	don't know	Apr 16, 2013 9:41 AM
3	As mentioned previously, water audits would be helpful.	Apr 16, 2013 7:09 AM
4	Training and information is sufficient.	Apr 15, 2013 8:44 AM
5	unknown	Apr 13, 2013 2:16 PM
6	Training on areas of camups that use the most water.	Apr 12, 2013 6:00 PM
7	Scaffolding assembly, scissor-lift training (aerial platforms), and how not to kill the landscaping when cleaning the outside windows with the prior mentioned equipment.	Apr 12, 2013 5:40 PM
8	eficiant water usage pratcices	Apr 8, 2013 6:56 AM
9	I am not aware of how I can be more water efficient in my job, so we could start there.	Apr 5, 2013 12:00 PM
10	I would like to learn about new cost saving measures that could be implemented and also about what the campus standards currently are.	Apr 5, 2013 8:54 AM
11	General overview to start with.	Apr 5, 2013 8:09 AM
12	continued training on better water usage.	Apr 5, 2013 6:45 AM
13	any	Apr 4, 2013 3:58 PM

23. If you are a manager or supervisor, what level of training do you want for your people with regard to energy and water efficiency?

		Response Count
		17
	answered question	17
	skipped question	68

Page 6, Q23. If you are a manager or supervisor, what level of training do you want for your people with regard to energy and water efficiency?

1	The best	Apr 17, 2013 2:48 PM
2	A High Level of Training.	Apr 16, 2013 11:37 AM
3	the highest ,	Apr 16, 2013 9:45 AM
4	Yearly general training	Apr 16, 2013 9:33 AM
5	N/A	Apr 16, 2013 7:10 AM
6	none	Apr 15, 2013 3:18 PM
7	I would like all of our team to be trained in saving utilities.	Apr 15, 2013 1:08 PM
8	unknown	Apr 13, 2013 2:17 PM
9	Continuous	Apr 12, 2013 7:33 PM
10	The more they can get the better, because the more they know the more likely they are to buy into the idea of conserving both.	Apr 12, 2013 5:44 PM
11	There isn't a whole lot of ways in the custodial area to save water except for the newer mopping systems.	Apr 12, 2013 4:32 PM
12	I would like annual training at a minimum for each individual so it stays on their mind through the year.	Apr 12, 2013 4:22 PM
13	I would like to have my team-members trained in the most up to date methods of water and energy savings.	Apr 5, 2013 9:58 PM
14	I would like to see a comprehensive training that has been approved by upper management that would address where we have come from, where we are, and where we are going.	Apr 5, 2013 8:57 AM
15	Trained on policies and ways to say for efficiencies	Apr 5, 2013 8:14 AM
16	At least a basic knowledge of its importance, our reasoning for doing it, and common practice for conservation. Also training on smart electronics that utilize energy saving capabilities, as well as their tag codes and symbols that tell what they are and what kind of energy conservation they implement.	Apr 5, 2013 8:13 AM
17	as much as they can possibly get.	Apr 4, 2013 3:58 PM

24. Thank you for taking this survey. Do you have any other comments for improving energy and water efficiency at Weber State?

	Response Count
	16
answered question	16
skipped question	69

Page 6, Q24. Thank you for taking this survey. Do you have any other comments for improving energy and water efficiency at Weber State?

1	No	Apr 17, 2013 2:48 PM
2	our outdated irrigation systems are a huge water wasting issue.replace with newer system	Apr 17, 2013 7:03 AM
3	A lot of time we see a lot of sprinklers that have broken and water flowing every where , I think that its all are jobs to help each other so if you see a broken sprinkler don't just shrug it off call and let some one know about it . thank you	Apr 16, 2013 9:45 AM
4	none	Apr 15, 2013 3:18 PM
5	No	Apr 15, 2013 1:08 PM
6	no	Apr 13, 2013 2:17 PM
7	Improving (decreasing) the make-up water usage has been tremendous as far as chemical usage. Turn off lights when not in use. Repair leaks ASAP.	Apr 13, 2013 3:29 AM
8	It might be helpful for the teams designing the new lighting to talk to the folks that change the lights or work in the buildings (yes the custodians there) so that they don't run into issues where the new lights can't be accessed or have them requesting that they replace the bulbs in the new fixtures with LEDs.	Apr 12, 2013 5:44 PM
9	I have found lights on in areas that appeared to be low use areas. With the question in my head, "How long has this been on?" My answer- long enough to pay for a motion detecting light switch.	Apr 12, 2013 4:54 PM
10	I would think that when a work order is put in for a leak, it should be fixed ASAP. There have been times when a shower in the SK has run for weeks before it was fixed. Yikes, that's a lot of hot water wasted. I don't believe it is that bad at this time. When we have a toilet that will not stop running, we turn it off, lock the door and put an out of order sign on it then put in a work order. This I am sure, saves a lot of wasted water.	Apr 12, 2013 4:32 PM
11	WSU is already doing many of the items outlined in the survey.	Apr 8, 2013 12:21 PM
12	Please communicate the status of Webers water and energy use better to all students and staff, the bad and the good. If students realize that their funds are going to wasteful projects, maybe the administrations attitude will change.	Apr 5, 2013 12:04 PM
13	Use of irrigation water in our cooling towers.	Apr 5, 2013 11:43 AM
14	Probably.....I'll get back to you. Thanks.	Apr 5, 2013 8:57 AM
15	No	Apr 5, 2013 8:13 AM
16	Looking at hydro electric generators on irrigation Mains. Better design for pump house at pond so we can utilize that water better. Trek transport plus bikes for use by some technicians.	Apr 5, 2013 6:47 AM

(THIS PAGE INTENTIONALLY BLANK)

APPENDIX E
FUTURES WORKSHOP SURVEY RESPONSES

APPENDIX E
FUTURES WORKSHOP
PARTICIPANT SURVEY DATA

Weber Futures Workshop - Evaluation

SurveyMonkey

1. What did you like BEST about the workshop?

	Response Count
	13
answered question	13
skipped question	0

Page 1, Q1. What did you like BEST about the workshop?

1	University wide involvement - broad and diverse perspectives	Oct 3, 2013 4:10 PM
2	Conversations. Thought provoking topics. Cross section of WSU voices - sharing of ideas	Oct 3, 2013 4:08 PM
3	Interaction	Oct 3, 2013 4:03 PM
4	Freedom to communicate with others. (Faculty and staff) from around the campus (various departments) to discuss ideas and share/collaborate.	Oct 3, 2013 4:01 PM
5	The small group scenarios.	Oct 3, 2013 3:58 PM
6	working w/ the different individuals.	Oct 3, 2013 3:56 PM
7	The multiple perspectives from the variety of roles.	Oct 3, 2013 3:54 PM
8	Working in small groups & hearing from a variety of perspectives.	Oct 3, 2013 3:52 PM
9	Synergy of the group discussions	Oct 3, 2013 3:50 PM
10	Mix of people from various disciplines and perspectives, - interesting discussions and ideas.	Oct 3, 2013 3:49 PM
11	The opportunity to learn from the diverse group. The opportunity to learn more about the academic/IT side of things.	Oct 3, 2013 3:45 PM
12	Working with others from different departments. Learning that as a whole group we share common goals.	Oct 3, 2013 3:40 PM
13	collaboration	Oct 3, 2013 3:38 PM

2. What did you like LEAST about the workshop?

	Response Count
	13
answered question	13
skipped question	0

Page 1, Q2. What did you like LEAST about the workshop?

1	Not enough time to fully discuss.	Oct 3, 2013 4:10 PM
2	Time commitment. (unavoidable - but challenging)	Oct 3, 2013 4:08 PM
3	The facilitator limited the discussion	Oct 3, 2013 4:03 PM
4	Small breakout groups were too small for brainstorming.	Oct 3, 2013 4:01 PM
5	The common red or green flag sessions (Tues 3-4ish) went on too long. Just too many people throwing out random points. Lost flow.	Oct 3, 2013 3:58 PM
6	Lack of specific conclusions	Oct 3, 2013 3:56 PM
7	The scenarios seemed a little stilted, but they were useful for the full process.	Oct 3, 2013 3:54 PM
8	It had a slow start on the 1st day.	Oct 3, 2013 3:52 PM
9	Room is a little small.	Oct 3, 2013 3:50 PM
10	Length of time, but likely was necessary. Not much was wasted in terms of the running of the workshop.	Oct 3, 2013 3:49 PM
11	I think it would have been good to have more folks involved in generating the scenarios for analysis.	Oct 3, 2013 3:45 PM
12	Talking doesn't always drive action.	Oct 3, 2013 3:40 PM
13	time consumption - but necessary	Oct 3, 2013 3:38 PM

3. How could the workshop be improved?

		Response Count
		10
	answered question	10
	skipped question	3

Page 1, Q3. How could the workshop be improved?

1	More time	Oct 3, 2013 4:10 PM
2	# of advanced readings shortened - might feel like less of time commitment. For example, article for using ocean water to cool IT resources not necessarily related to WSU.	Oct 3, 2013 4:08 PM
3	The focus should allow more opportunity to explore ideas that don't fit within the simple categories. Too much focus on "bullets" and not enough on nuance.	Oct 3, 2013 4:03 PM
4	Use of electronics for notes and presenting ideas after breakout sessions	Oct 3, 2013 4:01 PM
5	Action items - See value	Oct 3, 2013 3:56 PM
6	Get rid of the bottled water!! More students.	Oct 3, 2013 3:54 PM
7	Possible other perspectives included (I'm not sure who - community, business?). wellness???	Oct 3, 2013 3:49 PM
8	The conversations were great and I learned a lot but the bigger question is how the information will be used. What will ultimately be the workshop outcomes. Making that clearer to the group will make folks happier/more likely to participate in future workshops.	Oct 3, 2013 3:45 PM
9	More time for group breakouts, less time talking about activities for the day.	Oct 3, 2013 3:40 PM
10	product from workshop distributed	Oct 3, 2013 3:38 PM

4. Overall, how would you rate the workshop?

	Response Percent	Response Count
Excellent	46.2%	6
Good	**53.8%**	**7**
Fair	0.0%	0
Poor	0.0%	0
answered question		13
skipped question		0

5. What is your role at the University?

	Response Percent	Response Count
Student	7.7%	1
Faculty	**30.8%**	**4**
Administration	15.4%	2
Facilities Management (FM)	23.1%	3
Information Technology (IT)	7.7%	1
Other	15.4%	2
	Other (please specify)	3
	answered question	**13**
	skipped question	**0**

Page 1, Q5. What is your role at the University?

1	University Communication	Oct 3, 2013 4:08 PM
2	WSU Online / continuing education	Oct 3, 2013 3:52 PM
3	and Faculty	Oct 3, 2013 3:40 PM

6. How many of the online resource articles did you read?

	Response Percent	Response Count
Less than 5	30.8%	4
5 to 10	**46.2%**	**6**
10 to 20	7.7%	1
20 to 40	15.4%	2
More than 40	0.0%	0
	answered question	**13**
	skipped question	**0**

7. Any final comments?

	Response Count
	1
answered question	**1**
skipped question	**12**

Page 2, Q7. Any final comments?

1	However I'm aware of /familiar with the issues in those readings.	Oct 3, 2013 3:54 PM

(THIS PAGE INTENTIONALLY BLANK)

APPENDIX F
GEOTHERMAL STUDY REPORT

Sound Geothermal Corporation

3962 Alpine Valley Circle
Sandy, UT 84092
P: 801-942-6100 F: 801-942-6127
www.soundgt.com
soundgt@soundgt.com

GEOEXCHANGE™
Comfort from the ground up

December 19, 2013

Mr. Jacob Cain
Energy Manager
Weber State University
2601 University Circle
Ogden, UT 84408-2601
jacobcain@weber.edu

Re: Weber State University – Thermal Conductivity Test Report

Dear Mr. Cain,

This report contains drilling data, thermal conductivity data, and an analysis of the test boreholes completed on the Weber State University campus in Ogden, Utah. Three test boreholes were drilled on this site: borehole (BH) #1 near the northeast corner of the parking lot W-5, borehole #2 near the southwest corner of parking lot W-5, and borehole #3 near the southern side of parking lot A-2 (see attached map for approximate locations).

Borehole #1 Drilling Summary: BH#1 was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 280 feet. The upper zone from the surface to 140 feet included sand, silt, and clay with some gravel; drilling proceeded quickly through this zone. The zone from 140 to 280 feet consisted of layers of clay and gravel. In places the gravel appeared to be weakly cemented. Drilling slowed in this material. At 280 feet solid Tintic Quartzite was encountered; this very hard rock drilled slowly. Since the drilling speeds encountered would not be conducive to economical production drilling, it was decided to stop drilling and load the borehole at 350 feet. No significant lost circulation was noted while drilling. BH#1 was drilled with 5-1/4" carbide button bits. The 1.25" HDPE earthloop was inserted to 338 feet and would not go deeper. It was difficult to run the tremie in this bore, likely due to swelling clay layers. BH#1 was grouted from bottom to surface; it appears that there was minimal grout loss to the formation.

Borehole #2 Drilling Summary: BH#2 was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 318 feet. This zone included sandy clay and gravel to 70 feet, clay and silt from 70 to 160 feet, and layers of clay, silt, and gravel from 160 to 318 feet. Drilling proceeded relatively quickly to 318 feet with no issues. At 318 feet hard white Tintic Quartzite pebble gravel was encountered. Drilling in this zone was difficult and slow. It was decided to stop drilling and load the borehole at 355 feet. No significant lost circulation was noted while drilling. BH#2 was drilled with a 5-5/8" carbide button bit. It was difficult to run the loop and tremie in this bore, likely due to swelling clay layers. After multiple attempts, the 1.25" HDPE earthloop was inserted to 354 feet. The tremie would not go past 50 feet. Based on grout volume calculations, it appears that grout went to the bottom of the bore and there was minimal grout lost to the formation, but since the tremie did not go to bottom this cannot be determined with certainty. For this reason it was determined to conduct the TC test for lot W-5 on BH#1.

Borehole #3 Drilling Summary: BH#3 was drilled through landslide deposits and Lake Bonneville sediments (valley fill) to 406 feet. From the surface to 184 feet the formation consisted primarily of clay: relatively pure down to 90 feet, then silty with traces of gravel from 90 to 184 feet. From 184 to 230 feet layers of hard gravel were bedded in tan and green clay. These gravel layers contained both quartz and granitic material; several layers appeared to be water-bearing. Fine silt with traces of clay and gravel was present from 230 to 406 feet. From 406 to the total drilled depth of 428 feet hard black gravel was bedded with thin green clay layers. It is suspected that this layer represents the pre-Bonneville alluvium. Drilling proceeded relatively quickly to the contact layer with this deeper gravel at 406 feet, then slowed significantly. BH#3 was drilled with 5-1/4" carbide button bits. Very slight fluid loss was noted while drilling the gravel layers from 184-230 feet. The 1.25" HDPE earthloop was inserted to 401 feet with no issues; it was decided to load the loop to this depth to represent a production bore designed to avoid the harder gravel layers below. It was difficult, however, to run the tremie in this bore, likely due to swelling clay layers. Sealing this bore did require significantly more grout than anticipated (40% loss). It is not known if this loss is associated with the upper gravel layers, the deeper gravel layers, or both.

The GeoPro Thermal Grout Select and Thermal Grout Lite mixtures used meets all NWGA and State requirements for permeability and should be adequate to seal and protect any near surface aquifer. Complete drilling logs for all three bores are enclosed.

Drilling Economics: The change in composition and thickness of the sediments, and the depth to harder rock, across this site have a significant impact on drilling speed, and thus cost. In general, the landslide and lake deposits included more large grained material and gravel closer to the mountains, and more fine grained material with less gravel to the west. In addition, the quartzite was encountered shallower close to the mountains in BH#1, deeper in BH#2, and not at all in BH#3 to the West, although hard gravel was encountered in the bottom of BH#3. The table below summarizes drilling times and average rates of penetration for each test bore.

As Drilled and Tested:

Borehole	Drilled Depth (Feet)	Drilling Time* (H:M)	Avg. Rate of Penetration (Feet/Min.)
BH#1	350	8:48	0.7
BH#2	355	4:54	1.2
BH#3	428	4:40	1.5

*Actual bit turning on bottom drilling time, not including connections, repairs, etc.

Since the faster drilling is in the upper portion of each bore, there is an opportunity to optimize production drilling by designing to a shallower target depth. Based on the drilling data we suggest that for Lot W-5 the target depth be between 250-300 feet, and that for Lot A-2 a target depth of 400 feet is reasonable. The following table provides examples for each bore. These suggestions are subject to further evaluation relative to desired system capacity, etc.

Optimized Examples:

Borehole	Proposed Depth (Feet)	Drilling Time* (H:M)	Avg. Rate of Penetration (Feet/Min.)
BH#1	250	5:00	0.8
BH#2	300	2:43	1.8
BH#3	400	3:38	1.8

Another benefit of optimizing bore length for quicker drilling is that it increases the chance that a single bore can be drilled, looped, and grouted in one day. Due to the drilling schedule falling over the Thanksgiving holiday weekend, all three bores were drilled and completed over the course of multiple days, including days shut down for the holiday. We suspect that this down time contributed to the difficulty in inserting the loop and tremie pipes.

Thermal Conductivity Testing: Two thermal conductivity tests were conducted on the site from December 10-12, 2013. In Lot W-5 Borehole #1 was selected for testing due to the fact that the grout tremie went to bottom, ensuring proper grout placement. The single borehole in Lot A-2, BH#3, was also tested.

> **BH#1:** The thermal conductivity (TC) was very high for the Wasatch Front, **1.71 btu/hr-ft-°F** (vs. 1.0 btu/hr-ft-°F average). The diffusivity value calculated from the test was **1.20 ft^2/day**. The deep earth temperature range was **55.7°F – 57.4°F**, toward the higher end of the normal range for the Wasatch Front. *Note: if it is decided to optimize bore length to avoid the quartzite, then we suggest using a more conservative TC design value of 1.18 btu/hr-ft-°F for Lot W-5. Without further testing it cannot be determined how much of the higher TC value is due to the quartzite.*
>
> **BH#3:** The thermal conductivity (TC) was above average for the Wasatch Front, **1.18 btu/hr-ft-°F** (vs. 1.0 btu/hr-ft-°F average). The diffusivity value calculated from the test was **0.77 ft^2/day**. The deep earth temperature range was **56.2°F – 57.8°F**, consistent with the first test. The full thermal conductivity analysis for both bores is enclosed.

In summary, we would characterize the drilling on this site as favorable. Drilling speeds encountered should enable economical production drilling, provided the Tintic Quartzite and deep gravels are avoided. The thermal conductivity of both tested boreholes is better than average, and native temperature is within the expected range. Our conclusion is that this site is suitable for GeoExchange. We suggest that bore depth be optimized to suit the geologic conditions of each designated borefield, and that the more conservative TC value of **1.18 btu/hr-ft-°F** be used for both sites evaluated. More detailed evaluation of the specific configuration should take place during the ground heat exchanger design process. Due to the significant variations in site geology discovered in these test bores, we recommend that TC test(s) be conducted in each area (parking lot, etc.) considered for future ground heat exchanger installation to confirm optimal depth and thermal performance.

We will e-mail a consolidated report consisting of this cover letter, the drilling logs, and the TC test results. This package should be used as part of the drilling bid package in order to facilitate the bid process. We will also append this consolidated report to the loopfield specifications.

We will be happy to provide electronic or hard copies as needed, or forward this report at your request. If you have any questions, please call. Thank you for using Sound Geothermal testing and design services. We will look forward to working with you as your plans for the campus develop.

Sincerely,

David N. Eckels

Enclosures: TC Bore Map, TC Drilling Logs, FTC Test & Data Analysis

CC: File

WEBER STATE UNIVERSITY – THERMAL CONDUCTIVITY TEST BOREHOLE LOCATIONS

Drilled 11/25/2013 to 12/2/2013, left fusion capped as of 12/12/2013

Approximate Locations (hand held GPS WGS84)	
BH1	41°11'39.16"N, 111°56'17.53"W
BH2	41°11'35.72"N, 111°56'23.98"W
BH3	41°11'39.66"N, 111°56'35.22"W

Sound Geothermal Corporation

DRILLING LOG - Test Borehole

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #1
11/25/2013 - 11/26/2013

Location: Legal S3 T5N R1W SLBM
GPS WGS84 41°11'39.16"N, 111°56'17.53"W
Elevation 4756' (GPS)

Approx. Address: Near NE Corner of Parking Lot W-5
Near E3850 & Edvalson St.
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 1010' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite & Select 0.88 (1:4 Mix)
SPUD/TD: 11/25/2013 10:50 / 11/26/2013 14:52
Spud with: 5-1/4" Carbide Button Bit - Used, moderate condition (surface bit)
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	Time End	Activity	Duration Hrs:Min	Depth (Ft.) From	Depth (Ft.) To		Comments
11/25/2013							
10:30	10:50						Rig up, Mix 1.5 sx mud
10:50	10:57	D	0:07	0	10		Asphalt, road base, gravel
							Add 10' stabilizer, change to new 5-1/4" Button Bit
							Ream 0-10'
11:02	11:06	D	0:04	10	20	Silt, Clay, Sand, Gravel	70% coarse tan sand, 30% M angular multicolored gravel
11:06	11:10	D	0:04	20	30		AA
11:13	11:21	D	0:08	30	40		50% tan silty sand, 50% S-M gravel
11:21	11:28	D	0:07	40	50		Layers of fine silt & S gravel
11:30	11:39	D	0:09	50	60		AA
11:39	11:50	D	0:11	60	70		AA more clay
11:52	11:57	D	0:05	70	80		Fine silt, tr clay, tr gravel
11:57	12:02	D	0:05	80	90		AA
12:03	12:07	D	0:04	90	100		Fine silt, 20% clay, tr S gravel
12:07	12:13	D	0:06	100	110		AA
12:14	12:19	D	0:05	110	120		AA
12:19	12:30	D	0:11	120	130		Silty tan clay with coarse sand
12:32	12:43	D	0:11	130	140		AA
12:46	13:06	D	0:20	140	150	Layers of Gravel and Clay	Tan clay, tr silt, crs. Sand; harder 146-150' quartz gravel
13:08	13:28	D	0:20	150	160		150-156: Hard gravel, multicol. quartz, possibly cemented
							156-160: layers tan clay & gravel
13:28	13:46	D	0:18	160	170		Layers tan clay & hard gravel
13:48	14:01	D	0:13	170	180		AA
14:01	14:27	D	0:26	180	190		Tan clay w/ layers hard L gravel
14:30	14:39	D	0:09	190	200		AA more clay
14:39	14:54	D	0:15	200	210		Layers clay & S gravel
14:56	15:14	D	0:18	210	220		AA
15:14	15:35	D	0:21	220	230		AA
15:37	15:54	D	0:17	230	240		AA
15:54	16:20	D	0:26	240	250		AA harder

DRILLING LOG - Test Borehole

16:21	16:38	D	0:17	250	260		Large (3/4"-) gravel, possibly cemented
16:38	16:55	D	0:17	260	270		AA
16:57	17:07						POOH - SDFN - Bit in good condition
11/26/2013							
8:00	11:32						Rig up, repairs, Mix 1/4 sx mud, RIH to 270', tight due
							to swelling clay, but no caving, some small water zones 75'+
11:32	11:50	D	0:18	270	280		Hard gravel, partially cemented, with clay layers
11:50	12:14	D	0:24	280	290	Quartzite-Solid	Tintic Quartzite - hard, small chips, white, tr pink, yellow
12:16	12:40	D	0:24	290	300		AA
12:40	13:03	D	0:23	300	310		AA
13:05	13:30	D	0:25	310	320		AA
13:30	13:55	D	0:25	320	330		AA
13:57	14:20	D	0:23	330	340		AA
14:20	14:52	D	0:32	340	350		AA
							Decide to stop drilling and load borehole.
14:52	15:40						Circulate / Run for water
15:40	15:52						POOH - no problems - Bit missing 2 cones, carbides OK

Total Drilling Time: 8:48 Hrs:Min Drilling 0 - 350'

COMMENTS:

11/26/2013 Pressure test HDPE loop to 120 PSI for 1 hour.
15:52 16:01 **RIH HDPE loop to 338'** - will not go deeper.
16:29 17:44 RIH 1.25" Flexible tremie hose to approx. 338'
Difficult to insert past swelling clay layers
Mix and pump 2 units Geo Pro Thermal Grout Select 0.88 (1:4),
and 10 units Thermal Grout Lite 0.88 (1:4), returns to surface.

11/27/2013 Top off with 3/4 unit Thermal Grout Lite 0.88.

11/29/2013 Grout level stable at surface.
Total grout pumped 12.75 units - calculated min. annular volume approx. 11 units (no loss).
Est. 3000 gal. water to complete bore.

This bore was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 280 feet. The upper zone from the surface to 140 feet included sand, silt, and clay with some gravel; drilling proceeded quickly through this zone. The zone from 140 to 280 feet consisted of layers of clay and gravel. In places the gravel appeared to be weakly cemented. Drilling slowed in this material. At 280 feet solid Tintic Quartzite was encountered. This very hard material drilled slowly. It was decided to stop drilling and load the borehole at 350 feet (loop to 338). No significant lost circulation was noted while drilling. It was difficult to run the tremie in this bore, likely due to swelling clay layers. It appears that there was minimal grout loss to the formation.

Drilling observed and samples logged by David Eckels of Sound Geothermal.

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #2
11/27/2013 - 11/29/2013

Location: Legal S3 T5N R1W SLBM
GPS WGS84 41°11'35.72"N, 111°56'23.98"W
Elevation 4747' (GPS)

Approx. Address: SW side of Parking Lot W-5
Near 4004 Taylor Ave.
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 810' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite & Select 0.88 (1:4 Mix)
SPUD/TD: 11/27/2013 9:55 / 11/27/2013 15:43
Spud with: 5-5/8" Carbide Button Bit - Used, good condition
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	Time End	Activity	Duration Hrs:Min	Depth (Ft.) From	Depth (Ft.) To		Comments
11/29/2013							
	9:55						Rig up, Mix 1.5 sx mud
9:55	9:59	D	0:04	0	10		Asphalt, road base (gravel, sandy clay)
9:59	10:05	D	0:06	10	20	Sandy Clay, Gvl	Gravel in tan sandy clay; more gravel 14-15'
10:09	10:15	D	0:06	20	30		70% Red tan sandy clay, 30% S-M angular gravel
10:15	10:21	D	0:06	30	40		AA tr larger gravel
10:23	10:27	D	0:04	40	50		90% red-tan sandy clay, 10% gravel
10:27	10:31	D	0:04	50	60		90% red-tan sandy clay, 10% coarse sand, tr gravel
10:33	10:36	D	0:03	60	70		Red-tan clay, tr sand, large cuttings
10:36	10:40	D	0:04	70	80	Clay, Silt	Gray-brown clay, tr sand
10:44	10:47	D	0:03	80	90		AA
10:49	10:53	D	0:04	90	100		AA
10:55	10:57	D	0:02	100	110		Fine silt, few cuttings
10:57	10:59	D	0:02	110	120		AA
11:01	11:04	D	0:03	120	130		Gray-brown clay, tr gravel
11:04	11:08	D	0:04	130	140		AA
11:10	11:15	D	0:05	140	150		Fine silt, tr clay
11:15	11:19	D	0:04	150	160		AA
11:20	11:26	D	0:06	160	170	Clay, Silt, Gravel	Light brown silty clay, tr S gravel
11:26	11:32	D	0:06	170	180		AA
11:34	11:40	D	0:06	180	190		Silt, tr sandy clay, crs sand
11:40	11:53	D	0:13	190	200		AA
11:55	12:01	D	0:06	200	210		Layers of hard gravel & light brown clay
12:01	12:08	D	0:07	210	220		Silt
12:10	12:15	D	0:05	220	230		AA, tr clay
12:15	12:23	D	0:08	230	240		Layers of gravel & light brown silty & clay
12:25	12:31	D	0:06	240	250		AA

DRILLING LOG - Test Borehole

12:31	12:40	D	0:09	250	260	Layers of	AA
12:42	12:49	D	0:07	260	270		AA
12:49	12:58	D	0:09	270	280		AA
13:00	13:05	D	0:05	280	290		AA
13:05	13:11	D	0:06	290	300		AA
13:14	13:23	D	0:09	300	310		AA
13:23	13:43	D	0:20	310	320	Quartzite Gvl	AA to 318; 318-320' hard gravel, mostly white w/ gray/green
13:59	14:24	D	0:25	320	330		Hard L gravel - white, black, dark green, lots of quartz
14:24	15:01	D	0:37	330	340		Layers of L (3/4"-) white quartzite gravel & silt
15:03	15:24	D	0:21	340	350		Hard gravel - white quartzite
15:24	15:43	D	0:19	350	355		Hard gravel - white quartzite
15:48	15:56						POOH - leave one joint in hole
							Bit carbides OK, bearings loos, SDFN
11/29/2013							
8:00	8:45						RIH to 355' - tight from about 30'-140' - swelling clays
8:45	9:05						Circulate, thin mud,
9:05	9:25						POOH, no problems

Total Drilling Time: 4:54 Hrs:Min Drilling 0 - 355'

COMMENTS:

11/29/2013 Pressure test HDPE loop to 120 PSI for 1/2 hour.

9:38 9:46 Attemp to RIH HDPE loop - resistance @ 30', straighten pipe, still cannot go past 75'
9:48 10:16 POOH HDPE loop, RIH drill bit & ream to 160', add polymer, ream to 355'
10:16 10:41 Circulate, run for water, circulate, thin mud
10:41 10:51 POOH
10:51 10:58 **RIH HDPE loop to 354'**, no problems
11:10 11:42 Attempt to run 1.25" flexible tremie hose, will not go past 50'
Try repositioning loop, angle, etc. with no progress
11:45 12:59 Mix and pump Geo Pro: 10 Units Thermal Grout Select 0.88 (4:1)
2 Units Thermal Grout Lite 0.88 (4:1)
Returns to Surface

11/30/2013 Top off with 3 units Thermal Grout Lite 0.45 (0:1), returns to surface
12/2/2013 Top off 6" with Thermal Grout Lite 0.45 (0:1)
12/3/2013 Grout level stable at surface.
Total grout volume pumped approx. 398 gallons.
Calculated min. annular volume approx. 378 gallons (no loss).
Est. 3000 gal. water to complete bore.

This bore was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 318 feet. This zone included sandy clay and gravel to 70 feet, clay and silt from 70 to 160 feet, and layers of clay, silt, and gravel from 160 to 318 feet. Drilling proceeded relatively quickly to 318 feet with no issues. At 318 feet hard white Tintic Quartzite pebble gravel was encountered. Drilling in this zone was difficult and slow. It was decided to stop drilling and load the borehole at 355 feet (loop to 354). No significant lost circulation was noted while drilling. It was difficult to run the loop and tremie in this bore, likely due to swelling clay layers. It appears that there was minimal grout location to the formation, but since the tremie did not go to bottom this cannot be determined with certainty.

Drilling observed and samples logged by David Eckels of Sound Geothermal.

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #3
11/29/2013 - 12/2/2013

Location: Legal — S3 T5N R1W SLBM
GPS — WGS84 41°11'39.66"N, 111°56'35.22"W
Elevation — 4668' (GPS)

Approx. Address: South side of Parking Lot A-2
N of Elizabeth Hall
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 810' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite - various sand ratios - see notes below.
SPUD/TD: 11/29/2013 14:44 / 11/30/2013 12:43
Spud with: 5-1/4" Carbide Button Bit - Used, good condition
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	End	Activity	Duration Hrs:Min	Depth (Ft.) From	To		Comments
11/29/2013							
14:00	14:44						Rig up, Mix 1.5 sx mud
14:44	14:50	D	0:06	0	10		0-5' Roadbase; 5-10' brown clay w/ gravel layers
14:50	14:56	D	0:06	10	20	Clay, Silty Clay	Red-brown clay
							Add 10' stabilizer
15:04	15:08	D	0:04	20	30		Brown clay
15:10	15:12	D	0:02	30	40		AA
15:12	15:19	D	0:07	40	50		AA (add polymer)
15:21	15:24	D	0:03	50	60		AA
15:24	15:28	D	0:04	60	70		AA
15:30	15:34	D	0:04	70	80		AA
15:34	15:38	D	0:04	80	90		AA
15:40	15:44	D	0:04	90	100		Brown silty clay, tr gravel
15:44	15:48	D	0:04	100	110		AA
15:50	15:53	D	0:03	110	120		AA
15:53	15:57	D	0:04	120	130		AA
15:58	16:02	D	0:04	130	140		AA
16:02	16:07	D	0:05	140	150		AA
16:08	16:12	D	0:04	150	160		AA
16:12	16:17	D	0:05	160	170		AA
							POOH - SDFN
11/30/2013							Change to new 5-1/4" Carbide Button Bit
8:30	8:44						RIH - tight from 50' down (swelling clays)
8:44	8:50	D	0:06	170	180		AA (Brown silty clay, tr gravel)
8:50	8:56	D	0:06	180	190	Gravel Layers	AA w/ hard multicolored gravel layer 184-186'
8:59	9:07	D	0:08	190	200		Green silty clay w/ several water-bearing hard gravel layers
9:07	9:24	D	0:17	200	210		Green & tan silty clay w/ gravel layers (b&w granite in gvl)
9:26	9:35	D	0:09	210	220		Green & tan silty clay w/ larger gravel layers (including qtz)
9:35	9:46	D	0:11	220	230		Tan clay tr green, with gravel layers
9:48	9:52	D	0:04	230	240		Fine silt, tr clay & gravel
9:52	9:59	D	0:07	240	250		AA

DRILLING LOG - Test Borehole

10:01	10:05	D	0:04	250	260		AA
10:05	10:11	D	0:06	260	270		AA, less clay, more gravel
10:13	10:17	D	0:04	270	280		AA
10:17	10:22	D	0:05	280	290		AA
10:24	10:28	D	0:04	290	300		AA
10:28	10:32	D	0:04	300	310		AA
10:34	10:38	D	0:04	310	320	Silt	AA
10:38	10:45	D	0:07	320	330		AA (pump pit 2x)
10:51	10:57	D	0:06	330	340		AA
10:57	11:04	D	0:07	340	350		AA
11:06	11:11	D	0:05	350	360		AA
11:11	11:15	D	0:04	360	370		AA
11:18	11:24	D	0:06	370	380		AA
11:24	11:29	D	0:05	380	390		AA
11:32	11:38	D	0:06	390	400		AA
11:38	11:54	D	0:16	400	410		AA - Harder @406' - Multicolored gravel, mostly black
11:57	12:19	D	0:22	410	420	Gravel	Mostly black gravel, thin green clay layers
12:19	12:43	D	0:24	420	428		AA, Harder at 428, decide to stop and load borehole
12:43	12:46						Circulate / Run for water
12:46	12:58						POOH - no problems - Bit OK - SDFN
12/2/2013							
	9:02						RIH to bottom (428'), tight from 30' down (swelling clays)
							No caving
9:02	9:55						Circulate - Thin Mud
9:55	10:05						POOH, no problems

Total Drilling Time: 4:40 Hrs:Min Drilling 0 - 428'

COMMENTS:

12/2/2013 Pressure test HDPE loop to 120 PSI for 1/2 hour. (Using 810' loop to represent 400' target depth)

10:06 10:14 **RIH HDPE loop to 401**' - no problems.

10:35 Try to RIH 1.25" flexible tremie hose, stuck at 30', fight it to 36', stuck again.

POOH 1.25" flexible tremie hose

RIH 1.25" rigid PVC tremie to 370' (all the PVC tremie pipe on site)

Mix and pump Geo Pro: 2 Units Thermal Grout Lite 0.88 (4:1)
6 Units Thermal Grout Lite 0.69 (2:1)
20 Units Thermal Grout Lite 0.45 (0:1)

14:15 Returns to Surface

12/3/2013 Top off with 7 more units Thermal Grout Lite 0.45, and two bags of Cetco Bentonite Crumbles

12/10/2013 Grout level stable at surface.
Total grout volume pumped approx. 704 gallons.
Calculated min. annular volume approx. 392 gallons (no loss).
Est. 3000 gal. water to complete bore.

This bore was drilled through landslide deposits and Lake Bonneville sediments (valley fill) to 406 feet. From the surface to 184 feet the formation consisted primarily of clay: relatively pure down to 90 feet, then silty with traces of gravel from 90 to 184 feet. From 184 to 230 feet layers of hard gravel were bedded with tan and green clay. These gravel layers contained both quartz and granitic material; several layers appeared to be water-bearing. Fine silt with traces of clay and gravel was present from 230 to 406 feet. From 406 to the total drilled depth of 428 feet hard black gravel was bedded in thin green clay layers. It is suspected that this layer represents the pre-Bonneville alluvium. Drilling proceeded relatively quickly to the contact layer with this deeper gravel at 406 feet, then slowed significantly. Very slight fluid loss was noted while drilling the gravel layers from 184-230 feet, but sealing this bore did require significantly more grout than anticipated (40% loss). It is not known if this loss is associated with the upper gravel layers, the deeper gravel layers, or both. In addition, it was difficult to run the tremie in this bore, likely due to swelling clay layers.

Drilling observed and samples logged by David Eckels of Sound Geothermal.

Geothermal Soil Analysis

LEGEND

Colors:	Descriptors:	Lithology:	Drilling:
blk - black	ang - angular	bas - basalt	AA - As Above
blu - blue	cmt - cement	bdl - boulder	PU - Pick Up
brn - brown	crs - coarse	cbl - cobble	POOH - Pull out of hole
bu - buff	dk - dark	cche - caliche	RIH - Run in hole
clr - clear	f - fine	cgl - conglomerate	RU - Rig Up
crm - cream	frm - firm	cl - clay	SDFN - Shut down for night
gn - green	hd - hard	dol - dolomite	SX - Sack(s)
gry - gray	L - Large	grt - granite	TD - Total Depth
pk - pink	lt - light	grv - gravel	
rd - red	M - Medium	ls - limestone	
tn - tan	mtrx - matrix	qtz - quartzite	
trnsl - translucent	S - Small	sd - sand	
wh - white	sbang - sub angular	sh - shale	
yel - yellow	sft - soft	slt - silt	
	tr - trace	slts - siltstone	
	uncons - unconsolidated	ss - sandstone	
		volc - volcanics	

FORMATION THERMAL CONDUCTIVITY
TEST & DATA ANALYSIS

TEST LOCATION

Weber State University
Test Borehole #1
Ogden, UT

Near Northeast Corner of
Parking Lot W-5

TEST DATE

December 10-12, 2013

ANALYSIS FOR

Sound Geothermal Corporation
3962 East Alpine Valley Circle
Sandy, UT 84092
Phone: 801-942-6100
Fax: 801-942-6127

TEST PERFORMED BY

Sound Geothermal Corporation

EXECUTIVE SUMMARY

A formation thermal conductivity test was performed on Test Borehole #1 at Weber State University in Ogden, Utah with a GPS location of N 41° 11' 39.16" (latitude), W 111° 56' 17.53" (longitude). The vertical bore was completed on November 27, 2013 by Bertram Drilling, Inc. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of December 10, 2013.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 1.71 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity ≈ 1.20 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature ≈ 55.7-57.4°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

TEST PROCEDURES

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours**.**

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

Data Analysis

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. If a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear equation coefficients to produce a line that fits the data are calculated. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

Contact: Galen Streich
Regional Managing Engineer
Elkton, SD
(605) 692-9069
gstreich@grti.com

TEST BORE DETAILS
(AS PROVIDED BY SOUND GEOTHERMAL CORPORATION)

Site Name .... Test Borehole #1
Weber State University

Location .... Ogden, UT

Driller .... Bertram Drilling, Inc.

Installed Date .... November 27, 2013

Borehole Diameter .... 5 1/4 inches

U-Bend Size .... 1 1/4 inch DR-11 HDPE

U-Bend Depth Below Grade .... 338 ft

Grout Type .... GeoPro Thermal Grout Select/Lite

Grout Solids .... 200 lb sand per 50 lb bentonite

Grouted Portion .... Entire bore

DRILL LOG

FORMATION DESCRIPTION	DEPTH (FT)
Road base, gravel	0'-10'
70% coarse sand, 30% M angular gravel	10'-30'
50% tan silty sand, 50% SM gravel	30'-40'
Layers of fine silt and S gravel	40'-60'
Layers of fine silt and S gravel, more clay	60'-70'
Fine silt, trace clay, trace gravel	70'-90'
Fine silt, 20% clay, trace S gravel	90'-120'
Silty tan clay with coarse sand	120'-140'
Tan clay, trace silt, coarse sand	140'-146'
Quartz gravel	146'-150'
Hard gravel, quartz, possibly cemented	150'-156'
Layers tan clay and gravel	156'-180'
Tan clay with layers hard L gravel	180'-200'
Layers clay and S gravel	200'-250'
L gravel, possibly cemented	250'-270'
Hard gravel, partially cemented, with clay layers	270'-280'
Tintic quartzite	280'-350'

Thermal Conductivity Test Data

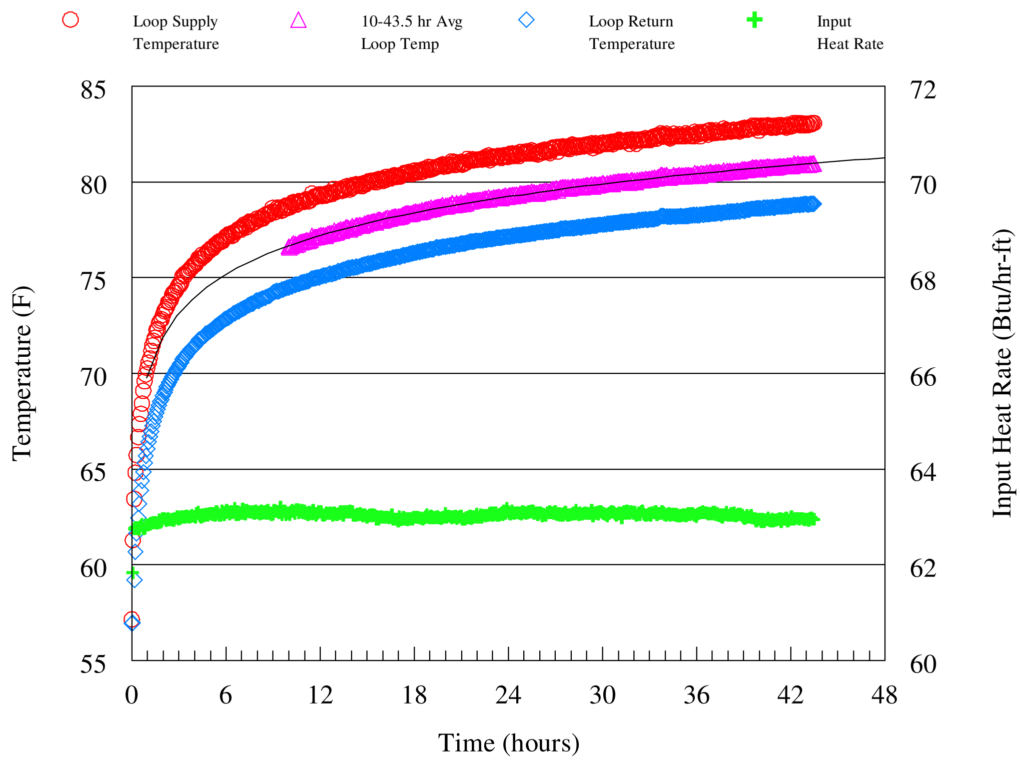


Fig. 1: Temperature & Heat Rate Data Vs Time

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

Summary Test Statistics

Test Date	December 10-12, 2013
Undisturbed Formation Temperature	Approx. 55.7-57.4°F
Duration	43.5 hr
Average Voltage	240.5 V
Average Heat Input Rate	21,307 Btu/hr (6,243 W)
Avg Heat Input Rate per Foot of Bore	63.0 Btu/hr-ft (18.5 W/ft)
Calculated Circulator Flow Rate	10.1 gpm
Standard Deviation of Power	0.09%
Maximum Variation in Power	0.22%

LINE SOURCE DATA ANALYSIS

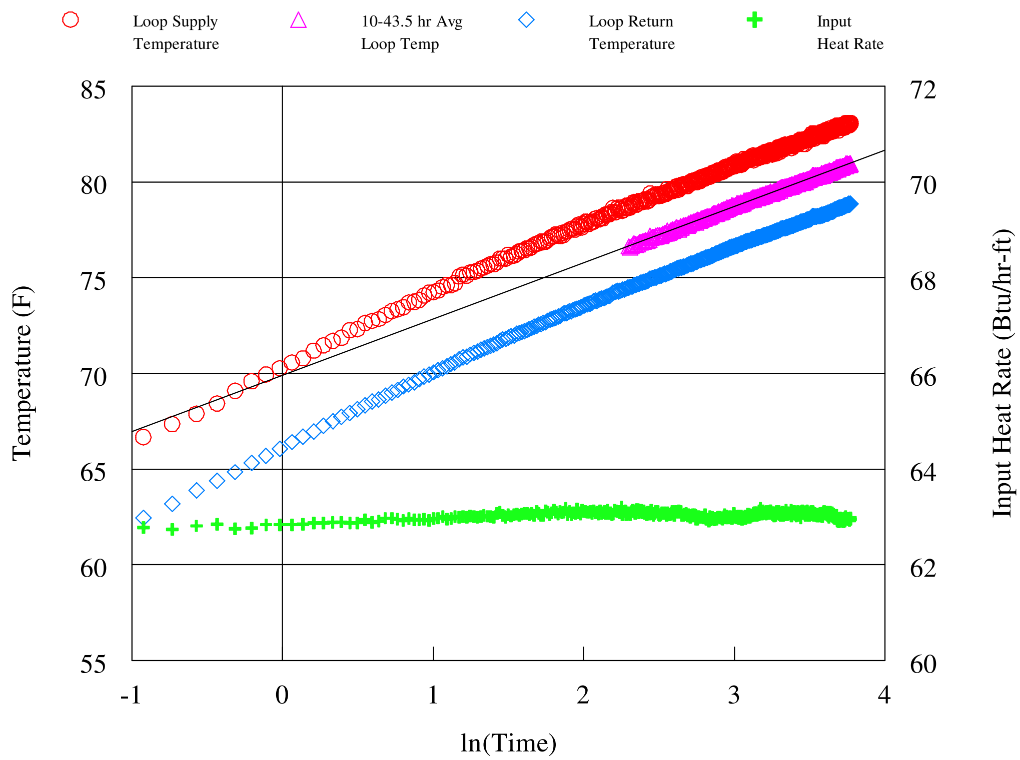


FIG. 2: TEMPERATURE & HEAT RATE VS NATURAL LOG OF TIME

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 43.5 hr. The slope of the curve fit was found to be 2.94. The resulting thermal conductivity was found to be **1.71 Btu/hr-ft-°F**.

Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of clay, silt, sand, gravel and quartzite. A heat capacity value for quartzite was calculated from specific heat and density values listed by Kavanaugh and Rafferty (Ground-Source Heat Pumps - Design of Geothermal Systems for Commercial and Institutional Buildings, ASHRAE, 1997). A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 34.2 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.20 ft^2/day**.

Certificate of Calibration

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a biannual schedule per the manufacturers recommendations. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit 233

DA Unit 14

Primary Equipment		
Component	Last Calibration Date	Calibration Due Date
Datalogger	10/29/2013	10/29/2015
Current Transducer	10/30/2013	10/30/2015
Voltage Transducer	10/30/2013	10/30/2015

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

Date	11/7/2013			
Thermocouple 1 (°F)	31.8 31.8 31.8			
Thermocouple 2 (°F)	31.8 31.8 31.8			
Thermocouple 3 (°F)	31.8 31.8 31.8			
Thermocouple 4 (°F)	31.8 31.8 31.8			
Digital Thermometer (°F)	32.0 32.0 32.0			

FORMATION THERMAL CONDUCTIVITY
TEST & DATA ANALYSIS

TEST LOCATION **Weber State University**
Test Borehole #3
Ogden, UT

Near South Side of

Parking Lot A-2

TEST DATE December 10-12, 2013

ANALYSIS FOR Sound Geothermal Corporation
3962 East Alpine Valley Circle
Sandy, UT 84092
Phone: 801-942-6100
Fax: 801-942-6127

TEST PERFORMED BY Sound Geothermal Corporation

Executive Summary

A formation thermal conductivity test was performed on Test Borehole #3 at Weber State University in Ogden, Utah with a GPS location of N 41° 11' 39.66" (latitude), W 111° 56' 35.22" (longitude). The vertical bore was completed on December 3, 2013 by Bertram Drilling, Inc. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of December 10, 2013.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 1.18 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity ≈ 0.77 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature ≈ 56.2-57.8°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours**.**

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

DATA ANALYSIS

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. If a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear equation coefficients to produce a line that fits the data are calculated. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

CONTACT: Galen Streich
Regional Managing Engineer
Elkton, SD
(605) 692-9069
gstreich@grti.com

Test Bore Details
(As Provided by Sound Geothermal Corporation)

Site Name .... Test Borehole #3
Weber State University

Location .... Ogden, UT

Driller .... Bertram Drilling, Inc.

Installed Date .... December 3, 2013

Borehole Diameter .... 5 1/4 inches

U-Bend Size .... 1 1/4 inch DR-11 HDPE

U-Bend Depth Below Grade .... 401 ft

Grout Type .... GeoPro Thermal Grout Lite

Grout Solids .... 2 units at 4:1 sand to bentonite ratio
6 units at 2:1 sand to bentonite ratio
27 units with no sand

Drill Log

Formation Description	Depth (ft)
Road base	0'-5'
Brown clay with gravel layers	5'-10'
Red-brown clay	10'-20'
Brown clay	20'-90'
Brown silty clay, trace gravel	90'-184'
Hard gravel layer	184'-186'
Silty clay w/several water bearing hard gravel layers	186'-200'
Silty clay with gravel layers	200'-210'
Silty clay with larger gravel layers	210'-220'
Tan clay with gravel layers	220'-230'
Fine silt, trace clay and gravel	230'-260'
Fine silt, less clay, more gravel	260'-406'
Multicolored gravel	406'-410'
Mostly black gravel, thin green clay layers	410'-428'

Thermal Conductivity Test Data

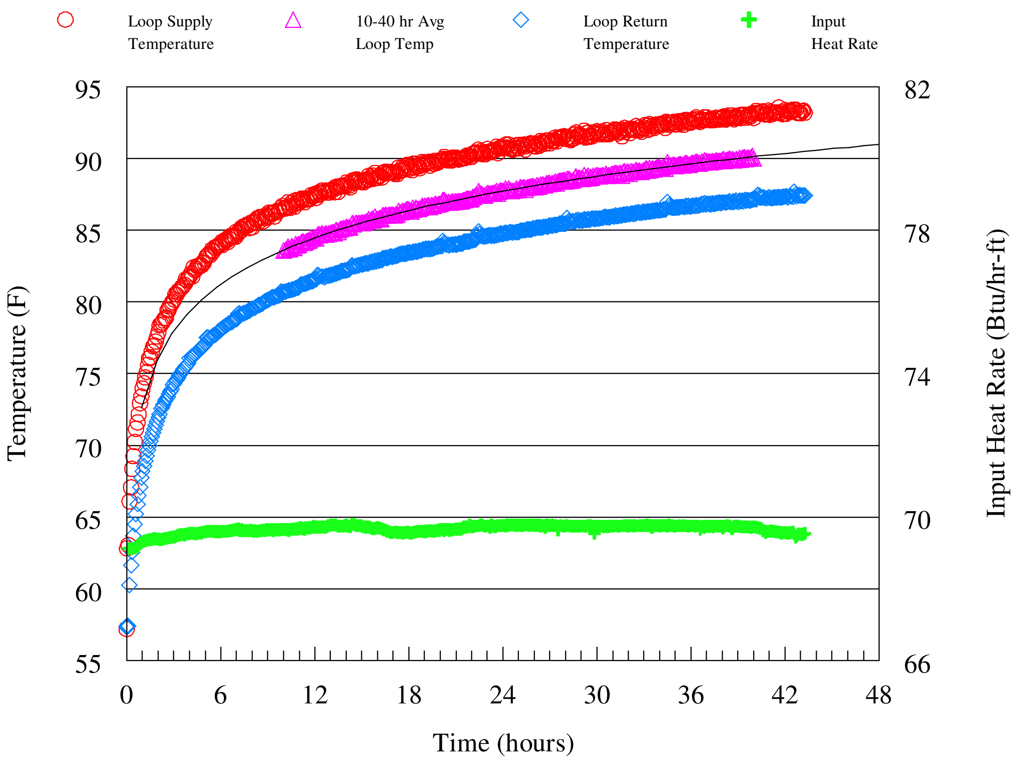


Fig. 1: Temperature & Heat Rate Data Vs Time

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

Summary Test Statistics

Test Date	December 10-12, 2013
Undisturbed Formation Temperature	Approx. 56.2-57.8°F
Duration	43.3 hr
Average Voltage	240.9 V
Average Heat Input Rate	27,959 Btu/hr (8,192 W)
Avg Heat Input Rate per Foot of Bore	69.7 Btu/hr-ft (20.4 W/ft)
Calculated Circulator Flow Rate	9.5 gpm
Standard Deviation of Power	0.09%
Maximum Variation in Power	0.25%

LINE SOURCE DATA ANALYSIS

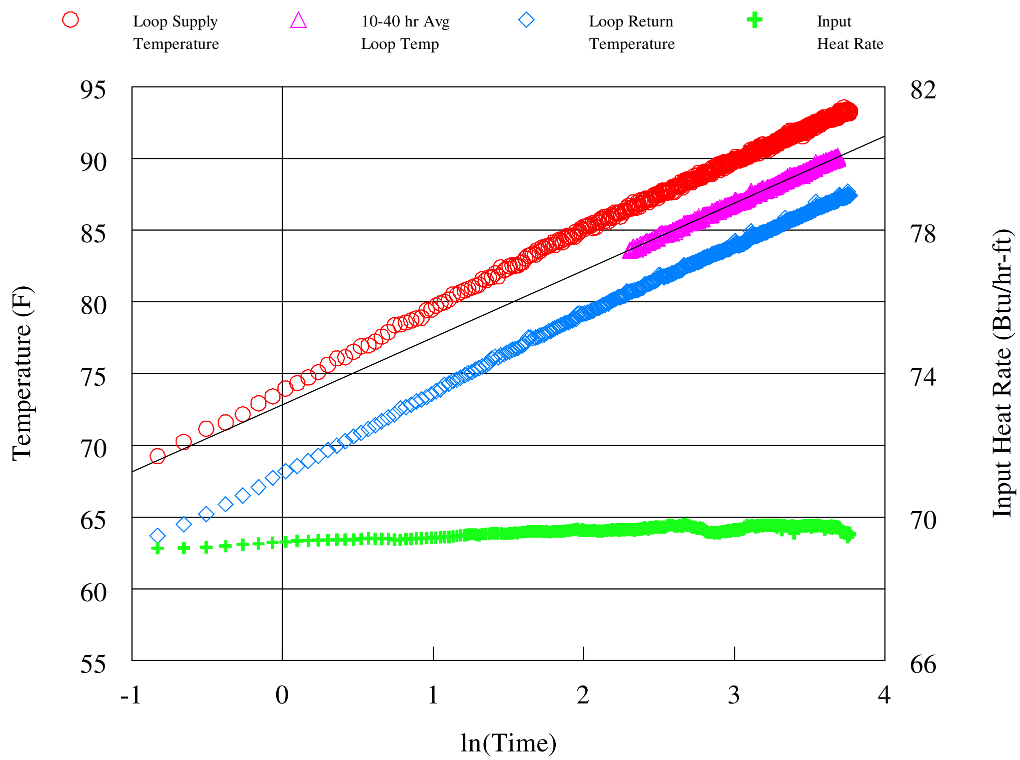


FIG. 2: TEMPERATURE & HEAT RATE VS NATURAL LOG OF TIME

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 40.0 hr. The slope of the curve fit was found to be 4.69. The resulting thermal conductivity was found to be **1.18 Btu/hr-ft-°F**.

Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of clay, silt and gravel. A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 37.0 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **0.77 ft^2/day**.

Certificate of Calibration

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a biannual schedule per the manufacturers recommendations. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit 226

DA Unit 42

Primary Equipment		
Component	Last Calibration Date	Calibration Due Date
Datalogger	6/5/2013	6/5/2015
Current Transducer	6/10/2013	6/10/2015
Voltage Transducer	6/10/2013	6/10/2015

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

Date	7/22/2013			
Thermocouple 1 (°F)	31.7 31.7 31.8			
Thermocouple 2 (°F)	31.9 31.9 31.9			
Thermocouple 3 (°F)	31.8 31.8 31.9			
Thermocouple 4 (°F)	31.9 31.9 31.9			
Digital Thermometer (°F)	32.0 32.0 32.0			