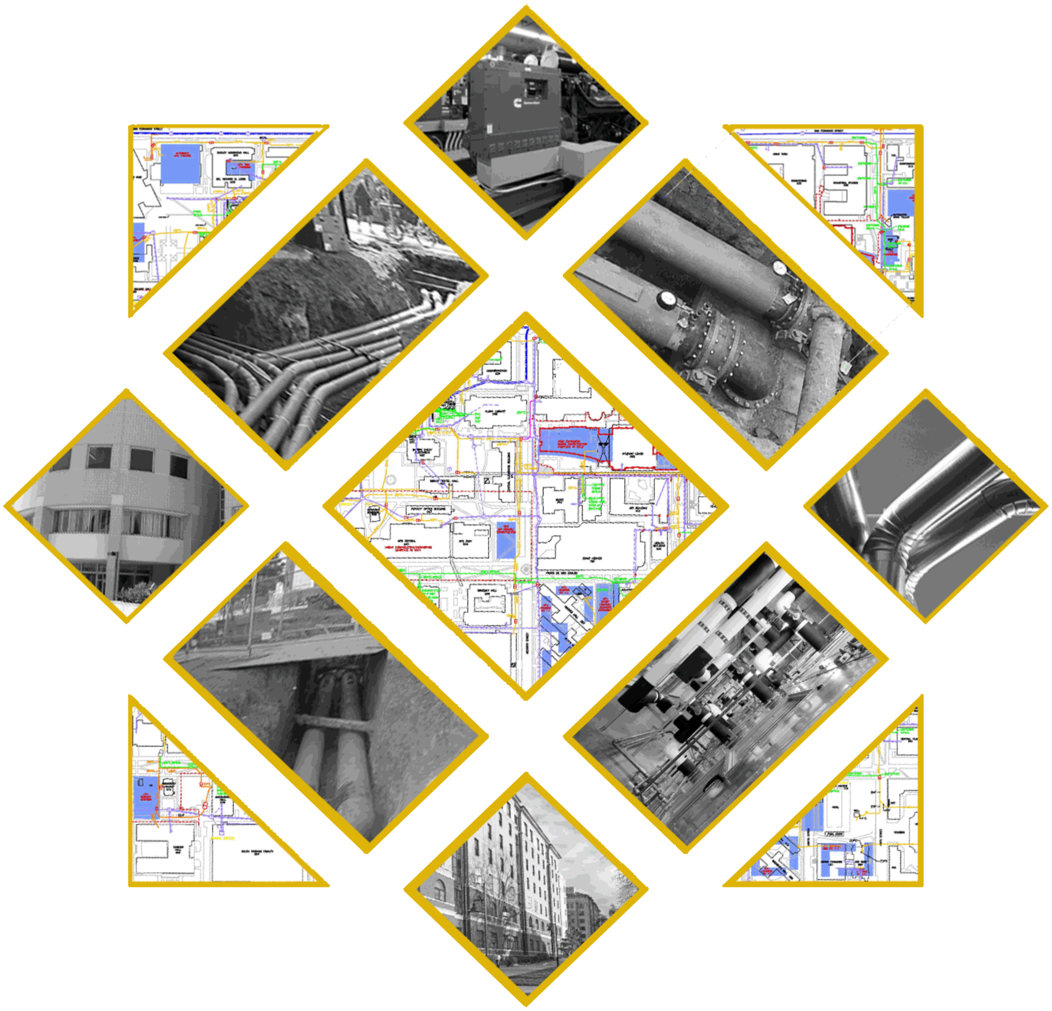
Utility Master Plan - 2014



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Prepared For:
CSU Chancellor's Office &
San Jose State University

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SAN JOSE STATE UNIVERSITY

Utility Master Plan - 2014

Sections

Appendices

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Utility Master Plan - 2014

San José State University was founded in 1857 and is the oldest public institution of higher education in the State. With a 2012 total enrollment of 30,448 students, the main campus is home to over 50 major buildings on 19 city blocks in downtown San José. Unseen and unrecognized by the population-at-large, the campus is supported by:

- ✓ **Underground District Utilities** connected to a sophisticated and "green"[1] central energy plant from which power, heat, and cooling is dispatched to main campus buildings at a global efficiency as high as 85%.
- ✓ **Seven other utility systems** which comprise an underground utilities network generally typical of any campus (potable water, storm drain, sewer, IT Infrastructure, etc.). Unique attributes of these systems include: a separate recycled water system for irrigation and toilet flushing and a public water system with a source well, distribution system and City water interface.

An appreciation of the complexity and breadth of the underground utilities infrastructure and central plant may only be exceeded by an appreciation of its replacement value. With a current value of not less than $100 million,[2] this complex asset can provide an efficient and sustainable foundation with which to support the 21st century teaching and learning environment.

The focus of this Utilities Master Plan (UMP) was to evaluate the existing, main-campus utilities infrastructure framed against current and future limitations; and the natural effects of aging and deterioration. Although this UMP provides a 20 year plan, it was developed with an eye towards the intrinsic, current value of the central plant and infrastructure while recognizing that scarce dollars available for utility and plant upgrades must provide for a financially efficient, energy efficient, flexible, reliable, sustainable and robust utilities infrastructure. In addition to the Guiding Principles associated with the development of this UMP, practical considerations included:

- ✓ The $10 million annual energy bill and $2 million maintenance bill.
- ✓ The campus carbon footprint which currently exceeds 25,000 metric tons.
- ✓ Ever increasing gas and electric rates, labor rates, aging equipment and new technologies.
- ✓ Increasing campus demands for robust and reliable capacity from the ten utilities.

With planned campus growth of 1.68 million square feet over the next 20 years,[3] including as much as 500,000 in the next 5 years, this UMP incorporated the President's priorities as well as the Chancellor's requirements, suggestions and Guiding Principles, including:

- ✓ Minimizing utility related shutdowns through planned rehabilitation.
- ✓ Creating budget certainty by modifying, operating and maintaining utilities in a predictable, cost efficient way.
- ✓ Leveraging the current asset value, capacity, and reliability of the existing infrastructure.
- ✓ Positioning the infrastructure to move away from reliance on fossil fuels with an eye towards a truly sustainable campus environment.

Recommendations were identified and summarized as 8 priority infrastructure projects; with an immediate funding request of $29 million. This immediate plan was then followed by an aggressive 5 year plan and an extended project vision through FY 23/24. The initial request for FY-2014/15 is summarized in the adjacent table, by area.[4]

Area	Cost	Description
3	$8,123,748	a) New/impacted upgrades to minimize risk; while constructing Campus Village; Spartan Expansion
4	$10,707,604	b) Existing utilities risk-related upgrades also impact capacity, deficiencies and expansion
5	$5,920,293	
6	$4,290,670	
Total	**$29,042,314**	

[1] The combined heat and power plant, or trigeneration plant, has a complex mix of heat recovery, power generation and thermal energy storage making it one of the most efficient and cost effective plants in the CSU system

[2] See Appendix O for valuation estimate

[3] See Appendix A – Master Plan Basis

[4] See Introduction for description of "infrastructure area" vs. campus quadrant

The remainder of this report provides the background and basis for the above. All utilities and recommended projects are identified in this main report. The main report is supported by significant background and details which are provided in the Appendices and in a separately issued drawing set.

This report relates to utilities infrastructure supporting the main campus. The campus infrastructure may best be presented and considered as:

- ✓ **District Utilities** made up of a central energy plant dispatching electricity, steam and chilled water and
- ✓ **additional utility systems** comprised of: (a) a campus owned and operated water system with source wells and distribution systems; (b) City supplied recycled water delivered through a campus-wide, campus-owned-and-operated recycled water distribution system; (c) a campus fire water system supported by the city water system and the campus distribution network; (d) sewers interconnected with a lattice of city collector pipes (large capacity) transferring the campus sewage and storm water to the City sewer systems and storm sewer; and (e) campus telecommunications fiber/copper/wireless sourced from four (4) MPOE's served by SBC, ATT and multiple Local Exchange Line towers, and the campus computer center.

Purpose of the UMP

The purpose of this UMP was to evaluate the current utilities infrastructure in order to review and assess issues, needs and conditions of the main campus including existing buildings, surrounding public utilities, and planned replacements and expansion in the context of the next 20 years. In addition, the analysis anticipates planned campus growth so that utilities are ready when needed and coordinated with the physical master plan. The financial impact of the existing utilities limitations and campus growth requires recognition that scarce dollars available for utility upgrades must also accommodate growing energy demands and costs, as well as a sustainable, efficient, robust and flexible utility network. As such, the existing infrastructure and the projects identified herein meet key criteria[1] and Guiding Principles, while also accommodating the impact of planned and unplanned campus growth.

Goals of the Utility Master Plan

The goal of the UMP was to produce planning documents and drawings that will enable the University to continue in the development and evolution of its usable and expanded space without being constrained by unexpected utilities issues. In reality, therefore, the ultimate goal of the overall UMP is to formulate and substantiate appropriate funding requests, supported by pre-feasibility project concepts, for incorporation into the 2014 CIP (and beyond) as a means of continuing to serve the teaching and learning environment.

Utilities' Constraints and Realities

Utilities infrastructures are made to last as long as 100 years. They are expensive, fixed and must precede any future campus growth (i.e. a high initial cost, significant physical disruption and "massing" associated with construction). It is this reality that requires that when a pipe is sized, and constructed underground, it must be of sufficient capacity and integrity to accommodate ALL of the future requirements.

Underground utilities must be constructed to provide "plug and play" support for new buildings; in advance of building occupancy, and must anticipate all future capacity requirements.

[1] See Appendix A item 6

If, for instance, a 100,000 square foot building is to be constructed as Phase 1 of an eventual, multi-phased 500,000 square foot building plan, the underground utility system must be installed in advance of the Phase 1 project, but must be sized to meet the full build out. A smaller pipe could have met the needs of the Phase 1 project, but when succeeding phases come along, the ground would need to be dug up and replaced with a larger pipe. With this in mind, the Campus Master Plan can be considered.

Basic Metrics: Current Campus and Master Plan

Demands on the campus utilities, plant and infrastructure are most directly affected by anticipated campus growth and by campus enrollment. Planned increases in campus square footage provide a key metric with which to analyze and predict utility capacity and size requirements.

This UMP employed the Campus Master Plan and the CIP requests to anticipate campus growth as indicated in Figure I-1. The figure indicates that as much as 1,679,550 square feet of space will be added in the next 20 years.

SJSU Campus Projected Growth Over 20 Years

Proposed Expansion	Increased Area (sf)	Expected Completion
Student Union Addition	98,000	2014
SPX Addition	8,850	2015
Student Health & Counseling	50,000	2016
Student Rec Center Expansion	94,000	2018
Residence Hall, Phase II	220,000	2019
Residence Hall, Phase III	600,000	2024
Dining Hall Modernization	50,000	10+ years
Science Addition	300,000	10+ years
Dudley Moorhead Hall Addition	11,700	10+ years
Theater	97,000	10+ years
Humanities Building	150,000	10+ years
TOTAL ADDITIONS	**1,679,550**	

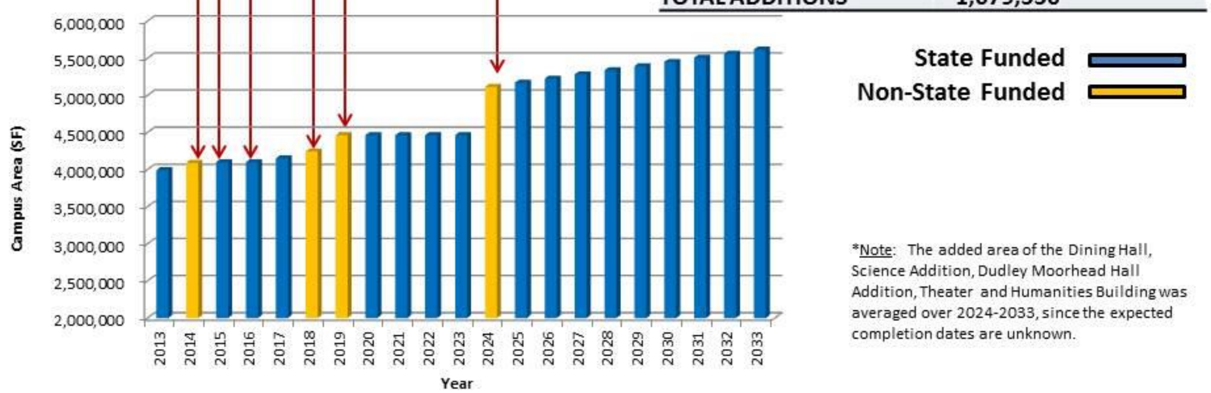

Figure I-1 Campus growth per Master Plan[2]

Because growth is so critical to predicting utility demand(s), Appendix A was developed in order to fully document the current vision relating to anticipated growth and expansion of the main campus building area. Key insights revealed by Appendix A detail the planned growth of almost 2 million square feet as summarized in Figure I-1.

Given the information above, the current utilities issues and conditions formed a "starting point" with future utilities framed against the 20 year "end point."

[2] See Appendix A for details and basis

Time	Square Footage	Basis
Starting Point[3]	3,993,751	See Appendix Q. The information was developed using site-specific utility based data. It was compared conservatively with the SFDB (square foot data base) which at time of issuance was reflecting 3.5 million sf.
End Point	5,673,301	The table was developed by taking a conservative approach to the planned projects listed in the Appendix A item 3. It was compared conservatively with the APPA-FPI of 6.2 million sf.

Another basic metric associated with utilities sizing, capacity and reliability is campus enrollment. Although generally unseen and unrecognized by the student population-at-large, the complex underground utilities network of piping, conduit and "plant" is relied upon daily by a student population.[4] A recent history of that enrollment follows:

SJSU Total Enrollment										
Year	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013
Term	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Total	32,746	31,455	31,280	27,422	29,076	26,796	30,236	28,002	30,448	27,503
FTE	23,852	22,314	21,893	19,651	21,326	19,616	23,054	21,167	23,420	20,719

The 1993 ORSA report stated that the student population (FTE) was 19,617 with changes in population from 1987 to 1993 (about +/- 5%). The above table indicates the enrollment between 2008 and 2013 had stayed essentially the same; albeit the 2012 enrollment, as stated in the Executive Summary of this report, is much greater.

It may seem inconsistent that the campus will be increasing by 1.68 million square feet, while the student population has been staying essentially constant. In addition to planned growth by 2020 to 30,000[5] students, there continues to be a shift on the campus towards greater on-campus living and on-campus student activities. Thus, it is the increase in on-campus housing and other non-state funded buildings such as Phase 2 and Phase 3 of the campus village, the Event Center and Student Union Expansion that will continue to place a significant demand on the utilities infrastructure along with the modest increase in student enrollment.

Methodology

The project team from Salas O'Brien worked through the SJSU project manager in an on-going process of identifying issues, updating "as-built" utility conditions and long-term planning. Secondary issues were also considered as follows:

1. The newly established greenhouse gas (GHG) regulations related to the San José State GHG threshold of greater than 25,000 metric tons annually
2. Funding related issues and demands such as the RFP and "UMP on-site assessment questions," which were issued by the Chancellor's office during development of this UMP
3. The on-going efforts associated with campus Master Planning related to landscaping and other planning activities
4. The current[6] design activities, design/build activities and construction activities on campus.

[3] Fall semester 2012
[4] FTE: full time equivalent; source: SJSU Institutional Effectiveness and Analytics
[5] See Appendix C
[6] During development of the UMP, significant design and/or construction activity was occurring at YUH, SPX, the anticipated Health building, and the Student Union Expansion projects.

Where possible, the many campus sources of real-time data and/or prior utility measurements and legacy information were consulted in order to validate assumptions relating to required plant capacity. For example, in February of 2013, the temperatures in San José were below a "design day" as defined by ASHRAE. Steam demand information was obtained from the central plant during that period. Likewise, meetings were held with key staff responsible for the various utilities in order to attempt to reflect actual, current conditions on the utility drawings issued with this UMP drawing set. Because the campus utilities have been so well managed and documented, the Appendix incorporates many valuable documents associated with the utilities, the central energy plant and overall campus sustainability.
The study evolved along two parallel paths:

Project Effort: *Parallel Paths*

Utilities "as built" updates		Project Identification & Issues Development
The "as built" effort involved a detailed consolidation of all available drawings as summarized in Section VI of this report. Although primarily employing available and evolving site drawings for present and planned campus projects, the effort also involved legacy interviews and site inspections.		Project identification evolved as a result of bi-weekly meetings where issues were identified, and "as-built" progress was reviewed. Legacy information was reviewed and framed against capacity, loads and other UMP analysis. Minutes were retained and are provided as Appendix N: Meeting Minutes.

Any planning document involves an iterative process of discovery, analysis, and discussion. Generally speaking, the process followed the pre-mentioned two-path process and the following steps:

Phase I
- Site documentation (present layout and capacity)
- Review and analysis of planned growth
- Site analysis (loads, conditions)
- Presentation(s) of site analysis and initial findings

Phase II
- Draft Report
- Final Report
- Presentation of Final Report
- Completion of study and incorporation of budgets into a 5 year Capital Improvements Program

The process focused on analysis that was in conformance to, and in alignment with, the Guidelines and Guiding Principles of the University and Chancellor. This included key utility issues such as:
- Anticipated campus growth
- System reliability and capacity
- Environmental and energy considerations
- Leveraging the existing utilities infrastructure and existing protocols and procedures against practical economic realities
- Ensuring that recommended projects included considerations for cost and timing

Within the framework of the above process, this UMP attempts to document and reveal the current state of each utility and to define a recommended program for addressing deficiencies, shortcomings, renovation, expansion, and maintenance over a 20 year life cycle. The recommendations address estimated costs,[7] and time frames based upon deficiencies, anticipated campus growth, practical construction logistics/timing and adherence to the "key issues" described above.

[7] Cost estimates are based on uni-format and are to a level of detail associated with a pre-feasibility statement of probable cost

Process Specifics

In addition to the Guiding Principles, some process specifics warrant mention because of the policy and sustainability issues which are reflected in this Utility Master Plan. Most important were the issues discussed in the formal presentations held at the 35% and 50% issuance of the current UMP. These presentations involved those SJSU and Chancellor's staff noted as contributors in Table of Contents. The presentations are provided in Appendix D of this report. Considerations from those formal meetings which affected the UMP process included:

- ✓ Although not typically considered to be a utility issue, some discussion and follow up revolved around "critical[8] buildings" which are also referred to in the Chancellors guiding principals
- ✓ There was a continued dialogue as regards to the future vision and possibility of buildings, with "net zero energy demands" vs. the practical realities of existing campus buildings which reflect deferred maintenance issues and energy inefficiencies such as single pane windows, packaged air conditioning, lack of insulation and many other issues associated with deferred maintenance and limited capital for building renovation. As a result this UMP was ultimately developed with an eye towards "zero energy" possibilities, but with respect for the many practical demands that will be placed on the utility infrastructure as the campus slowly migrates to a more utopian, zero-net-energy situation.

An ongoing part of the process involved definition of specific areas of activity. Although, generally along the lines of the formal definition of the 4 "campus quads" the issued Utilities Master Plan (UMP) considered 8 separate "infrastructure areas." In order to clarify any potential confusion between the Campus Quads and the UMP "Areas of Construction" Figure 1 & 2 are developed. They are detailed and described in the following section.

Campus Quadrant System vs. Campus Infrastructure Areas

Historically, the main campus grew block-by-block. This expansion over the years has resulted in a square shaped property of approximately 88.5 acres. Only the North Parking Facility, Admissions and Records are located outside this square. The landscaped malls running north/south and east/west through the campus both tie the total campus together and define four distinct zones or quadrants of the campus. These quadrants help organize the functions of the campus and provide the basis for coordinated wayfinding systems. For the 2013 Utility Master Plan, the traditional quadrant system was not applicable for construction planning. Project areas were formed by defining areas of similar infrastructure.

Campus Quadrant System

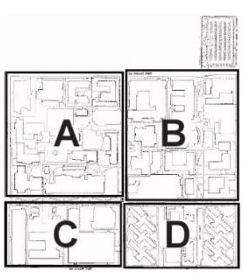

Figure 1

Quadrant A, to the northwest, contains the original SJSU campus and its oldest buildings, including Tower Hall. It is the most memorable area of campus, with the greatest amount of open space, including Tower Hall Quad and Mulberry Tree Allée.

Quadrant B is located in the northeast and contains a mixture of academic and student services buildings, including the renovated Student Union and Cafeteria. The 9th Street Mall runs through Quadrant B and offers a strong organizing element.

Quadrant C, to the southwest, contains several large building including two parking structures. This area of campus dates from the late 60's to early 1970's.

Quadrant D, to the southeast, is the site of the existing student residential complex and is slated for construction of higher density housing to serve a greater number of students, faculty, and staff.

[8] Generally speaking the UMP did not consider "inside building conditions," but rather highlighted "critical buildings" (see Appendix Y) and briefly identified conditions with an order of magnitude estimate.

Campus Infrastructure

Figure 2

Infrastructure 1 – Area 3 includes the most immediate campus utility expansion to accommodate the upcoming housing, dining, and event center expansion. It is also a cornerstone of utility reliability because it establishes the utility loop concept; while also addressing the area of most immediate campus growth.

Infrastructure 1 – Area 4 targets the most critical buildings in the northwest portion of campus which are a significant distance from the central plant as well as aged piping and conveyance.

Infrastructure 1 – Area 5 targets the oldest campus utilities located in the B quadrant.

Infrastructure 1 – Area 6 corrects deficiencies in the utilities transitions which are in poor condition at Duncan and MacQuarrie Hall.

Infrastructure 2 develops and targets the "Legacy Projects" on campus, identify deficiencies and issues associated with the practical operation of their campus utilities and equipment. The objective was to reveal all of the "legacy" projects which would otherwise have been undocumented.

Infrastructure 3 targets irrigation infrastructure repairs and modifications, to ensure that water efficiency is maximized and accommodates the goals of the Landscape Master Plan.

Infrastructure 4 upgrades the energy management system for areas on campus no currently on the Tridium Platform with Invensys components. This includes the Central Plant and, when implemented, optimizes opportunities for energy efficiency.

Infrastructure 5 implements the most critical elements from the campus Fire Alarm System master plan and provides IT infrastructure upgrades for future buildings.

Infrastructure 6 implements essential upgrades and modifications to the campus exterior lighting to improve overall campus safety and energy efficiency, utilizing a priority approach specific to the exterior lighting system at large.

Infrastructure 7 targets the preparation required by the campus for the new academic building by constructing a utilities extension.

Infrastructure 8 address needs for a central plant upgrade as the plant equipment approaches the end of its useful life.

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Available Resources

This section of the report provides an overview of each of the utilities reviewed in the Utilities Master Plan. The development of this section is described in the Introduction of this UMP. However it is also important to mention the use of the University Archives as a key resource employed by the UMP team.

University FD&O maintains an excellent set of drawings and document archives. The archives contain valuable drawings and documents dating as far back as 60 years. These include bound specifications; blue lines; operations and maintenance manuals; and a plethora of documentation that can and should be reviewed prior to embarking on any design or major building or site improvement project.

The SJSU "document archives" has hanging files of hard copies of the campus buildings and infrastructure. Almost 75% of the legacy drawings are scanned and available electronically. There are also AutoCAD versions where available. There is a searchable reference database to help direct requests to the appropriate hard copies of drawings. Electronic drawings are available by perusing a directory structure on the "S" drive at the library.

Although well organized and accessible, this valuable legacy information can be accessed in the future by more advanced software like "Digicality," which is currently used by some of the CSU's. Here the information in the database is available and can be updated by all users in bidirectional methods using hand-held devices. In continuing the update the valuable information the following suggested improvements to the document library should be considered:

- ✓ Requiring project drawings to conform to a SJSU CAD standard to ease the process of conforming building and utility backgrounds.
- ✓ Updating of the utilities infrastructure whenever projects are completed.
- ✓ Considering an update of an abandoned "access data base" for all the SJSU utilities that was last updated in 2002. Building architectural backgrounds are updated by students as projects are completed, but changes to utilities are not conformed in the central database.

The remainder of this section of the UMP provides a discussion of each of the utilities and their associated risk(s).

A. STEAM SYSTEM

System Overview: one of the most sophisticated and efficient central steam plants and systems of the CSU system campuses, the steam plant consists of over four miles of steam supply and condensate return piping. The underground system is a mix of full-sized vaults, walk thru tunnels, and direct buried piping. They are accessible throughout campus by 23 manholes and mechanical rooms located in each building served by the steam system.

Current Value: $20 to $60 million

Life/life expectancy: piping/plant varies in age from 1 to 60 years. Life expectancy is greater than 20 years (system at large).

Strengths: The system is well maintained; well documented; and is efficient, robust and reliable

Weaknesses: 1900's "Cadillac" technology. It is relatively complicated to maintain, is dependent on fossil fuels and requires high temperature heat. In addition, despite the consistent maintenance and operational parameters, several physical limitations exist, requiring an effective shutdown of the entire system for most repairs or repair scenarios.

Significant Annual Costs:
Of approximately $500,000/yr. in maintenance for all underground utilities, steam requires approximately 25% or $125,000 annually.

Capacity/Load metrics: At a plant capacity of 124,000 pounds per hour (90,000 pph, firm) and with pipe sizes able to deliver on the order of 103,567 pounds per hour to the farthest building in the system (i.e. with minor modifications identified herein), the system has ample capacity to meet all demands for the next 20 years including full build-out per the Master Plan.

20 year plan: the system should be retained, expanded, maintained and relied upon for the next 20 years with an eye towards the eventual phase out with a less fossil fuel intensive technology.

Sustainability Considerations: Because steam is a critical part of the central energy plant, it is providing energy efficient operation and a cost effective and sustainable operations reserve. However, projects and discussions contained herein afford the campus with an option to migrate towards a less fossil fuel intensive technology in the 20 to 25 year time frame (see Section 4 – Sustainability and Appendix M, T, and U).

Redundant Service: The system architecture is a radial configuration, with no redundancy.

Historical Failure Points: A critical limit, which can be defined as a failure point, is a general inability to isolate and shutdown segments of the system. The overall system has inoperable valves that require replacement as well as an inability to provide isolation between quadrants on campus. In effect, all major repairs require a complete shutdown of the system to implement necessary piping replacement.

Projects/Priorities: A series of projects should be commissioned that serve to both replace weak or compromised piping while simultaneously addressing the inability to isolate shutdowns. By planning and installing isolation valves in select locations to allow for, at a minimum, shutdowns per quadrant, the overall operability and reliability of the system can be enhanced and improved.

The steam systems have been well maintained, but by their nature are complicated and maintenance intensive. These photos show two types of traps, the inverted bucket (top image) and thermodynamic (bottom image). The photos also reveal the general complexity of the piping arrangements, insulation and physical constraints.

System Overview - Steam Distribution

Steam is generated at the Central Plant (see the Central Plant portion of this report). Plant steam is distributed from the Central Plant to over 30 buildings on the downtown campus. These buildings and load estimates are included in Appendix Q: Utility Summaries and Loads. Maintenance on the distribution system has been ongoing, with the major emphasis on steam manholes upgrades and repairs. Piping is predominately schedule 40 steel for steam and Type K copper for condensate. There are some occurrences of steel condensate lines used, typically schedule 80 steel. The Housing Village is a notable exception to copper.

A major project was undertaken in the past five years to replace steam isolation valves and rebuild the expansion compensation ball joints in the main tunnel. Condensate is pumped back to a central hot well located below grade at the Central Plant. Individual buildings utilize pump equipped condensate return units. There are also instances of separate 'high pressure drip condensate' return systems that utilize main steam pressure to move the condensate. MLK library utilizes a steam powered condensate return unit to move condensate back to the Central Plant.

See the Central Plant portion of this report for a schedule of steam producing equipment.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Safety – there is a potential for a catastrophic failure in the system related to pressure and/or release of steam above ground due to several failure conditions such as condensate piping lacking pipe guides.
2. Redundancy – in the radial configuration, the system has no redundancy, leaving the campus and critical areas prone to losing heating and heating hot water.
3. Isolation – the system has limited ability to isolate services for repairs and maintenance, requiring a complete system shutdown for work.

Major System Elements

Manholes

Steam manholes are distributed throughout the campus, and are typically used to accommodate changes in elevation and/or branch connections to buildings. Manholes are concrete and are fitted with concrete sump pumps to keep them dry. A manhole refurbishment project was undertaken in a 1997 project which included the replacement of drip line traps with 'Steamgard' traps (a fixed size venturi orifice with no moving parts), addition of power and lights, addition of electric sump pumps, increased the size of the access to 36" round lids and added new insulation for all piping.

Unfortunately, these manholes are in such a severe environment that several issues quickly ensued with the modifications including failure of GFI outlets, subsequent power outages to sump pumps and ultimately flooding of the manholes rending most of the insulation ineffective and raising the temperatures even higher in the manholes.

One of the most problematic steam manholes seems to be the manhole installed to intercept the existing piping across Paseo De San Carlos used to serve the Housing Village and sized to accommodate future housing phases 2 and 3. The existing line was routed very deep across San Carlos due to the abundance of existing utilities. Although the biggest issue is the unreliable power-feed from the well, there appears to be a leak somewhere in the old piping or casing that continuously leaks into the manhole, raising the temperature and typically failing the sump pump. These deficiencies are being addressed with the campus Steam Manhole Maintenance projects currently underway. See project listing for appropriate expansion projects being incorporated into the overall utility master plan.

Piping

Originally (circa 1915) steam was routed from the old central plant to the original Tower Hall which at the time had a West and an East wing with steam routed in the basement. Eventually this basement piping from the wings was expanded to serve Washington Square Hall and Science. When the two wings were demolished due to seismic concerns, this piping was moved into shallow concrete tunnels to eventually serve Hugh Gillis Hall, Wahlquist Library, Washington Square Hall and Science. These concrete trenches are commonly referred to as the 'coffins.' As landscape projects progressed in the area, some of the tunnels are now substantially deep. It is interesting to note that the 1906 wings were demolished due to seismic concerns, yet the foundations of each wing were left in place as they were too difficult to remove! These old, large, reinforced brick foundations have proven problematic for installation of subsequent utilities.

When the Wahlqist Library was demolished and replaced with the current MLK Library around 2000, a new steam manhole and piping were added to serve the new library. The steam was routed from one end of the 'coffin' system in Tower Lawn to the basement of the library. This steam line is a prefabricated, preinsulated steam piping system (Multitherm 500 by Ricwil/Permapipe with a schedule 40 steel steam line and Type K copper condensate). A few years later, the old steam service to Hugh Gillis Hall finally failed and was replaced using direct buried steel pipe and a Gilsulate powdered insulation system for protection. The old piping was abandoned in place.

Steam service was expanded from the Central Plant to Housing Village around 2002 by utilizing the same Ricwil/PermaPipe Multitherm 500 system from a new manhole to the Village. The manhole intercepted an existing prefabbed steam line that was installed under Paseo De San Carlos several years earlier when San Carlos Street was closed and re-landscaped to the present Paseo (circa 1995).

For the most part, steam piping is schedule 40 steel, while the condensate lines are predominately type K copper. One notable exception is the condensate piping inside the Housing Village Parking level which is schedule 80 steel.

Several sections remain of older steam lines still in service throughout the campus, most notably, the steam piping between Dwight Bentel Hall and service from the main tunnel to Art, Music, Event Center and the Health Building. The lines serving the Art/Music/Event Center and Health are included to be replaced in this report. Many of those lines are insulated with asbestos containing material (ACM). The following buildings were observed to have ACM: Administration, Art, Central Classroom, Duncan Hall, Old Engineering, Faculty Office Building, Hugh Gillis Hall, MacQuarrie Hall, Tower Hall, and Yoshihiro Uchida Hall. The replacement lines will also provide a more direct route from the current boiler plant. There is also an abandoned original steam tunnel system from South of the Computer Center out to Tower Lawn. This was part of the original steam distribution system from the old boiler plant. This tunnel ends in an empty manhole just across the sidewalk from the computer center, in Tower Lawn. The rest of this old tunnel system used to serve steam from the boiler plant to Tower Hall through Dwight Bentel Hall via SMH-12.

The original 'coffin' steam service to Hugh Gillis Hall had steam leaks and was re-serviced from a prefabbed system (similar to GalvaGuard by Ricwil). The original service entered Hugh Gillis through SMH-19. After some time, the condensate line on the 'new' service failed, the building was served steam from the Ricwil and condensate was returned through the coffin for several years. Eventually, the Ricwil steam line failed and was replaced with the Gilsulate system mentioned above. Both old services were abandoned in place. These are shown on the steam maps in the separately issued drawing set.

The Loma Prieta earthquake in 1989 damaged the steam piping between the mechanical rooms in Sweeney Hall. These lines were below grade and were abandoned in place. New steam lines were routed overhead between the mechanical rooms.

When UPD was constructed onto one end of the South Parking Structure, steam was routed from MacQuarrie Hall basement to the parking structure. Below grade lines used the same Gilsulate system as Hugh Gillis piping, and then routed exposed along the side of the parking structure.

Steam Traps & Condensate Return
Steam traps in manholes were removed and upgraded to "Steamgard" traps in 1996. These traps are engineered fixed venturi orifices with no moving parts and have worked fairly reliably. This style of traps is ideal for constant loads such as line drips that continuously drain the steam piping of condensate. There are other styles of traps in use throughout the campus buildings including thermostatic, inverted bucket and F&T (float and thermostatic). Most traps are limited to inside the main steam rooms at the buildings where steam is typically used to produce heating hot water for heating needs or used to provide domestic hot water.

Condensate from each building's steam using equipment is usually collected in the steam room or basement in a packaged condensate return unit, consisting of a tank and electric pumps which pump the condensate back to the hot well at the Central Plant. One notable exception is the MLK library which uses a steam powered condensate return unit to 'push' the steam back. A vessel is filled with condensate from the traps. Then, at a predetermined liquid level, the vessel is isolated and live steam allowed into the vessel to push the condensate back to the plant. There were some issues with the pressure of motive steam at the library. FD&O adjusted the pressure to provide reliable operation.

Condensate from the campus is returned to an underground hot well at the central plant. This hot well is in need of some repair work including new insulation. From the hot well, condensate is transferred to the boiler de-aerator (DA) tank and the HRSG DA tank for preheating and feeding to the boilers and HRSG.

Capacity & Performance

Current capacity of the installed steam producing equipment is sufficient to provide adequate steam service throughout the next 20 years, as shown in the Central Plant section of this report. The limiting factor in providing sufficient steam to the campus is from the distribution system itself. As noted in the Central Plant section of this report, the boilers were originally designed for at least 170 psig operating pressure. This has been reduced to 100 psig and as also noted above, there are components used in the distribution system that limits the operating pressure to less than 125 psig. Pipeline capacity is limited by pressure drop and requires end use pressure at terminal buildings. Each building is equipped with a pressure reducing station for end use. These pressures are listed in Appendix L – Steam Archive Reports.

Building related steam issues:
The most limiting building appears to be Duncan Hall which has a 60 psig end use. It is the furthest building on the distribution system. The Housing Village uses 50 psig steam for distribution to the four various mechanical rooms, however this complex is virtually across the street from the Central Plant. The same may be true in Duncan - i.e., the 60 psig may be used for in-building distribution, but end use may be 15 psig or less. Piping capacity was calculated to allow 60 psig at Duncan Hall. If this end use pressure

requirement is relaxed, the distribution system could accommodate higher steam flows with correspondingly higher pressure drops.

Migration Plan

Because many campus steam systems are being replaced by heating hot water systems, a significant amount of effort was placed on considering a practical migration plan associated with eventually and effectively converting the steam system to be a part of a greatly reduce carbon footprint or even a "zero fossil fuel" campus. As stated earlier, if new science or engineering facilities are provided in the future, any required steam could be provided with localized electric sterilizers/autoclaves or boilers.

Use of steam at greater than 15 psi in a building is a result of legacy systems. For example, the old engineering heat exchangers, date stamped 1961, are shown on the schedule to be supplied with 25# steam. Likewise:

- ✓ The Campus Village instantaneous water heaters are scheduled at 50#.
- ✓ There is a line to a lab in engineering that has a small Parsons turbine for a pump with an estimated line pressure at more than 15 psi.

A "steam at a tipping point" discussion is provided as a part of this report and at the end of this section. Efforts have already been initiated to begin this migration. For instance:

- ✓ The current safety valve project was initiated to limit steam pressure via plant safeties at 125#, the minimum pipe rating in any building. The concept of this project is that all of the individual building safeties can be eliminated[1] as the campus steam system "migrates" to a more maintainable state.
- ✓ As new buildings are constructed or modernized, the 20 year plan (i.e. to retain and operate the steam system in the most efficient/effective way possible) is compared with the 20 to 40 year option to migrate AWAY from steam. A good example of this parallel effort is demonstrated by the current SPX/YUH and Health Building construction projects. In the three projects currently under construction, no steam coils are being used. Rather heating hot water coils are employed with a steam-to-hot-water heat exchanger at the building "entrance." This configuration provides a potential migration path towards conversion to solar thermal (or another no-or-low carbon footprint) or to a more conventional heating hot water system.

Legacy Information

Steam has been used on the main San Jose State University campus since at least 1915. The original steam plant/boiler house was located near where the Computer Center is located today. The original central plant was added to and service was expanded as the campus grew. This included expanding services as far away as the Health Center, Building 38. Distribution was primarily buried steam lines in shallow concrete trenches. Remnants from the original tunnel system can be found today near the Computer Center, Dwight Bentel Hall and the Music/Art/Health/Event Center piping.

In 1972, a new Central Plant was constructed at its current location and housed four steam boilers, a steam turbine driven centrifugal chiller and two single effect, low pressure steam absorption chillers. At this time, a central backbone utility tunnel was constructed that ran from the Central Plant, North up 9th Street and then West down between the Student Union and Art/Music, continuing to and ending at Dwight

[1] Current thinking is to retain the building safeties that are protecting the low pressure side of the PRV's

Bentel Hall. This central tunnel houses the main steam and chilled water service for the majority of the campus. The tunnel was constructed under the Central Classroom Building which still existed at the time of construction. The new tunnel system was used to tie into old service laterals from the original central plant and many are still in use today. In addition to the main central tunnel, there is an additional walk through tunnel under SPX crossing Paseo De San Carlos and terminating between MacQuarrie Hall and Sweeney Hall. This tunnel was constructed while San Carlos was still an active public street. This tunnel houses chilled water and steam for Quad C of the campus (MacQuarrie, Sweeney, Duncan Halls, and UPD).

Over the years, the distribution system has been expanded to serve new buildings or portions have been replaced due to age and/or failure.

Steam at a Tipping Point

The installed steam plant and steam distribution system is positioned to last another 20 to even 100 years, barring any catastrophic seismic event. However, no matter how efficient the steam infrastructure is operated; no matter how valuable the steam infrastructure is; and no matter how well maintained the steam system is, steam plants and steam utilities infrastructures are a dying breed on campuses. This is because of the relatively high cost and more sophisticated nature of a system which, in the early 20th century, was considered the "Cadillac" of system. Likewise, this is because of 21st century interest in creating a "zero fossil fuel" and/or a "zero carbon footprint" campus environment.

For this reason, a significant effort was expended on framing the current system value, against an eventual migration plan from steam. This is provided as a stand-alone discussion in Appendix T – Steam Tipping Point.

Recommended UMP Projects

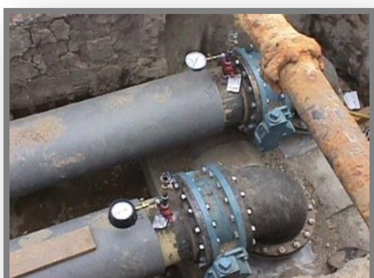
All projects are identified in Section V and Appendix H.

B. CHILLED WATER DISTRIBUTION

<table>
<tr><td rowspan="4">System Overview: one of the most sophisticated and efficient central, chilled water plants and systems in the CSU. The chilled water plant is connected to almost 4 miles of chilled water supply and return lines; through a complex mix of full-sized tunnels, and direct buried pipe; accessible from tunnel access points and mechanical rooms. Because the central, chilled water plant has been upgraded and reconfigured to provide CHW at 20 degree deltaT, the distribution network has essentially doubled in capacity.</td><td>Current Value: $15 to $30 million</td></tr>
<tr><td>Life/life expectancy: piping/plant varies in age from 1 – 40 years. Life expectancy greater than 20 years (system at large).</td></tr>
<tr><td>Strengths: system employs a complex and flexible mix of electric, absorption and ice technology; and is efficient, robust and flexible. See also Part K in Section III and Appendix K for more on the Central Plant.</td></tr>
<tr><td>Weaknesses: The Central Plant is limited by cooling tower and central plant real estate (limited expansion possibilities). The chilled water pipe system is a not a looped system.</td></tr>
<tr><td colspan="2">Significant Annual Costs:
Of approximately $500,000/year in maintenance for all underground utilities, CHW requires approximately 25%</td></tr>
<tr><td colspan="2">Capacity/Load metrics: At a plant capacity of 7,568 tons (4,800 tons, firm) and with pipe sizes able to deliver 18,000 gpm (15,000 tons at a 20 °F deltaT; 7500 tons with a 10 °F deltaT) to the main lines at the plant, the system; with the modifications identified herein, can meet current loads and has capacity to meet anticipated demands for the next 20 years.</td></tr>
<tr><td colspan="2">20 year plan: The system should be retained, expanded, maintained and relied upon for at least the next 20 years.</td></tr>
<tr><td colspan="2">Sustainability Considerations: There will no longer be sufficient reserve capacity if the full 2 million square feet of new space is added, rather than construct a “satellite plant,” it is planned to connect the system during Infrastructure 1 as a “loop system”. This will facilitate reliability and long term load diversity or load shed strategies without imposing the added capital cost and long term maintenance of a satellite plant.</td></tr>
</table>

Redundant Service: Currently, there is no redundancy in the system as this is a radial system.
Historical Failure Points: In general, the historical failure points are centered on both an inability to isolate services or areas on campus as well as the length of time the shutdowns occur.
Projects/Priorities: A series of projects should be commissioned that serve to both replace weak or compromised piping while simultaneously addressing the inability to isolate shutdowns. By planning and installing isolation valves in select locations to allow for, at a minimum, shutdowns per quadrant, the overall operability and reliability of the system can be enhanced and improved. In addition, completing the chilled water loop will provide redundancy and relief for future maintenance or emergency repairs, allowing segments of the campus to remain online while others are down for work.

CHW Piping is Ricwil/PermaPipe “Polytherm” prefabricated system (schedule 40 black steel carrier pipe, polyurethane insulation and fiberglass reinforced plastic outer jacket); These particular elbows appear to be field fabricated, as they don’t seem to have the insulation or jacketing factory installed. Working on a congested campus such as SJSU will almost always require some field adjustments to accommodate unforeseen conditions.



Below the rusted water line are the 16” Polytherm CHW lines which, in turn, tap onto old 16” transite lines (also CHW). The transite lines route the main tunnel CHW to the Computer Center/Clark Hall/Admin/etc.

System Overview

The chiller plant is described in detail in Appendix K – Chilled Water Archive Reports, and is a mix of electric and steam fired chillers, with an ice on coil thermal energy storage (TES) system.

A total of 25 buildings utilize chilled water distributed from the Central Plant, representing a total conditioned area of approximately 3,100,000 square feet[1]. These numbers are down from previous reports due in part to the demolition of Building BB and the Cafeteria. The existing chilled water system has a diversified load of 3,960 tons on a peak day. Chilled water (CHW) is distributed to each building by a primary only piping/pump system, and typically distributed throughout each building by a booster piping/pump system. The booster pump system is necessary due to insufficient pressure for distribution in the primary piping system. Based on the size of the existing piping system, as well as assuming a 20 °F difference between the chilled water supply and return temperatures, the peak capacity of the pipes is 15,000 tons.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Isolation – there are inoperable valves in several areas, resulting in a need to shut down the entire system to effect repairs or emergency work.
2. Recurring Issues – Currently, in WSQ Plaza, there is a recurring leak that needs to be addressed.
3. Campus Outage – With any break, the timetable to bring the campus is a minimum 8 hours due to a required six (6) hours to refill the system.

Major System Elements

The newer Engineering building was originally provided with two 600 ton Trane electric centrifugals and a smaller 150 ton chiller for smaller loads. Central Plant chilled water service was added to this building in 1996. The cooling towers for these chillers were replaced at about the same time as Campus was exploring the possibility to use these chillers as a 'satellite plant' for the loop. This concept has been abandoned and it is included as a project to demolish the old chiller plant in Engineering.

There are several other building chillers throughout campus, including:

- ✓ Hugh Gillis Hall: abandoned single effect absorption chiller in the penthouse
- ✓ IRC: abandoned single effect 200 ton absorption chiller in the penthouse.
- ✓ Computer center: Active, backup 200 ton reciprocating air cooed chiller located on grade on the South side of the building. Chiller is operable and used for back up purposes.
- ✓ Event Center: Active, backup, approximately 200 ton reciprocating air cooled chiller located on grade on the North side of the building. Chiller is operable and used for backup/off hours purposes.

There are also several (65 plus) standalone cooling systems ranging from 2 to 10 tons installed to provide 24/7 cooling to miscellaneous BDF's, MDF's and computer rooms. These are typically small split systems, controlled locally. There are no plans to convert these systems to chilled water, as the cooling demands are continuous.

[1] See also, Appendix K, The Cogent report states 26 buildings and 3,273,000, respectively. This 3% difference is considered de minimis relative to overall campus loads.

In conjunction with the Data Center Conditions Assessment Study, recommendations for replacement and updated cooling demands will be provided.

Piping

Chilled water is distributed to individual buildings through a primary piping loop. The primary piping loop distributes chilled water to each building. Typically, due to insufficient pressure from the primary loop, the chilled water is further distributed throughout the building by a booster pumping system. In the few cases when the pressure from the primary loop is sufficient, the chilled water is distributed throughout the building by the primary loop. Design goals are to keep the building pressure drops sufficiently low so as to not require a booster pump. A schematic diagram for the chilled water piping system is found in Appendix K.

Piping systems include or included: Bare Fiberglass; bare PVC; pre-insulated PVC, Transite; Pre-insulated transite within transite (Johns Manville Temp-Tite); pre-insulated steel pipe with FRP jacket (Ricwil/PermaPipe Polytherm); and field installed steel pipe with fiberglass insulation and all service jacket (central plant and tunnels). Current Campus 'standard' is PermaPipe Polytherm for new direct buried chilled water lines.

Pumps

Each chiller has a primary pump that circulates chilled water around the primary loop. The primary pumps are all variable speed pumps. Three campus primary pumps, each with a variable frequency drive (VFD), circulate the chilled water through the main primary loop. When the pressure from the primary loop is insufficient, a booster pump equipped with a VFD distributes the chilled water throughout the building. This booster configuration is typical of most buildings, with only a select few buildings utilizing the pressure from the primary loop for chilled water distribution.

A major project in 1996/1997 entailed the replacement of the 8" bare, direct buried PVC chilled water lines to Washington Square Hall. These lines were suspected of leaking and a direct replacement was called out. Upon excavation, the old lines were found to be woven in and out of the old foundation structure from the 1906 wings that were demolished. The removal of these lines was aborted and the lines are abandoned in place. New pipes are routed north of the original location and are comprised of Ricwil/PermaPipe Polytherm prefabbed, pre-insulated piping with FRP jackets.

In 2001/2002, with installation of the TES ice system and 1510 ton electric driven glycol chiller (CH-8), additional buildings were fitted with tertiary pumps and controls to complete the mostly primary/secondary/tertiary pumping configuration. Several buildings located in close proximity to the plant and/or main secondary lines were connected to the plant as secondary connections only (i.e., no tertiary pumps). Variable flow in the secondary loop was to be provided with the installation of several two way secondary crossover control valves.

Also during the 2001/2002 upgrades, Clark Hall (then Clark Library) had chilled water modifications to remove a plate and frame heat exchanger and use central plant chilled water directly. The old tower originally installed to provide passive cooling was also removed. The water storage tanks intended to be charged at night from the tower were abandoned in the basement of the building.

This infrastructure project also provided a set of 16" chilled water lines across Paseo De San Carlos to serve the new Housing Village project. These lines were also fitted with 12" or 14" taps (both are indicated in various documents) to allow connection to future phases 2 and 3 of the housing development in Quad D.

This same 2001/2002 project routed new 16" chilled water lines from the 16" mains behind Tower Hall across Tower Lawn for the upcoming MLK library. The piping system used for both of these chilled water extension was Ricwil/PermaPipe Polytherm pre-insulated, FRP jacketed pipe. 12" capped valves were installed on these lines in the vicinity of Hugh Gillis Hall, as there were projects under investigation for a very large combined use facility in the area of Hugh Gillis, Dudley Moorhead and Administration. This project was dropped from any further consideration.

There seems to be some plain fiberglass piping used for chilled water between IRC and Hugh Gillis. The taps described above should be extended to replace these failing lines. Installation date of these plain fiberglass lines is unknown.

With the construction of the University Police Department (UPD) at the South Parking tower, chilled water was extended from Sweeney Hall's South mechanical room.

During the site piping work on the chilled water and subsequent demolition of Wahlquist Library, it was discovered that substantial amounts of both plain Transite pipe (the 16" mains behind Tower Hall) and double wall, pre-insulated Transite pipe (Johns Manville "Temp Tite" piping systems) had been used for portions of the chilled water distribution.

Recommended UMP Projects

All projects are identified in Section V and Appendix H. The piping modifications to existing campus buildings have occurred in the last 2 years. These were initiated to help alleviate the "low delta-T" that the central plant has been experiencing. Work included: addition of check valves and altering control sequences and flows.

C. NATURAL GAS

System Overview: There is no central distribution network for natural gas. For the most part, any gas services on campus are remnants of the old residential gas services; however, there are dedicated gas services to several buildings. Except for the central plant accounts, the gas utility PG&E, maintains and manages the various gas accounts as well as all piping upstream of the individual meters. There are two main accounts for the central plant with a dedicated high pressure service and meter for the cogeneration system. All of the other accounts combined are well below 10% of total campus gas usage (i.e. compared to the central plant and cogeneration consumption of natural gas).	**Current Value:** $-nominal **Life/life expectancy:** not currently applicable (utility owned and maintained) **Strengths:** the central plant gas accounts for cogeneration and boiler gas affords lower cost gas, resulting in a high financial benefit. **Weaknesses:** because there is no central distribution system the campus cannot take advantage of current or future natural gas 'bundling' purchase/distribution strategies.
Significant Annual Costs: The central plant accounts for almost 6 million therms per year.	
Capacity/Load metrics: Currently, there are multiple meters from PG&E (see Appendix E)	
20 year plan: extending a gas line, not separate from but coincident with, other infrastructure project work will afford the campus flexibility in the future for a consolidated service with possible reduced pricing of delivery of natural gas to multiple campus facilities. The objective is to consolidate 18 services to a total of 6 PG&E meters located at: (1) Student Union, (2) Industrial Studies, (3) Engineering, (4) Central Plant, (5) Yoshida Hall, and (6) the Trades Building.	
Sustainability considerations: an extended gas distribution system would offer an ability to purchase and distribute natural gas through a reduced number of utility meters. For accountability, the campus should consider installing building meters if the services are consolidated.	

Redundant Service: The system lacks central distribution throughout the campus.
Historical Failure Points: No historical failures have been reported.
Maintenance/Spares: No annual or current maintenance or equipment concerns have been reported.
Projects/Priorities: An addition of gas meters and a central distribution of the natural gas are the major projects recommended for this utility.

The central plant takes higher pressure gas and is able to purchase at a lower cost.

Much of the natural gas supplied on campus is typical residential style for single building service.

System Overview

Two prime gas accounts serve the central plant. There is one for boiler use and one higher pressure service dedicated to the cogeneration system with a 6 MW gas turbine. There are 18 other separate gas accounts for the immediate downtown campus buildings (excluding Student Services Center). These accounts are listed in Appendix E.

Typical building gas service is an extension of the PG&E owned and operated residential piping network. Most of these lines were updated by PG&E in the last 15 years by installing plastic (Polyethylene) piping inside the old cast iron lines.

A separate gas main on 10^{th} Street is used for high pressure gas delivery to the cogeneration system. Delivery pressure is 265 psig. Prior to supplying the turbine, the gas is further compressed via a campus owned electric driven gas compressor. Department of General Services (DGS) provides this gas through a PG&E owned and operated transportation and distribution pipeline system.

A separate account to the boilers is also a DGS provided, PG&E delivered, gas system. Delivery pressure is 65 psig.

Historical Failure Points and Critical Areas

No historical failure points have been submitted or reported as part of this effort.

Recommended UMP Projects

Although not a detailed project, it is recommended that as underground utilities are installed from the central plant. Thought should be given to include gas lines for future consolidation of loads to six meters located across campus.

All projects are identified in Section V and Appendix H.

D. ELECTRICAL SYSTEM

System Overview: The campus electrical system architecture is a radial feed which stems from the Central Plant. The 12.47kV main distribution system, has seventeen 12.47 kV feeders to provide power to different areas and buildings across the campus. All of the buildings on campus with 12.47kV distribution are dual fed for redundancy. Some of the existing buildings and the Chiller Plant inside the Central Plant are currently on the 4.16kV service, derived from the 12.47kV service. The campus has a 6MW Co-Generator delivering power to the campus 12.47kV switchgear which off-sets 80% of total campus usage.

Current Value: $20 to $40 million

Life/life expectancy: The existing campus medium voltage switchgear (12.47kV and 4.16kV) was replaced in 2000. The existing campus substation was upgraded and purchased by SJSU in 2002. Life expectancy is greater than 30 years (system at large).

Strengths: Much of the electrical system is relatively new (2000/2002) and has been well maintained. System distribution is adequate and has built-in redundancy. It will be more reliable once the differential relays for the transformers and batteries have been replaced. Systems have the ability to isolate each building on campus.

Weaknesses: there are various pullbox locations in the system that has been identified as single point of failure due to multiple feeders routed through the same location.

Significant Annual Costs:
Campus has allocated approximately $125,000/year for Preventative Maintenance including substation and electrical manhole maintenance.

Capacity/Load metrics: Campus electrical capacity is 20MVA, derived from a redundant pair of 12/16/20MVA 3-Phase, 115kV to 12.47kV transformer banks. The 2012 peak demand is 8.7MVA (based on ION Meter data of 6.97MW and 0.8PF)**.** Anticipated future growth of 2 million sq. ft. will require an additional load of approximately 6.6MVA. Total campus build-out will require approximately 15.3MVA, which is on the order of 77% of total campus capacity. Therefore, the existing electrical system can accommodate future growth.

20 year plan: the system should be retained, expanded, maintained and relied upon for at least the next 20 years. The existing buildings currently fed by the 4.16kV system should be transferred over to the 12.47kV system to provide redundancy to the buildings. This will allow for the campus to use the 4.16kV system solely for the chillers at the central plant. The Phase II future housing shall obtain electricity from EMH-18. The objective is to eliminate the PG&E feed at Joe West Hall and the Dining Commons.

Sustainability Considerations: The campus is considering conversion of all building to 12 kV, solar (PV) and more practically, the potential to eventually replace the cogeneration system with a fuel cell or other low/no-fossil fuel prime mover.

Redundant Service: System redundancy is provided with dual feeders to buildings on campus.

Historical Failure Points: Currently, a failure has occurred affecting the feeder serving the Computer Center, Clark Hall, and Engineering. The Computer Center is a critical facility and, should the second feeder be compromised prior to the repair/replacement of the failed feeder (12NW2), it will effectively render the buildings offline, with the Computer Center only able to utilize the generators and UPS systems. This is a good example of a critical failure point that must be addressed.

Maintenance/Spares: NETA testing (3 years) and other required maintenance will be addressed as part of the Preventative Maintenance allocation. Manhole flooding will require a corrective effort likely provided with sump pumps or larger infrastructure projects to address water intrusion and the high water table on campus.

Projects/Priorities: A series of projects should be commissioned that serve to address the risks associated with critical buildings/facilities as well as projects supporting the growth of the campus based on planning through 2024.

Although the 4160 and 12kV switchgear, feeder and conduit infrastructure is generally in good to very good shape it is necessary convert the remaining 4160 building to 12kV. Also, the exterior lighting system wiring infrastructure is in poor condition. This is being upgraded separate from the UMP, through already scheduled maintenance funding.

System Overview

Incoming Electrical Service:

Pacific Gas and Electric (PG&E) is the electrical utility provider to the campus via an 115kV substation known as the Markham Substation. The substation is owned and operated by SJSU (Campus), where it was purchased from PG&E back in 2002. It is a double ended and primary selective fed from the Stone and Evergreen Substations via 115kV overhead lines through two disconnect switches. During the purchase of Markham substation from PG&E the substation was upgraded. A pair of 12/16/20 MVA, 3-Phase, 115kV to 12.47kV oil-filled transformers were installed.

Campus System Architecture and Electrical Distribution:

Campus incoming electrical service is 115kV. The incoming 115kV service is then stepped down to 12.47kV for campus distribution, and it is rated for 2,000 Amps with 1,200 Amps main circuit breaker. Refer to Appendix J – Supporting Electrical Documentation, Campus 12.47kV and 4.16kV SLD for campus single line diagram.

The campus electrical system architecture is a radial feed which stems from the Central Plant. The 12.47kV main distribution system, has seventeen 12.47 kV feeders to provide power to different areas and buildings across the campus. Most of the buildings on campus 12.47kV distribution are dual fed for redundancy.

Campus 12.47kV electrical power distribution is a radial system with primary selectivity with main and alternate feed capability to distribute to the load. The majority of the buildings are being fed off the 12.47kV service. Eight (8) of the existing buildings (Health, Art, Music, Administration, Science, Dudley Moorhead/IRC, Hugh Gillis, and Morris Dailey Auditorium) and the Chiller Plant inside the Central Plant are currently on the 4.16kV service, derived from the 12.47kV service. Campus 4.16kV electrical is also radial system with no primary selectivity available. This is part of the original campus distribution system to the building and is being phased out.

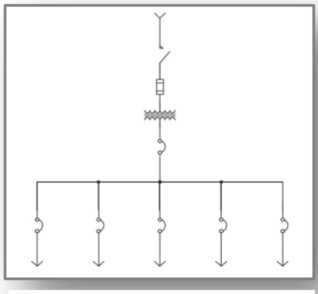


Figure 2: Radial System without Primary Selectivity

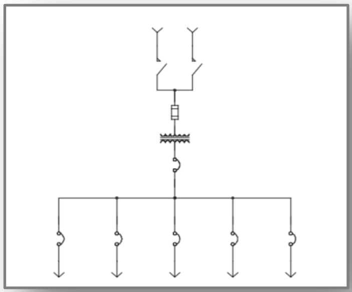


Figure 2: Radial System with Primary Selectivity

There are fifteen (15) 12.47kV feeders distributing power across the campus. Thirteen (13) 12.47kV feeders are serving majority of the building across the campus, with main and alternate feed selective, one (1) 12.47kV feeder feeds the 480v loads at the central plant and one (1) 12.47kV feeder stepped down and feeds the 4.16kV system. Refer to Appendix F – Energy Use and Electrical Load Demand, Feeder Use Schedule where it identifies which feeders the load / building are being fed / connected to and the feeder status switch location and configurations.

Existing 12.47kV feeders typically rated for 15kV, 500kcmil copper conductors while the 4.16kV feeders are rated for 5kV, #4/0 AWG aluminum conductors.

Each of the 12.47kV and 4.16kV feeders on the SJSU campus has its own PowerLogic ION7300 Series Power and Energy Meter. The ION7300 meter is a revenue-class power and energy meter, capable of event and min/max logging, real-time and harmonics measurements. This meter allows for identification of usage and peak demand for each feeder.

The existing campus medium voltage switchgear (12.47kV and 4.16kV) was replaced in 2000. The existing campus 115kV substation was upgraded in 2002. Life expectancy is greater than 30 years (system at large).

Co-Generation Plant:

SJSU campus has a 6MW Co-Generator delivering power to the campus 12.47kV switchgear. The co-generation plant is also provided with a 500kW black start generator to restore power to the campus without relying on the external electric power transmission network.

The co-generation plant has been a reliable source providing net power of up to 80% of campus electrical use (based on 2012 energy data – campus usage: 46,903,664 kWH; co-generation produces: 37,374,448 kWH[1]) while auxiliaries of co-generation are demanding approximately 400kW.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Replace damaged feeder 12NW2 to restore redundancy to the critical buildings
2. Separate feeders occupying three (3) consecutive manholes in an effort to separate the potential risk of a catastrophic failure of one impacting others.
3. Address the oil switch for Tower Hall, currently undersized at 6000A (with 10,000A available).
4. Transfer buildings currently on the 4160V service to the 12kV Central Plant service for redundancy and reliability.
5. Chiller power redundancy should be provided at the 4160V service at the Central Plant to ensure cooling.

Capacity & Performance

Campus electrical capacity is 20MVA. The 2012 peak demand is 8.7MVA (based on ION Meter data of 6.97MW and 0.8PF). Anticipated future growth of 2 million sq. ft. will require an additional load of approximately 6.6MVA. Total campus built-out will require approximately 15.3MVA, which is on the order of 77% of total campus capacity. Therefore, the existing electrical systems have the capacity to accommodate the anticipated future growth of the campus. However, the existing underground infrastructure will need to be expanded to accommodate the growth.

The Master Plan development at the Campus includes future planned expansion of square footage for new Campus and housing buildings. The current electrical service has enough capacity to serve these anticipated future buildings.

[1] See Appendix F - Energy Use and Electrical Load Demand

Building Energy Usage
The Building Energy Usage 2009-2012 in Appendix F – Energy Use and Electrical Load Demand shows the entire campus electrical usage as well as individual buildings from 2009 to 2012.

Load Distribution Summary
Load Distribution Summary in Appendix F – Energy Use and Electrical Load Demand, presents the load distribution summary from 1993. It also compares the 2004 and 2012 actual KVA demand as well as a projection of the campus demand to 2033.

Future Electrical Demand
Future Peak Demand Calculation in Appendix F – Energy Use and Electrical Load Demand provides the load calculation on how the 2033 projected demand was calculated.

Load Survey
The updated load survey is based on load data taken at the feeder level. This data was correlated to the building square footage. It identifies monthly electrical usage (kWh) for each medium voltage feeder and each load / building. Refer to Building Energy Usage 2009-2012 in Appendix F – Energy Use and Electrical Load Demand.

Feeder Load (Demand) Summary
Medium Voltage Feeder Load Demand – Year 2012 in Appendix F – Energy Use and Electrical Load Demand identifies the load demand for each of the 12.47kV and main 4.16kV medium voltage feeder. Data was taken from the ION meter readings from January 2012 to December 2012.

Refer to Appendix J – Supporting Electrical Documentation for campus medium voltage single line diagram, site map, electrical and IT Infrastructure manholes map, manhole butterflies, and a list of stand-by generator and transformer present on campus.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

E. DOMESTIC WATER, FIRE WATER AND WELL WATER SYSTEMS

System Overview: The campus potable water system is a highly reliable system which receives water from an existing on-campus well and back up from the San José Water Company (SJWC).

The SJWC system is connected to supply the steamer hydrants and serves as a backup supply for Campus domestic water. If the well is inoperable, SJWC provides 50psi of water pressure versus 80 psi from the campus well.

The onsite well provides water to wharf hydrants; building fire sprinklers and Class II standpipe systems (see App. V).

The campus has a monitoring plan which addresses the need to evaluate bacterial counts of the water system. The 21sampling points located throughout campus make obtaining representative specimens of the distribution system water quality more efficient.

Current Value: $5.4million

Life/life expectancy: 20 to 40 years

Strengths: highly reliable "backup" from SJCW; well provides low cost, owner-provided water.

Weaknesses: SJWC water can only serve up to 3 floors without booster pumps (i.e. when/if the well is off).

Additional meters are required and piping at the domestic meters needs to be upsized.

Based on the hydrant analysis, additional steamer hydrants are required to supply campus.

Significant Annual Costs: Water system costs are on the order of $100,000 per year to maintain.

20 year plan: Continue to rely on this system as installed with improvements that are described herein including relocation of well to Quad C.

Capacity Load and Future metrics: Per city ordinance 25,838 allowed by 1998 CFC, local city fire authority has approved a reduction for the maximum required fire flow to be 4,500 gpm when future buildings are provided with an approved automatic fire sprinkler system. Peak hour demand of 950 gpm of potable water and peak sprinkler demands of 300 gpm are currently being met and will continue to be met by a 1,200 gpm system.

Sustainability considerations: The well water system should be maintained and retained so as to continue to provide a sustainable water source for the university

Redundant Service: SJWC provides a redundant and supportive water service to the campus at 50 psi.

Historical Failure Points: Failures have not been reported but campus staff has noted several potential and likely failures that would adversely affect the campus. These are documented in the Risk Assessment in Chapter 7.

Maintenance/Spares: Insert Text here

Projects/Priorities: Provide Booster pumps to the system for redundancy.

Provide replacement of aged galvanized piping in identified areas on campus.

Typical elements of the domestic water and fire system are shown: a backflow preventer, standpipe service and fire dept. connection (bottom); a "steamer" hydrant (middle); a portion of water line A3WL02, East of Morris Daily (upper pipe in top photo).

System Overview

The SJSU water system currently receives water from an existing on-campus well. This well has provided adequate support to the campus 47 domestic and fire connections; and has provided for campus water demand growth even with large increases in campus demand associated with such major changes as the Campus Village and the MLK library additions. The San Jose Water Company is a backup supply for water if the campus well malfunctions. SJWC water provides water supply of 4500 gpm at 20 psi by city ordinance to some buildings for domestic and sprinkler systems.

The SJWC system has three interties to the SJSU distribution piping system through a total of three water meter connections to the City's domestic water system. These meters are located in the following areas:

1 – 145 South 7th Street near Admin) – 8" pipe connection
2 – 4th Street (4th Street Parking) – 6" pipe connection
3 – 9th Street (Central plant) – 12" pipe connection

These meters provide the water distribution system flexibility for the campus and have delivered the required campus water demand when the well is out of service. Connections are provided with single backflow preventers and automatically supply SJWC water when the campus system drops to city water pressure. The SJSU system provides water at a discharge pressure of approximately 62-80 psi. The SJWC system operates at approximately 60 psi which is reduced to approximately 50 psi because of the head loss across the reduced pressure backflow preventers. SJWC requires break tanks be installed wherever building booster pumps are used. There are currently two buildings with booster systems that do not have break tanks.

A new 8" domestic water looping distribution system was installed between 1999 and 2000. The old lines were separated to provide a separate irrigation piping network. In the mid-2000's, this separated piping system was confirmed to have no cross connection. As of 2012, the entire system now employs recycled water from South Bay Water Recycling (SBWR). This separate irrigation and recycled water system is summarized in recycled water section of this report and discussed in more detail in Appendix V. One of the opportunities mentioned in Appendix V is that the real driving force for the 80 psig well discharge pressure was from irrigation sprinkler heads and as irrigation is removed from the well, there is a chance that pressure requirements could be reduced.

Appendix V provides an expanded discussion of the domestic water, fire water, and well water system.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Fire sprinklers above the third floor of buildings are compromised due to potential reduced pressure in the event of a well failure and utilization of the domestic water service provided by SJWC.
2. Aging piping in the vicinity of the Faculty office building and in the areas adjacent the Music and Arts Buildings have surpassed their useful life and risk eminent failure.

Legacy Information

As stated earlier, a new 8" campus loop was installed in 1999 to 2000 with the old lines converted (and confirmed separate) to recycled water use (for the bulk of campus use and irrigation). The well system has a single 2" sample line to monitor chlorine levels for the system.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

F. FIRE WATER

System Overview: San José State University's fire water system is served by a combination of water from the campus on-site well and San Jose Water Company (SJWC). The steamer fire hydrants on campus are primarily supplied by SJWC and depend on their system to meet fire hydrant flow requirements. The existing on-campus well provides supply to 47 campus domestic and fire connections. It supplies water to fire sprinkler and/or standpipe system for 16 campus buildings. SJWC is the backup supply for water if the campus well/water system malfunctions or requires repair.

The campus system has 20 (1-1/4" to 2-1/2") wharf hydrants supplied by the well. They serve as flushing points and their flow rates range from about 300 to 900 gpm. These wharf hydrants are not meant to meet fire flow requirements but could be used if responding agencies need them.

There are three connections between SJSU and SJWC and provide a discharge pressure of 42 psi. These connections provide the standby source to meet water demands if the well is out of service or if the campus system pressure drops below the pressure in the SJWC system. The SJSU water system supplies either partial or full fire protection in its buildings. Some of the buildings do not have fire booster pumps. Buildings with full sprinklers should have engine driven fire booster pumps or electric pumps with engine generators that provide a backup for fire suppression. Fire protection for most buildings consists of fire sprinklers. These buildings do not have SJWC connections and are dependent on the SJSU water system.

Current Value: $4M (approx. 30,000LF pipe x $120 + hydrants) ; + $2.2M for campus well

Life/life expectancy:

- 40 years for actual well
- 10-15 years for pump

Strengths: The SJSU water distribution pipelines and the well have sufficient capacity to provide supply to existing fire sprinkler systems. Based on the Fire Flow Model results from SJWC, an upgrade to onsite well is not necessary since SJWC provides adequate flow

Weaknesses: Many of the buildings have fire sprinklers and rely on a single source, the onsite well, to provide adequate system pressure. Therefore, the threat of low pressures within the system may make sprinklers/standpipes inoperable if the well was ever out of service.

Although SJWC can be used as a backup, it supplies water at a significantly lower pressure (40 psi versus 80 psi from the well). In order to provide the same pressure as the well, booster pumps would need to be installed. The campus well pump does not have enough water flow to meet the possible fire water demand. Therefore, there is no redundancy in the fire water system.

There are locations on campus that are over 500 ft from a SJWC steamer hydrant which is not in compliance with the CBC.

The Health Building, Sweeney Hall and MacQuarrie Hall do not have domestic booster pumps for standpipes[1]. Therefore, if the well is not operating, SJWC's pressure would be too low to serve the fire suppression for these buildings.

Significant Annual Costs: Onsite Well Operation and Maintenance Cost:

Campus Fire Hydrant Improvements: $485,000	Campus Well Relocation: $2.2M

20 year plan: Relocate the onsite well to Duncan Hall to accommodate Campus Housing Phase II. The campus will continue to maintain the use of the well because it provides a lower cost, higher quality water supply. The campus will add steamer hydrants on a case-by-case basis to meet CBC.

Redundant Service: See previous DOMESTIC AND FIRE WATER section	
Historical Failure Points: See previous DOMESTIC AND FIRE WATER section	
Maintenance/Spares: See previous DOMESTIC AND FIRE WATER section	
Projects/Priorities: See previous DOMESTIC AND FIRE WATER section	

A wharf hydrant (far right) supplied by the campus well. A steamer hydrant (right) supplied by SJWC.

[1] Appendix V Table 6, SJSU Water Master Plan – Kennedy Jenks 2008

System Overview

San Jose State University's campus fire water system is supplied by both San Jose Water Company and the campus' own on-site well.

The SJWC system provides water to the steamer hydrants located through campus. Some hydrants are located more than 500 feet away from buildings. To meet CBC, the installation of additional steamer hydrants should be evaluated on a case by case basis. See Appendix EE for Hydrant Analysis.

The existing well was constructed in 1994 and can produce up to 1300 gpm at 80 psi with the existing pump and motor. It has been estimated that the well, with an upgraded pump and motor, could produce up to 2500 gpm. The current plan is to relocate the on-site well to another location to accommodate the future Campus Housing Phase II. The on-site well provides 80 psi water through the campus distribution pipelines to the fire sprinklers in the buildings. If the campus on-site well is down, SJWC provides backup to these systems. SJWC typically maintains its system at 50-60 psi. The SJWC interties include reduced pressure backflow preventers which lower the pressure available to the SJSU system to between 40 and 50 psi.

Historical Failure Points and Critical Areas

See previous DOMESTIC AND FIRE WATER section

Major System Elements

- On-site Campus Well
- 20-Wharf Hydrants supplied by on-site well
- 2- Steamer Hydrants supplied by on-site well
- Steamer Hydrants supplied by SJWC

Capacity & Performance

The current SJSU water distribution pipelines and the well have sufficient capacity to provide supply to existing fire sprinkler systems.

SJWC supplies water to the steamer hydrants throughout campus. See Appendix V, SJSU Water Master Plan prepared by Kennedy/Jenks in 2008 for additional Fire Flow Model results and Appendix S for the H20Net Water System Model. An upgrade to onsite well is not necessary since SJWC provides adequate flow.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.
Campus Hydrant Improvements – See Appendix EE for Hydrant Analysis.

G. RECYCLED WATER

System Overview: This is the only campus-wide recycled water system in the CSU. The system is a stand-alone, fully permitted, single-metered, loop system which deploys 100% recycled water for campus irrigation, central plant cooling towers, and a slowly expanding system of building toilet water (for flushing). Building toilet water flushing requires separate piping.	**Current Value:** $4,000,000 **Life/life expectancy**: well beyond 20 years **Strengths:** Able to take full advantage of the City's green vision recycled water system. It saves water and sewer fees and is completely separate from the campus potable water system. **Weaknesses:** none
20 year plan: continue to expand the recycled water system by expanding connection to buildings at every opportunity. This includes a policy for separate interior piping for toilet flushing.	

Redundant Service: Not Applicable
Historical Failure Points: No historical points of failure have been reported at the time of this study.
Maintenance/Spares: Not Applicable
Projects/Priorities: No projects for recycled water related to corrections or maintenance are required.

Recycled water, the purple pipe, enters the central plant for cooling tower make up.

Recycled water use requires posting of warning signs.

System Overview

In 1997, the University installed a new potable water piping infrastructure with the intent of eventually re-using the old system as a fully deployed, campus-wide recycled water system. This was undertaken in order to take advantage of the recently deployed recycled water lines provided by the City of San José, South Bay Water Recycling. At that time the University became the first campus in the state to employ recycled water for the central plant cooling towers. This single change continues to save over 20million gallons of potable water PER YEAR. Shortly after the turn of the new century, the campus-wide recycled water system was confirmed to be fully separated from the potable water system and the campus succeeded in permitting recycled water throughout the campus to accommodate nearly all of the campus irrigation needs. This was further enhanced when the SBWR recycled water lines were extended along E. San Fernando Street so that the MLK Library toilets, already duel-piped for 100% recycled water use during its original construction, could be connected.

The recycled water provided by SBWR has total dissolved solids (tds) similar to that of the SJSU groundwater from the well. This affords the University an advantage relative to other facility's applications of recycled water because most campuses do not have their own well; therefore tds and subsequent treatment can vary significantly.

When considering use of recycled water in toilet flushing, the University has had no complaints of odor or staining in the MLK library. There have been minor issues associated with the higher amounts of silt like particulate that results. This has caused failures in Cla-Val, pilot operated level control valves. As a result, the break tanks were retrofit with direct operated float valves. There have been no related problems since that retrofit project and this standard is now employed across campus.

Historical Failure Points and Critical Areas

No historical failure points or critical areas have been reported at the time of this study.

Recommended UMP Projects

All projects are identified in Section V and Appendix H. Note the following:

- ✓ The campus plans to utilize recycled water for boiler make up in the central plant. The pre-treatment requirements for this are currently under investigation.
- ✓ All new buildings are being dual-piped to utilize recycled water for toilets and urinals.
- ✓ The main campus connection to SBWR is from a 12" main in San Fernando that connects to the campus distribution system as shown in the drawings set; and on the schematic drawing on the next page.

H. SANITARY SEWER

System Overview: The sanitary sewer is a gravity fed system which consists of a combination of City owned mains and Campus owned laterals.	**Current Value:** $4.5 million
	Life/life expectancy: 50 years
	Strengths: The systems have and can provide adequate collection capacity to meet current and future needs. The campus employs no septic systems
	Weaknesses: Most of the piping is old and some velocities are at or below current standards. Area adjacent to the pool has history of foul smells. The old pipes are owned by the City.
Significant Annual Costs: *n/a*	
20 year plan: Continue to rely on the existing City system and SJSU infrastructure with no significant changes unless provided by the city.	

Redundant Service: Not applicable	
Historical Failure Points: Recently, a condition developed in the area of campus near Hugh Gillis and Dudley Moorhead, whereby sewage backup occurred and completely saturated the lawn with effuses. In addition, several smaller, local failures have occurred related to the existing installation of vitreous clay piping.	
Maintenance/Spares: Not applicable.	
Projects/Priorities: The existing sanitary sewer piping is beyond its useful life and requires planning for replacement.	

A typical sewer manhole

System Overview

Existing Collection System:

The San Jose State University sewage collection system is by gravity flow for most parts of the campus. Building laterals are of 4-inch and 6-inch clay pipes. The lift stations are small electric motor pumps equipped with float switches to activate and deactivate the pumps. The campus main collection system varies from 6-inch through 12-inch clay pipes. The majority of campus flow discharges into the existing city owned 72-inch trunk sewer line running north and south in 7th Street. Several buildings along the northern edge of campus discharge into the 37-inch and 48-inch trunk sewer line running east and west in East San Fernando Street. There is also a 10-inch overflow sewer line running in 4th Street.

The Manning formula is an empirical formula for estimating open channel flow and is as follows:

$$V = \frac{1.41 \times Rh^{2/3} \times S^{1/2}}{n}$$

V = velocity
n = roughness coefficient, dependent on pipe material
Rh = hydraulic radius
S = slope of pipe

The existing capacity of the SJSU maintained sewer laterals, SS pipes from the buildings to the City of San José mains, was analyzed using the Manning formula. Each SS lateral was modeled based on 'open channel flow' hydraulics principles. The method looks at the pipe geometry, material, slope and the expected average and peak flow rates through each pipe. Both the average and peak flow rates were estimated based on the building area. The two important parameters when considering the function of the existing SS piping are the velocity and full pipe flow percentage. The velocity typically should be between 2 ft/s and 12 ft/s. The full pipe flow percentage should not exceed 75%. This variable represents the height of sewage discharge relative to the pipe diameter.

The analysis input the existing and new building areas to predict an average and peak flow rate. If a new building is expected to be connected to an existing SJSU lateral pipe, that additional flow was accounted for in this analysis. In most cases, the new buildings can have laterals connected directly to the City of San José mains and would have no effect on the capacity of the <e> laterals. Overall the pipe velocities, under average and peak flow conditions, are on the low end between 1.5 and 2.5 ft/s. The full pipe flow percentage was sufficient for both the average and peak flows, except for the 6-inch lateral from MLK Library. Based on the existing data, this pipe is undersized for peak flow conditions. An 8-inch SS pipe would provide sufficient capacity for the peak flow. However, when looking at an average flow rate for this line, a 6-inch pipe provides enough capacity.

Since there are no known issues regarding the sewage piping, and the vast majority of SS pipes have sufficient capacity, current philosophy is to expect that during design work with city, no infrastructure projects are necessary for the <e> piping. This analysis can be used as a guideline when sizing SS pipes for new buildings; however, a more accurate (per 2010 CPC) method of sizing the sewer laterals would be to determine the actual drainage fixture units for each new building. This method is difficult to use for existing buildings because the entire plumbing system would be required to be "as built." The results from the modeling performed in the

UMP are very useful for determining the potential effects of increasing the load on an existing pipe capacity, resulting from either a building addition or connecting a new building to an <e> SJSU lateral (rather than connecting the new building directly to the San José main).

Appendix DD provides the flow analysis for the Sanitary Sewer System

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Poor and/or improper disconnection of campus laterals from the City main lines, leading to significant sewage backup and noxious fumes.
2. The remaining VCP piping installed on campus is an extremely high risk for a catastrophic failure.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

I. STORM

System Overview: The storm system is a combination of City owned mains and Campus owned laterals. Generally speaking the system employs gravity feed with a limited number of lift stations.	**Current Value:** $5.8 million **Life/life expectancy:** 20 to 40 years **Strengths:** n/a **Weaknesses:** localized water intrusion and ponding is occurring
Significant Annual Costs: *n/a*	
20 year plan: *n/a*	

Redundant Service: Not applicable
Historical Failure Points: The campus has historically experienced local flooding and ponding due to drain blockage and sump/lift station operation.
Maintenance/Spares: The maintenance of the sumps and lift stations are crucial in helping prevent local flooding and ponding.
Projects/Priorities: Projects 88 and 89 address drainage concerns related to Dwight Bentel Hall and Engineering respectively. In addition, local drainage issues associated with flooding of EMH-27 are addressed as part of Project 38.

A typical drain in hardscape

A typical catch basin/ area drain for landscaped areas

System Overview

Existing Conditions:
The SJSU campus topography is very flat. The ground slopes at less than ½% northwesterly. The storm run-off and conveyance system depends heavily on the subsurface storm drain network collection system and the inlet structures with catch basins. The available record drawings for the storm drain collection system are of the plane view with no vertical alignments. The size and location of the inlet structures are not well defined. Inlet drains have been constructed throughout the campus to collect localized storm runoff and carry the flow to city's major storm drains. There are six sump pump stations located at various areas of the campus. These pumps are mainly used for the buildings with building pads and courtyards located below the street grade.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Flooding at the Engineering and Tower Hall Buildings due to inlet blockages at ground level
2. Sump pump/Lift station failures causing minor flooding (in areas such as Corp Yard, outside of Science, Business)
3. Water filling up EMH-27 (electrical) due to storm drain being blocked

Major System Elements

The major existing City storm drain lines consist of a 36-inch pipeline running north and south in 7th Street. This storm drain pipeline becomes a 42-inch pipeline at East San Carlos Street as it picks up the flow from the 18-inch RCP pipeline. This line turns westerly on San Fernando Street and picks up another 24-inch pipeline running in San Fernando Street, between 7th and 10th Street. There is also a 54-inch pipeline running north and south in 4th Street. The west section of campus drains into this pipeline.

The major storm drain collection system in the streets within the campus are owned and maintained by the City of San Jose. Throughout the campus, the campus-maintained storm drain collection system consists of a network of pipes ranging from 6-inch to 15-inch in diameter.

Capacity & Performance

The Rational Method was used for calculating peak flows, per the Santa Clara County Drainage Manual, 2007. The Rational Method formula is as follows:

$$Q = A \times C \times i$$

Q = Peak runoff flow rate (cfs)
A = Drainage area (acres)
C = Runoff coefficient
i = Rainfall intensity (in/hr)

The Rational Method is a valid methodology for calculating peak runoff rates for the SJSU campus because the campus is less than 200 acres and meets the following criteria specified in the 2007 Drainage Manual:

- No water detention areas
- Minimal surface storage effects
- Minimal areas of pervious soils

The rainfall intensity (*i*) is derived using the Intensity-Duration-Frequency (IDF) curves provided in the 2007 Drainage Manual. These curves are a function of mean annual precipitation and the time of concentration. The mean annual precipitation for SJSU is 15 inches of rainfall. The SJSU campus was modeled as a 'commercial' area intermixed with hardscape and landscape.

The existing system capacity was evaluated by determining the connected drainage area for the SJSU maintained system. Using the Rational Method formula above, a peak runoff rate is determined. Finally, Table 11-2 of the 2010 CPC provides maximum allowable flow rates for storm drainage pipes sized from 3-in to 15-in. Overall, the existing storm drainage lines are adequately sized; however, there are several areas where minor flooding does occur, detailed on the following page.

Flooding Problems:
For the most part, the campus has not experienced any major flooding problems. Minor flooding problems have occurred at the Engineering Building located at the north central part of campus and Tower Hall located in the northwest quadrant. These floods have been a result of inlet blockages at the ground surface. There have been some other minor flooding problems associated with the sump pumps in some of the buildings where the pump float switches have malfunctioned and operational staff has operated the pumps manually.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

J. IT Infrastructure

System Overview: The campus data network and IT Infrastructure system is comprised of a Campus Computer Center, housing all operational equipment, a peripheral MDC (located at the Music Building) and a series of direct buried conduits and manholes distributed throughout the campus. Each building has a minimum of two 4" conduits servicing the building MDF with a main trunk of conduits comprised of fourteen 4" conduits serving the areas south of the Campus Computer Center and ten 4" conduits servicing the areas north of the Computer Center. The system is comprised of copper, fiber, five (5) networked phone switches and coaxial cabling installed throughout campus. In addition, a microwave antenna data/phone link to South Campus is located at Joe West Hall, as well as a repeater installed at the Business Building that serves the University Police Department.

The TIP II project provided a backbone fiber at the campus core from the Computer Center, to Music and MacQuarrie Hall. Future buildings shall be designed to have a pathway to the MPOE at the Computer Center as well as a pathway to MacQuarrie Hall to provide redundancy to the system.

Current Value: $15 to $20 million[1]

Life/life expectancy:

- The physical equipment on campus adheres to a five year replacement schedule, with the last replacement occurring in 2011.
- The copper plant has a life expectancy of approximately 20 years.
- The fiber has an indefinite physical life expectancy. The fiber identified as TIP I is outdated and should be removed. The fiber identified as TIP II should be considered for replacement as well, allowing a contiguous technology implementation that encompasses the current industry technology for speed, bandwidth and reliability.

Strengths: The IT Infrastructure has a physical and operational redundancy of service provided by the dual cable fiber installed during the TIP II Project. The system also includes backup generators and UPS systems for power reliability/emergency support at several buildings including the Campus Computer Center. Overall the system is well maintained.

Weaknesses: The system is in need of a technology refresh related to the fiber system. Also, there is a physical limit in several areas of conduit where fiber was abandoned in place. This could be removed to provide additional conduit capacity.

20 year plan: the UMP anticipated that the system would be updated both in terms of the existing equipment within the next three years, fiber replacement scheduled within a seven to ten year period and the necessary relocation of the phone switch/antenna installed at Joe West Hall (in conjunction with the building demolition). To accomplish this, the UMP projects provide a pathway to the MPOE at the Computer Center as well as a pathway to MacQuarrie Hall to provide redundancy to the system. In addition, the conduit systems will be "cleaned up" which includes removing abandoned fiber to allow conduit utilization for future projects.

Redundant Service: There are two (2) separate, redundant fiber services installed throughout the campus, providing dual services for all buildings.

Historical Failure Points: The majority of system failures are related to equipment rather than infrastructure.

Maintenance/Spares: Not applicable

Projects/Priorities: A series of projects should be commissioned that serve to both replace limited conduit infrastructure to existing buildings as well as install conduit infrastructure in preparation for future buildings. All equipment considered as part of the overall resolution of system limits will be determined as part of the Facilities Conditions Assessment/Data Center Conditions Assessment Report.

A typical building fiber entrance.

Older 66 style punch down block.

[1] A true valuation of the IT Infrastructure network would require an analysis of all underground infrastructure and a complete inventory of all equipment throughout campus. The valuation provided is based on construction costs for TIP III and lineal footage for conduit/cabling & expected performance/equipment installation for each building.

System Overview

AT&T provides the incoming phone service at the MPOE[2]. This is a 2400 pair copper cable that is distributed from San Fernando Street throughout the campus via several phone switches. Comcast provides an incoming CATV service via coaxial cabling and services several locations on campus. Both providers provide adequate, reliable services to campus.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses in the following areas:

1. Several conduit locations represent choke points for fiber replacement and expansion
2. There are operational limits of the telecommunications system usually manifested in issues with the system equipment, not infrastructure

Major System Elements

- Campus Computer System/Data Center
- Backup Generators are in place per Appendix J
- Secondary MDF @ Music provides data network redundancy via fiber and switching installed at the Music Hub
- South Campus Microwave Antenna (located at Joe West Hall)
- UPD Repeater (located at Business Tower)
- Campus Phone Switches (5)

Capacity & Performance

The Master Plan development at the Campus includes future planned expansion of square footage for the new Campus Housing project, the Aquatic Center Expansion, the Recreation Center Expansion, Duncan Hall Annex, the new Theater (adjacent to MLK Library), and the new Science Building. The current IT Infrastructure equipment and cabling plant has sufficient capacity to serve these future buildings.

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

1. Install new (2) 4" conduit infrastructure in select locations to accommodate new/future buildings.
2. Replace existing Systimax fiber (in conjunction with the relocation of the Secondary MDF from the Music Building to the MacQuarrie Building) with new Single-Mode Fiber Plant.
3. Provide ten (10) 4" conduits to displace the existing infrastructure currently installed at the Music Building. Determine new network connectivity schematic for campus based on updated conduit routing and equipment layouts.
4. Provide removal of abandoned fiber and copper in the existing conduit infrastructure
5. Provide scheduled equipment replacement for the campus Data Center and the Secondary MDF.
6. Provide assessment and upgrades of backup generators for the campus IT Infrastructure network.
7. Relocate or replace the Microwave Antenna/Receiver currently housed at Joe West Hall to a new location identified on campus.
8. Relocate the existing phone switch currently housed at Joe West Hall to a new location identified on campus.

[2] Located at the Campus Computer Center

K. CENTRAL PLANT

System Overview: The Central Plant is located on the Eastern border of the downtown campus at 10th St and San Carlos. Although not actually centrally located on the campus, the plant serves as a central 'clearing house' for major utilities on campus, including electrical, steam and chilled water. Virtually all buildings are heated, cooled and powered from this central plant.

The plant includes a 20 MVA campus owned 115 kV substation, a 6 MW Cheng Cycle gas turbine cogeneration system with a heat recovery steam generator (HSRG) for turbine steam injection and campus heating/cooling, (3) water tube steam boilers for campus heating, (2) electric centrifugal water cooled chillers, (2) steam absorption chillers and (1) dual ice making and HVAC duty electric driven, water cooled centrifugal. The ice making chiller charges a large external melt ice bank located adjacent to the cooling towers.

Current Value: $45,000,000

Life/life expectancy: Varies, typically 20 years

Strengths: Extremely flexible centralized system for utility generation and distribution. Centralized major equipment for maintenance and support activities. Single source of major refrigerant storage and accounting. Larger water cooled chilling systems offer superior efficiency. Diversity of chilled water generation systems (steam absorbers, electric centrifugals, and ice storage) provides maximum fuel source flexibility for cooling. The ice bank adds substantially with higher peak cooling capacity than the chiller that charges it. (1250 ton chiller, at peak conditions, the ice bank can deliver just over 2700 tons). The cogeneration system is also flexible in that in periods of low heat demand, steam can be injected into the turbine for increased electrical output.

Weaknesses: Large combustion equipment has more stringent emission requirements and typically more complex emission control systems. Primary weakness of this plant is the landlocked cooling tower with virtually no expansion capability.

Significant Cost: The cogeneration system can generate power at approximately $0.09/kWh including maintenance. See also, Appendices E and M- Supporting Sustainability Documents.

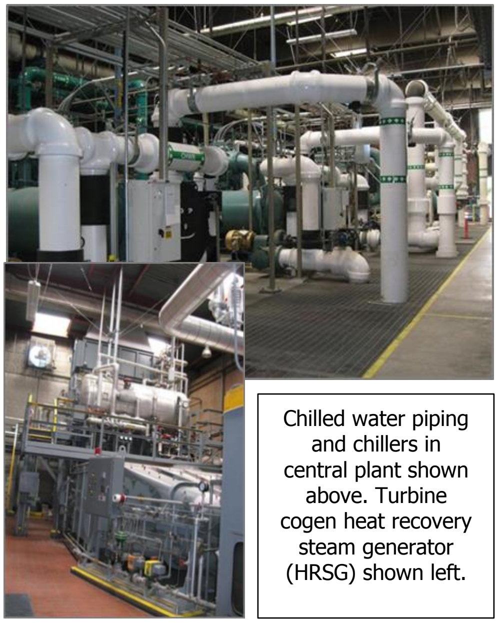
20 year plan: Keep, maintain and upgrade central plant equipment to continue providing reliable and efficient utility generation and distribution to the downtown campus. Some major items include Bay Area Air Quality Management District (BAAQMD) mandated upgrades to at least one steam boiler burner/controls and the eventual replacement/major overhaul of the cogeneration system. Also anticipated is the addition of at least one boiler stack economizer, Boiler 3 as it has a dedicated stack arrangement.

Redundant Service: The hydronic services on campus are configured in a radial system, without loop redundancy.

Historical Failure Points: No historical failures were reported but weaknesses in the operation of the system associated with the infrastructure and piping can be reviewed as part of the other sections of this report.

Maintenance/Spares: Not applicable.

Projects/Priorities: The projects associated directly with the Central Plant are encompassed in the other utility sections of this report. The UMP also includes projects for upgrading the controls at the Central Plant, encompassed in projects 72, 73, & 74.

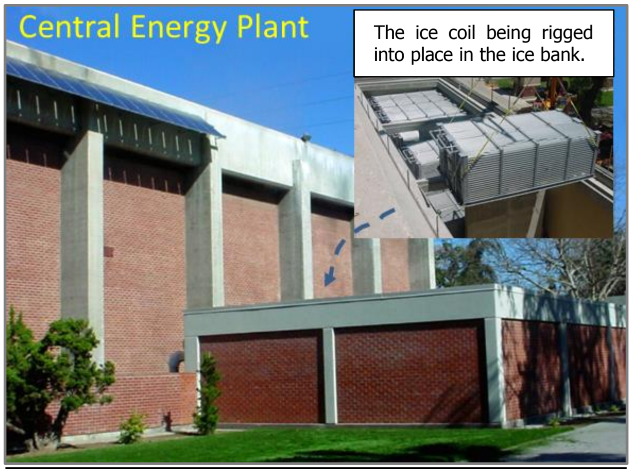


Chilled water piping and chillers in central plant shown above. Turbine cogen heat recovery steam generator (HRSG) shown left.

Steam

System Overview

The campus central plant has three natural gas fired Cleaver Brooks water tube steam boilers with capacities shown in the table, below. These boilers generate 100 psig of steam for the central steam system. Steam is used to heat buildings directly (steam coils, radiators) as well as to provide heating hot water for building heat and for the production of domestic hot water. Although industrial uses of steam still exist on campus, there will continue to be reduced reliance on industrial steam uses on campus. Currently, for instance, there is a lab steam turbine in engineering and there are autoclaves/sterilizers in Duncan Hall. Because of a desire to move towards zero fossil fuels these will eventually be replaced by "spot" electric steam generators.



With a cheng cycle tri-generation plant, a solar array, a thermal energy storage (ice) system, and recycled water, SJSU's central energy plant is one of the more sophisticated and "green" plants in the State.

The existing central plant boilers were installed in 1995 and replaced the four original steam boilers. Two boilers were relocated from the old central plant along with 2 newer boilers. Steam generation is also augmented by the central Cheng Cycle natural gas turbine based 6 MW cogeneration system installed in 1984 utilizing a Heat Recovery Steam Generator (HRSG). The cogeneration system is also equipped with a steam super heater. Superheated steam is only used to augment the output of the gas turbine (steam injection for additional electrical power and for NOx control).

> Although a 20 to 40 year horizon suggests a migration plan towards steam phase out, the inherent value, and robust and cost-effective nature of the steam system demands continued use of this infrastructure for the next 10 to 20 years.

The three Cleaver Brooks boilers have a dedicated deaerator and feed water system; the cogeneration system HRSG has its own dedicated deaerator and feed water system due to the higher operational pressure of the HRSG. A main pressure reducing valve allows the cogeneration HRSG to feed steam to the campus system.

The original boiler configuration of this plant was four steam boilers utilizing two stacks, one stack serving two boilers. The stack configuration was maintained with the new arrangement of three boilers, resulting in one stack serving Boilers #1 and #2 and a single stack dedicated to Boiler #3. All make up water for the boiler systems is pretreated by a central reverse osmosis water treatment and softening skid. The softener regeneration brine tank is located underground, directly in front of the main roll up door entrance to the boiler room, facilitating truck deliveries of salt. A project was recently completed to improve the safety valve protection for the steam system. This project includes the addition of a main 125 psig safety to the main campus header, as well as replacement of rupture disks with safety valves and piped discharges to the superheater on the cogeneration system. This work was promulgated from a recent steam survey and recent insurance inspections on the plant.

MARK	SERVICE	MAKE	NORMAL OP PRESS (PSIG)	NORMAL OP TEMP (F)	DESIGN PRESS (PSIG)	BTUH INPUT	STEAM CAPACITY (PPH)	
B-1	CAMPUS STEAM	CLEAVER BROOKS	100	338 (SAT)	260	38,100,000	30,000	
B-2	CAMPUS STEAM	CLEAVER BROOKS	100	338 (SAT)	260	38,100,000	30,000	
B-3	CAMPUS STEAM	CLEAVER BROOKS	100	338 (SAT)	260	38,100,000	30,000	
HRSG	TURBINE/CAMPUS STEAM	DELTAK	200	388 (SAT)	295		60,846	
SH	HRSG SUPERHEATER	DELTAK	170	1,000	245		(26,780)	
					Max Steam to Campus:		124,066	PPH
					'firm capacity':		90,000	PPH

Central Plant Steam Equipment

Note: Maximum steam to campus is taken as the sum of the boilers, plus the HRSG, less the steam to the superheater.

Boilers

System Overview

The three Cleaver Brooks water tube boilers (Model DL-52) were installed in 1995 and have a 'required capacity' of 30,000 pounds per hour (with 228 degrees F feed water) and a 'maximum rating' of 45,474 pounds per hour, each. Boiler design pressure is 260 psig, specified operating pressure of 150 psig. The boilers are equipped with 2 safety valves each, one set at 170 psig, the other set at 175 psig. Current operation is set at 100 psig. As mentioned previously, a main safety valve is being provided on the steam header to protect campus piping which has a mix of 125 pound and 150 pound fittings and valves.

Boilers were originally specified to provide 25 ppm NOx and 100 ppm of CO, corrected to 3% oxygen on natural gas. Burners are specified with a 10:1 turndown and specified to be PowerFlame burners.

The cogeneration system and HRSG were installed in 1984 in an area of the central plant originally designed for cooling tower expansion. The HRSG capacity is listed above. Design pressure for the HRSG is 295 psig and specified operating pressure is 205 psig. The superheater only feeds the gas turbine combustion section for the Cheng Cycle operation of the turbine. Superheater design pressure is 245 psig, specified operating pressure is 176 psig and is used to superheat the steam up to 1000 degrees F. This steam injection is used for both additional shaft power output of the turbine as well as allowing the system to be licensed at 42 ppm NOx.

Controls

The Boilers are staged on manually[1] with typically one boiler operating as standby or supplementing the HRSG as campus demand fluctuates. The cogeneration plant is controlled by a Bailey Industrial PLC system.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses associated with potential future expansion of the central plant cooling towers and the system lacks redundancy of the steam services.

[1] See also project #16

Capacity & Performance

Current capacity of the installed steam producing equipment is sufficient to prove adequate steam service throughout the next 20 years,

The cogeneration HRSG is used as the base loaded boiler and the Cleaver Brooks are used to augment and load follow for the campus demands.

Emissions Issues
The boilers are installed in a facility with a stationary gas turbine subject to Bay Area Air Quality Management District (BAAQMD) Regulation 9, Rule 9, and should fall under the Limited Exemption of Regulation 9, Rule 7, Article 9-7-116, allowing a two year extension to the mandatory dates for boiler compliance if the Turbine has been modified to meet Reg 9, Rule 9. Article 9-9-301.2. As the requirement in Regulation 9, Rule 6 for this size of turbine is 42 ppm NOx and the unit was originally licensed at 42 ppm NOx, it is not clear if this Limited Exemption is applicable. Requirements based on a nominal fuel input of 46.5 MMBH for the turbine.

Current BAAQMD requirements for these boilers is covered under Reg 9, Rule 7, Article 9-7-307.4 or 9-7-307.5 (307.4 allows for load following installations, which this facility should qualify for). Article 9-7-307.4 requires a maximum of 15 ppm NOx and 400 ppm CO, dry, corrected to 3% oxygen. As noted above, original boiler/burners were specified at 25 ppm NOx and 100 ppm CO, corrected to 3% oxygen. It would seem the burners/controls will require upgrading to lower NOx burners. The above noted Limited Exemption, if it can be claimed may be effective in postponing the compliance dates required in 9-7-308 by two years, or 100% compliance by January 1, 2016. Without the Limited Exemption the compliance schedule is 33% of boilers by Jan 1, 2012, 66% of boilers by January 1, 2013 and 100% of boilers by January 1, 2014. As these boilers were manufactured more than 5 years prior to effective dates, the published effective dates would apply. Depending on load and operation of the boilers, there are also possible limited fuel use exemptions that may be applicable.

The HMH Energy Resources Group Strategic Energy Plan, prepared March of 2012 provides a more detailed analysis on the cap and trade programs and regulations for carbon as promulgated by AB32. See also Appendix M – Supporting Sustainability Documents.

Legacy Information

Steam has been used on the main San Jose State University campus since at least 1915. The original steam plant/boiler house was located more or less where the Computer Center is located today.

In the 1970's a new Central Plant was constructed at its current location and housed four steam boilers, a steam turbine driven centrifugal chiller and two single effect, low pressure steam absorption chillers.

The four original steam boilers were replaced with the three current Cleaver Brooks boilers in 1995. These boilers were fitted with 175 psig safety valves, as operation of the steam turbine driven chiller required 170 psig steam. A central pressure reducing station then served the campus with 100 psig steam. After removal of the steam turbine driven chiller, the pressure reducing station was subsequently removed and the plant now serves 100 psig steam directly to the campus. A recent project added a main safety valve on the steam header to protect the campus steam distribution system, as the boiler safeties could not be retrofit to the lower pressure setting without major boiler modifications. The cogeneration plant was installed in 1984 has operated virtually continuously since. A major turbine overhaul was completed in 2008.

Steam at a Tipping Point

No matter how well maintained the steam system is, steam plants and steam utilities infrastructure are a dying breed on campuses. For this reason, a significant effort was expended on framing the current system value, against an eventual migration plan from steam. This is provided as a stand-alone discussion in Appendix T – Steam Tipping Point.

Chilled Water

System Overview

The chilled water system consists of two electric centrifugal water chillers, one electric centrifugal chiller that can also be used as an ice making glycol chiller and two steam-fired double effect lithium bromide absorption chillers. All chillers are located in the Central Plant. Another integral part of the chilled water system is the two (2) counter flow cooling tower cells. The tower cells are part of the condenser water (CW) loop of the chillers, cooling the warm condenser water that exits the chillers before returning the cooler CW to the chillers. This process helps ensure the chillers are operating at their peak efficiency. Finally, there is a thermal energy storage (TES) system used in junction with a plate-and-frame heat exchanger to provide chilled water to the campus.

Chillers

CH-6 and CH-7 are both 1,230 ton York double effect steam absorption chillers, using steam provided from either the cogeneration plant or the boiler plant to produce chilled water. The absorbers were installed in 1997/1998. CH-8 is a 1,930 ton electric centrifugal water chiller, but is typically used as a 1,510 glycol chiller to make ice for the TES. CH-8 was added with the TES facility in 1999-2000. Finally, CH-9 and CH-10 are both 1,200 ton York electric water chillers, installed in 2012, replacing the two old 734 ton electric chillers. All chillers are presently in good condition.

The absorbers were test run at the factory prior to shipment and actual capacity was measured at less than 1200 actual tons at test conditions. As this capacity was within the ARI specified tolerance, the chillers were accepted and installed.

With the recent installation of CH-9, CH-10, the connecting chilled and condenser water piping delivery systems in the plant were extensively modified to both the condensers and evaporators of the absorbers to 'cascade' with the electric chillers. With a series arrangement on the chilled water, the plant delta T can be raised to 20 degrees, and having the absorbers cool the warmest water works well with their operating principles. Likewise, with the condenser water in series, the tower can take advantage of a larger range of temperatures, deliver colder water to the electrics (the lower the better for these York units) while the absorbers can operate with a higher temperature condenser, suited to optimal performance on both machines.

Pumps

Each chiller has a primary pump that circulates chilled water around the primary loop. The primary pumps are all variable speed pumps. Three campus primary pumps, each with a variable frequency drive (VFD), circulate the chilled water through the main primary loop. When the pressure from the primary loop is insufficient, a booster pump equipped with a VFD distributes the chilled water throughout the building. This booster configuration is typical of most buildings, with only a select few buildings utilizing the pressure from the primary loop for chilled water distribution

Cooling Tower

Condenser water leaving the chillers is cooled by a two cell counter flow fiberglass Ceramic/BAC cooling tower. Each cell is rated for an 8,000 gpm flow with an entering water temperature of 95 °F and a leaving water temperature of 80 °F. Each cell has a 200 horsepower fan equipped with a VFD. The cooled condenser water is distributed back to the chiller by two vertical turbine pumps per cell. Both pumps operate in parallel, with one rated at 6,000 gpm at 110 feet of head and the other rated at 3,000 gpm at 110 feet of head. The smaller pumps are fitted with VFD's while the larger pumps are fixed speed.

Thermal Energy Storage (TES) System

The TES system was installed in 2002-2003 and consists of a field erected ice bank, a dual rated electric centrifugal chiller, a heat exchanger, a dedicated ethylene glycol loop and pump and a VFD equipped for primary chilled water.

The TES system has a total effective latent capacity of 16,800 ton hours. The system consists of an ice-on-coil type storage tank, the glycol chiller (CH-8), a heat exchanger and the pump/piping distribution system. The TES system works by circulating a low temperature glycol solution from the glycol chiller and through the coil in the storage tank. Ice builds up around the coil and is stored throughout the night. During peak hours, a glycol solution is pumped through the heat exchanger cooling the chilled water by 10 °F before it is distributed to campus. The glycol solution returns through the ice coils where it is cooled before passing back through the heat exchanger. The TES system is rated for a 6,500 gpm flow through the coils. The calculated capacity for a 6,500 gpm flow and a 20 °F temperature differential is 2,708 tons; therefore, the TES can discharge at peak capacity for 6 hours.

The 'ice bank' is a poured in place, partially subterranean concrete tank, with an external insulation and finishing system (EIFS by Dryvit). The tank is internally coated with a moisture resistant resin/epoxy coating and filled with water. Inside the tank, 24 factory-fabricated, galvanized steel coils are stacked three high and provides the surface area for ice generation and storage. Ice is formed from the water filling the tank.

The chiller is dual rated, meaning it can be used for making ice or for making higher temperature chilled glycol to provide HVAC temperature chilled water through the heat exchanger.

There is a single heat exchanger which is a plate and frame unit with stainless steel plates. The glycol loop has a dedicated glycol make up system.

There are dedicated pumps for the glycol loop and primary chilled water supply through the heat exchanger. The chilled water pump is VFD controlled and leaving water temperature is maintained by modulating the glycol flow through the heat exchanger via control valves. There are no standby pumps on the system.

The TES works by storing ice produced from the glycol chiller during off peak hours when electricity demand is lower on the grid and cooling load from the campus is low, resulting in lower tower demand off hours). When the campus demands cooling, the chilled water passes through the heat exchanger and is cooled by the ice cooled glycol circulating through and melting the ice stored in the TES. The TES helps lower the energy costs for the chilled water system by avoiding the higher costs of electricity during peak hours. The TES further is a method to increase the utilization of the real estate limited cooling tower by generating ice during the night when campus cooling loads are minimized. The ice bank can also be used at virtually any capacity from a couple of tons to approximately 2700 tons, effectively increasing the maximum cooling capacity during peak hours.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, the system has weaknesses associated with potential future expansion of the central plant cooling towers and the system lacks redundancy of the chilled water system piping.

Capacity & Performance

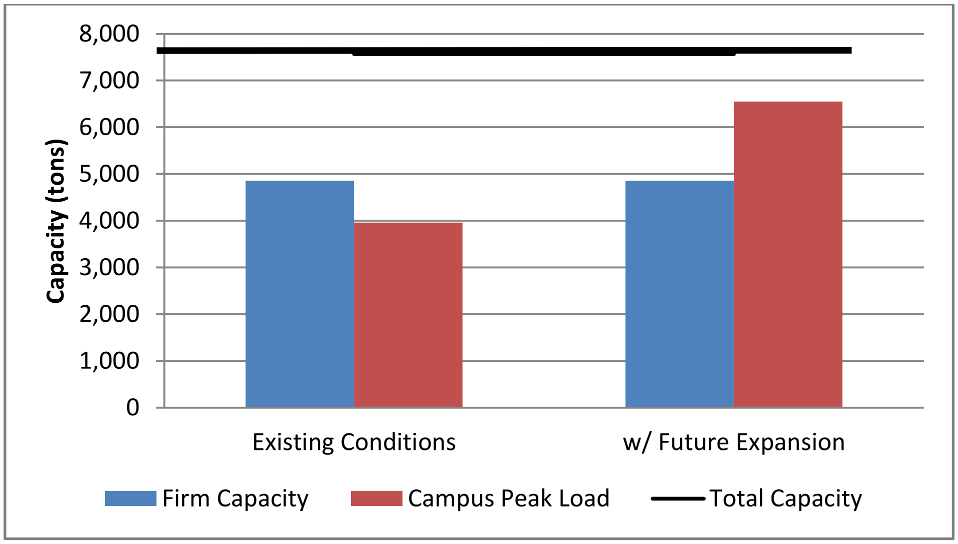
The total capacity of the existing chilled water system is 7,568 tons with a firm capacity of 4,860 tons which is calculated by subtracting the capacity of the largest equipment from the total capacity, in this case the capacity of the TES tank. The table below summarizes the capacities of the equipment that make up the chilled water system.

CHW Equipment	Rated Capacity (tons)
Absorption chiller, CH-6	1,230
Absorption chiller, CH-7	1,230
Absorption chiller, CH-9	1,200
Absorption chiller, CH-10	1,200
TES Tank	2,708
Total Capacity	**7,568 tons**

The campus peak demand is 3,960 tons. This load was estimated by using the diversified plant load of 116 tons/KSF for the average campus building. The same diversified load value of 1.16 tons/KSF was also calculated in the Cogent Energy MBCx report, as well as the Fundament & Associates, Inc. report, both found in Appendix K.

The campus plans to add approximately 2,235,000 square feet of additional buildings, representing a peak load of 2,591 tons. With the addition of these buildings, the total campus peak load would increase to 6,552 tons. The graph below depicts how the existing chilled water capacities, both total and firm, compare with the existing campus demand and the future campus demand.

Chilled Water Capacity



From the graph above, when accounting for the additional campus load due to future expansion, the chilled water system's total capacity can still meet the campus peak load. However, when considering the future additions, the firm capacity is approximately 1,700 tons less than the campus peak load eliminating the ability for the chilled water system to have redundancy. Without adding at least 1,700 tons of capacity, the chilled water system will not be able to meet the future campus peak load in the event the largest rated piece of equipment fails.

Legacy Information

The original chilled water plant was constructed in 1972 and was comprised of four steam boilers, a 1280 ton steam turbine driven centrifugal chiller, two steam fired, single effect 1060 ton absorption chillers and two cells of cooling tower, slated for a future build-out of approximately 6 cells of cooling tower. These chillers were originally tagged CH-1, 2, and 3. This plant was state of the art at the time of construction. Operation was intended to operate the centrifugal as a backpressure turbine with exhaust steam firing the absorbers. Unfortunately, for the plant to operate at peak efficiency, all three chillers would be required to operate. Connected load was never adequate to mandate the operation of all 3,200 tons of chillers, and operation consisted basically of operating the low efficiency absorbers to serve the campus. Pressure regulation on the exhaust side of the turbine driven chiller was comprised of a 12" regulated relief valve. If the absorbers didn't need the steam, it was vented to atmosphere. The operation of the steam turbine chiller required the steam plant to operate at 170 psig (a pressure reducing station was located in the basement to control steam pressure to the campus to around 100 psig)

The cogeneration system was put on line in December 1984 and occupies the space slated for future cooling tower expansion, by enclosing the area and providing a basement and equipment floor to the central plant.

In the early 1990's two electrical driven R-123 chillers (CH-4 and 5) at 734 tons each, were added to the plant to provide efficient operation and to augment the output of the absorbers. These chillers were constant speed models, operating at 4160 volts.

In 1997-1998, the steam fired turbine driven centrifugal and the two single effect absorbers were removed and two new steam fired, double effect 1250 ton absorbers (CH-6 and CH-7) were installed and the old wood fill (and wooden pipe!) cooling tower was demolished and replaced with a new fiberglass tower with PVC fill to handle the increased capacity. At this time, the pumping system was converted to a primary/secondary pumping configuration with constant speed primary CHW pumps and variable speed secondary pumps.

During this same project, chilled water service was expanded to serve the new Engineering building. The chillers in the penthouse were left as backup and for possible future use in augmenting the central plant output. The cooling tower for Engineering was also replaced under this project. The variable condenser water flow had allowed hard water deposits to build up to the point that the tower was ineffective and was considerably heavier than the isolators could support. The chillers are currently 'landlocked' inside the penthouse - a large access opening was installed in the original construction, but the chillers are installed on the other side of a large structural beam, so they can't be slid into position for removal. There are two 650 ton R-11 centrifugals and one 115 ton R-22 reciprocating chiller in Engineering.

In 2001-2002, the 16,800 ton-hour TES ice system and 1510 ton electric driven glycol chiller (CH-8) and appurtenances were added to increase the capacity of the tower limited central plant. By making ice at night, the ice making chiller could utilize the tower capacity as the building loads drop substantially overnight. At this time, the cooling tower was also upgraded to its maximum configuration by adding two additional feet of fill and increasing the size of the fan motors. The tower cannot easily be expanded in its present location.

Finally, in 2011, the two 734 ton electric centrifugals (CH-4, 5) were replaced with new 1200 ton electric centrifugals (CH-9 and CH-10). Piping modifications in the central plant included some degree of primary/secondary interface piping (moved the main crossover from the basement pump room up to the chiller room level (in the piping trench) as well as piping and controls to allow the centrifugals to operate in series or in parallel with the absorbers. The ultimate intent of the modifications being made is to provide a 20 degree chilled water temperature difference to the campus. This increase in delta T has the added benefit of basically doubling the capacity of the installed chilled water distribution infrastructure, which was originally sized for a 10 degree delta T. At the same time, modifications were made to allow the condensers for the centrifugals to be 'cascaded' from the electrics to the absorbers operating in series, effectively increasing the capacity of the tower by increasing the plant delta T for the condenser water loop.

Cogeneration System

Completed in 1984, the cogeneration system has been operating virtually continuously ever since. As noted in the electrical sections of this report, the system delivers over 60% of the campus electrical needs.

The system is a unique application of a gas turbine, referred to as a "Cheng Cycle". Somewhat similar to a combined cycle gas turbine plant, steam generated is used to provide additional electric generation from the waste heat of the turbine. This cycle is unique in that rather than incorporating a dedicated steam turbine driven generator, superheated steam is actually injected into the power turbine section of the gas turbine to increase shaft horsepower and generator output. Although not meeting the higher electrical outputs of a true combined cycle system, it offers a nice compromise with increased electrical output a lower total capital cost. In addition, the steam injection serves a dual purpose, replacing the usual water injection with steam to accomplish NOx emission reductions in the turbine exhaust. The plant is currently licensed for 42 ppm NOx emissions.

The heart of the system is an Allison 501H gas turbine, packaged with a gear box and a generator in a sound attenuating enclosure. Major overhauls of the turbine are scheduled at 40,000 hours, or close to 5 years with continuous operation. Exhaust from the turbine is ducted through a superheater, a duct burner and then to a field erected Deltak HRSG with economizer and feedwater heater coils prior to be exhausted to atmosphere. The duct burner is used to augment HRSG steam output when required.

The HRSG underwent a recent repair/refurbishment in 2008 that included work to the duct burner, replacement of duct liner and a new feedwater heater assembly. In addition, rupture disks on the superheater were replaced with safety relief valves, and the DA was fitted with new safety valves in 2013.

It is anticipated that the cogeneration system will be replaced and/or upsized within the next 10 to 20 years.

L. UTILITY TUNNEL SYSTEM

<table>
<tr><td rowspan="4">System Overview: Although only available under portions of the campus, there is a large underground utilities tunnel system.</td><td>Current Value: $5,000,000</td></tr>
<tr><td>Life/life expectancy: well beyond 20 years</td></tr>
<tr><td>Strengths: The tunnels provide a highly functional and flexible pathway for utilities deployment of all types. It provides ready access for several main isolation valves as well as access to the main expansion compensating ball joints without disruption to the surface of the campus. Lines can readily be inspected and repaired if necessary and kept dry and free of corrosion from ground water.</td></tr>
<tr><td>Weaknesses: Tunnel requires maintenance for the lighting and plumbing systems to keep the tunnel serviceable.

Adding new service take offs from the tunnel has proven somewhat problematic in areas where the tunnel was not originally designed for such take offs.</td></tr>
<tr><td colspan="2">20 year plan: continue to maintain and employ this valuable asset.</td></tr>
</table>

Redundant Service: Not applicable.
Historical Failure Points: Due to the age of the tunnel, water intrusion, cracks in the concrete, and general accumulation of debris are the culprits contributing to the potential for deterioration and failure. To date, no failures to the tunnel have been reported but a thorough review of the tunnel should be provided for seismic and operational reliability.
Maintenance/Spares: Not applicable
Projects/Priorities: Project 87 of the UMP outlines measures which should be taken to address the issues associated with the utility tunnel.


Tunnel section showing conduit and building drain.


View of entrance to tunnel from central plant.

System Overview

The University is lucky to have the tunnel system, a remnant from a time when the ease and functionality of tunnels was considered a basic requirement of a campus.

The largest section runs from the Central Plant, north on 9th St, down the main campus between the Student union and Art Buildings and ends at Dwight Bentel Hall. This tunnel is fully walkable, with stairs for elevation changes, full lighting and a distributed ventilation system. This tunnel houses the main steam and chilled water distribution lines, and it includes various changes in elevation to miss various utilities. Several elevation changes are utilized for the installation of offset ball joints on the steam and condensate for expansion compensation. The tunnel cross section is typically expanded at main utility take off points to provide room for isolation valves and piping take offs. This tunnel also includes various drains and pumps to keep the tunnel from flooding. There are three access points to this main tunnel – from the Central Plant basement and two access stairwells, one near the old cafeteria (café demo'd) and one at the Eastern end of Dwight Bentel.

The smaller tunnel originates on the north side of SPX, proceeds under SPX, under what used to be San Carlos St and terminates at a manhole between Sweeney Hall and MacQuarrie Hall. This tunnel is much smaller in cross section than the main tunnel, yet it is still walkable. This tunnel transports steam and chilled water as well as other utilities such as IT Infrastructure and power. The main reason for this tunnel was to cross San Carlos when it was a public street.

As shown on the drawings and photographs, the existing tunnel system is the main backbone of the steam and chilled water system, with various branches to serve buildings throughout the campus…. Some of the advantages of the tunnel are easy accessibility to as well as inspection and repair of utilities without requiring excavation with attendant disruptions to campus. A project in past 5 years replaced the steam and condensate isolation valves in the main tunnel and serviced the expansion ball joints.

Historical Failure Points and Critical Areas

The Risk Assessment (provided in Chapter 7) details the historical failure points and critical areas of the system. In general terms, no failures have occurred but there are several projects which would greatly benefit the system and reduce risk of failure. These include:

1. Provide updated lighting throughout the entire utility tunnel
2. Address the piping support degradation
3. Address the water intrusion and limited storm water removal

Recommended UMP Projects

All projects are identified in Section V and Appendix H.

San Jose State has a long history of sustainable practices and projects that date back to the min-1980's and continue today. With a focus on balancing cost-efficiency and energy efficiency the University has proven to be a leader among the CSUs and the State at large. A list of just some of the sustainable practices and projects is impressive; a few of which include:

While deploying aggressive, yet practical, energy strategies and projects SJSU continues to explore renewable opportunities of all types (see Appendix M).

- ✓ The campus has operated its own well water system since before the 1970's, this saves over $100,000 per year in water related fees and has afforded the campus a sustainable reserve account to both maintain the wells and to foster related environmental efforts;
- ✓ In 1985 the campus began generating power with an 85% efficient, Cheng-cycle cogeneration system. Now approaching 30 years of age, the system continues to be well maintained and highly efficient. In addition to being energy efficient, the current "spark spread" between utility provided power and campus co-generated power is the differed between $0.15/kWh and $0.09/kWh (i.e. for the utility vs. campus respectively). Given current campus electric consumption of over 50 million kWh per year, this results in a campus financial resource with which to maintain and operate campus critical systems in an efficient and sustainable manner.
- ✓ In 1997 the campus added black start capability to the cogeneration system and replaced its single-effect absorption chillers with double-effect absorption chillers (all "fired" by waste heat from the cogen plant).
- ✓ Also in 1997 the campus became the first campus in the state to employ recycled water for the central plant cooling towers. This saves over 20million gallons of potable water PER YEAR
- ✓ In 2002 the campus installed the largest ice-storage system in the CSU. This system effectively displaces 1,000kW of electric demand during "on-peak" utility periods
- ✓ In the mid-2000's, the campus succeeded in dispatching recycled water throughout the campus to accommodate all of the campus irrigation needs. This was further enhanced when the MLK Library toilets were converted to 100% recycled water use.
- ✓ For the past ten years, the University has taken steps to reduce their energy consumption through lighting upgrades and monitoring based commissioning (MBCx) projects;
- ✓ The long term campus strategy is to diversify and install new generation assets such as solar PV (if proven to be cost effective). This includes "forward," "outside of the box" thinking and technologies, such as the slowly maturing Fuel Cell technologies. See also Appendix M.

Housing village building B facing 10th St showing possible future wind turbines.

Campus structures with medium and high solar potential.

In addition to the above, the SJSU central energy plant is, arguably, one of the most sophisticated, cost/energy efficient plants in the CSU system, perhaps even the state. Yet, in spite of these cost-efficient, financial, sustainable and globally efficient technologies and practices, the campus is often at odds with external "green" efforts. Generally speaking there is no consolidated roadmap or perfect definition for "clean energy". But specific examples of this "at odds" situation include:

- ✓ The University, specifically the Central Plant, is penalized by the California Resource Board as a "covered entity" relating to its localized greenhouse gas emissions of greater than 25,000metric tons. This is in spite of operating a plant that is achieving close to 80% global efficiency.
- ✓ Nationally recognized green building ratings such as LEED and AASHE STARS (for university campuses), focus on individual buildings and generally struggle to give credit to the concept of a highly efficient, but complex and sophisticated central energy plant.

> Although SJSU operates one of the most cost/energy efficient central plants in the CSU, little benefit is recognized when rated by LEED or Stars standards

In summary, the whole "market transformation" associated with LEED and STARS presents challenges because in both rating systems, the base case is a standard building with a boiler and a chiller. This is even further complicated by the Chancellors guiding principles which promote a distributed system that allows a zero net energy in the future (2030 for new buildings by Title 24).

Given the above, the projects and practices identified in this Utility Master Plan will continue to reflect forward thinking relative to practical maintenance and operation of globally efficient systems which can sustain themselves financially and position the campus to gradually move to phase out Carbon Technology. In addition, all of the utility projects recommended in the UMP will be conceived with an eye towards accommodating both practical thinking and "outside the box" forward thinking that has been the stalwart of true sustainability at San Jose State. See, also, Appendices M, T and U

A. SJSU Sustainability - background

In 2006, the California State University system passed Executive Order No. 987 – Policy Statement on Energy Conservation, Sustainable Building Practices, and Physical Plant Management for the California State University (see Appendix I – CSU/Local Sustainability Programs). The order was passed to help reach the goal of reducing consumption to 15% below its 2003 levels by 2010. San Jose State reached this goal in 2010, reducing consumption by 17%.

San Jose State requires that new buildings meet or exceed LEED Silver standards. Moss Landing Marine Labs, an off campus research building, received a LEED Gold rating in 2004. The University no longer seeks to obtain formal LEED certification. Rather projects are designed to LEED standards without the formal documentation and application.

B. AASHE STARS

The Association for the Advancement in Higher Education's (AASHE) Sustainable Tracking, Assessment and Rating System (STARS) is a program for universities and colleges to measure their sustainability against other higher education institutions. The program aims to create a standard by which universities in the US and Canada can measure their sustainability while also creating incentives to improve. All information is self-reported and does not require a 3rd party to verify the audit.

SJSU received a STARS rating of Silver with a score of 50.55 on September 15, 2011. Table 7.1, below, illustrates the breakdown of the University's score.[1]

Table 7.1 SJSU AASHE STARS Score Breakdown	
Education & Research	**54.33%**
Co-Curriculum	13.54/18.00
Curriculum	26.39/55.00
Research	14.40/27.00
Operations	**39.04%**
Buildings	4.13/13.00
Climate	1.99/16.50
Dining Services	5.37/8.50
Energy	5.73/16.50
Grounds	0.75/3.00
Purchasing	2.31/7.50
Transportation	6.66/12.00
Waste	6.96/12.50
Water	5.04/10.25
Planning, Administration & Engagement	**52.28%**
Coordination & Planning	10.00/18.00
Diversity & Affordability	13.75/13.75
Human Resources	12.75/19.75
Investment	0.25/16.75
Public Engagement	15.53/31.75
Innovation	**2.00**
Innovation	2.00/4.00

The University's lowest score was in the operations category which includes most of the major utilities on campus. The Energy section, outlined in Table 7.2, suggests that the University could improve building consumption as well as clean and renewable energy.

[1] All scores and information in this section taken from AASHE STARS website on 02/12/13 - https://stars.aashe.org/institutions/san-jose-state-university-ca/report/2011-09-15/

Table 7.2 SJSU Energy Score Breakdown		
Energy	**5.73/16.50**	
Credit	Status	Points
Building Energy Consumption	Pursuing	3.99 / 8.00
Clean and Renewable Energy	Pursuing	0.49 / 7.00
Timers for Temperature Control	Pursuing	0.25 / 0.25
Lighting Sensors	Pursuing	0.25 / 0.25
LED Lighting	Pursuing	0.25 / 0.25
Vending Machine Sensors	Not Pursuing	0.00 / 0.25
Energy Management System	Pursuing	0.25 / 0.25
Energy Metering	Pursuing	0.25 / 0.25

The building energy consumption score is based off of the percent decrease in energy consumption from 2005 to the performance year, 2010 in this case. The data used for the University is summarized below in Table 7.3.

Table 7.3 SJSU Basis for Energy Consumption Score	
Total building energy consumption, 2005	447,049 *MMBtu*
Building space, 2005	3,539,209 *Gross Square Feet*
Total building energy consumption, performance year	427,507 *MMBtu*
Building space, performance year	4,510,448 *Gross Square Feet*

The clean and renewable energy section is based off of the total clean and renewable energy generated on-site, off-site, green energy purchases, and energy produced with co-generation technology. The required criterion also includes brief descriptions of any renewable generation on the campus. SJSU only received points in this section for the 118,634 MMBtu[2] of electricity generated with co-generation technologies.

The buildings section highlighted below in Table 7.4, shows that the University can improve in all three areas specifically the indoor air quality section.

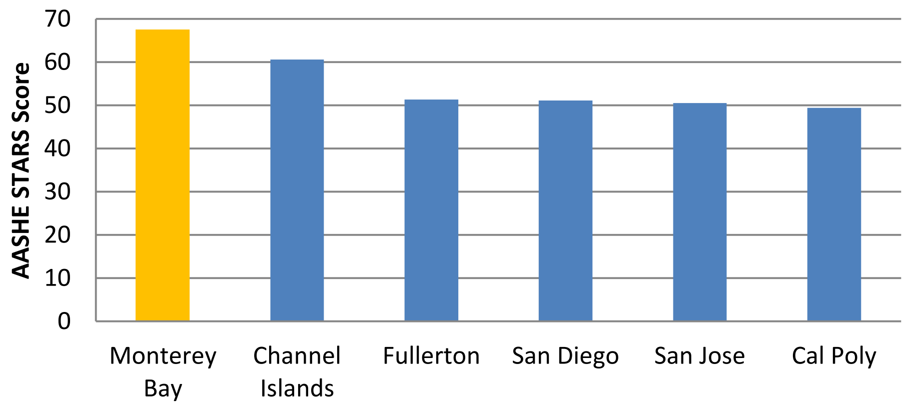
Table 7.4. SJSU Building Category Breakdown		
Buildings	**4.13/13.00**	
Credit	Status	Points
Building Operations and Maintenance	Pursuing	2.63 / 7.00
Building Design and Construction	Pursuing	1.50 / 4.00
Indoor Air Quality	Not Pursuing	0.00 / 2.00

Table 7.5 and Figure 7.1 below illustrate how San Jose State University compares to other ranked California State Institutions. The University is not far behind other CSU institutions, but it can potentially improve its score with an increase in utility and energy efficiency (to show a decrease from the 2005 energy use) as well as clean or renewable energy generation.

2 The UMP was unable to confirm or acquire the report the University submitted to AASHE

Table 7.5. CSU AASHE STARS Scores			
#	University	Rating	Score
1	CSU Monterey Bay	Gold	67.51
2	CSU Channel Islands	Silver	60.61
3	CSU Fullerton	Silver	51.35
4	San Diego State	Silver	51.10
5	San Jose State	Silver	50.55
6	Cal Poly, Pomona	Silver	49.45

Figure 7.1. CSU AASHE STARS Scores



C. Potential For Solar

A Photovoltaic (PV) Project Evaluation was completed in March 2011 (see Appendix M). The report states that the campus has the potential to install 1.3 MW AC-CEC of solar. It was also mentioned that due to constant construction, the parking lot locations will not be guaranteed in the long-term plan. The final estimate of potential solar for the campus was determined to be 918 kW AC-CEC.

The new student union building has been designed to include 138 kW AC-CEC of solar panels leaving a potential for 18 kW AC-CEC. This brings the current potential to 782 kW AC-CEC.

New panels would be located on the roofs of buildings including Clark Hall, the South Parking Garage, etc. In 2011, the CSU system released a request for proposals (RFP) in order to find a solar developer to install solar through a power purchase agreement on CSU campuses. No developer that met the CSU's requirements was found. However, the University can still release a *campus-specific* RFP to find an appropriate solar developer. See Figure 7.2 Potential Solar Locations at the end of this section

See Appendix M: Supporting Sustainability Documentation for the full SJSU Photovoltaic Project Evaluation.

With the campus expanding there are areas that have not even been built yet that will be able to utilize solar power, such as the new pool area. The RAC, which will be located next to the pool, will have over 13,000 square feet of space on the roof where solar water collectors could be placed to heat the water to the pool during the day. It is estimated that with that much space 775 kW could be produced. See Figure 7.3 below for placement of the solar collectors and Appendix GG for the calculations.

D. Carbon Action Plan

The University would like to increase its long standing history of sustainability by creating a long-term Carbon Action Plan similar to those created by other CSUs. The purpose of this document would be to set forth goals and projects to increase the sustainability of the SJSU campus. San Francisco State University's (SFSU) Climate Action Plan, published in May 2012, encompassed transportation, energy efficiency, renewable energy, green building, academics, waste and compost, water, procurement and food. SJSU will choose which areas, similar to those explored by SFSU, that the University would like to address and evaluate the former and current policies regarding these areas.

Figure 7.2 – Potential for Solar

Parking Garages*	
Site	**kW**
10th St.	174
South	243
West	95
Total	**512**

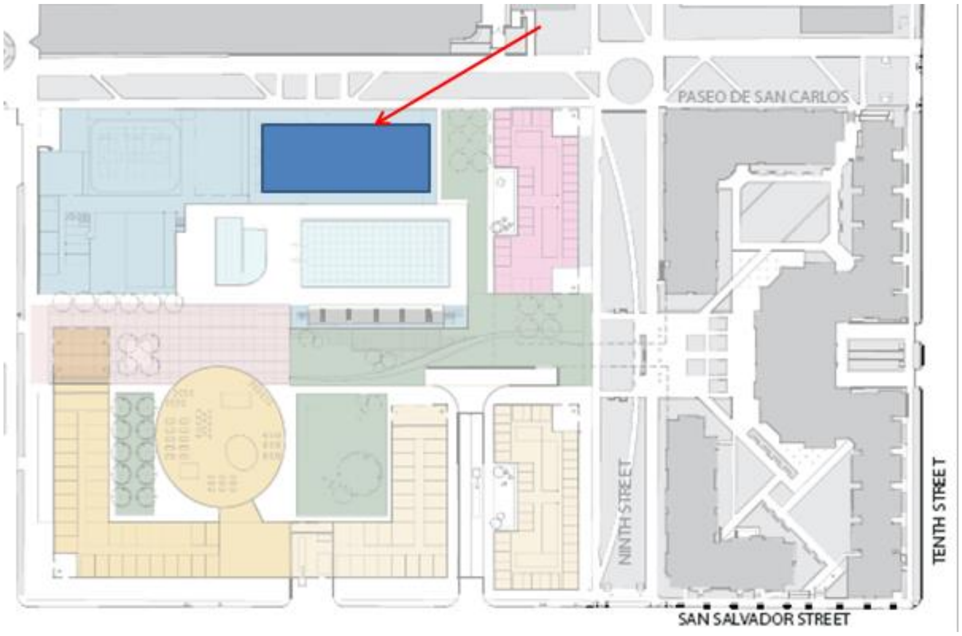
Sites to Consider**	
Site	**kW**
Art	34
Business	53
Clark Hall	63
Music	45
SU	18
Sweeney	55
Total	**268**

*in Red
**for consideration when re-roofing, in Yellow

Grand Total 782 kW

Notes:
1. Reference: Sheet T-1, Campus PV Project Drawings, Digital Energy Inc.
2. Note that all kW is kW-ac

Figure 7.3 Solar Water Heating



As noted throughout this Utility Master Plan, the utility infrastructure is of significant value in its current condition. As a system, the 10 utilities provide excellent current and future value for the next 20 to 50 years. This value comes from the intrinsic worth of the piping and other conveyance, conduit and fiber systems, as well as the ability to deliver needed capacity, in a consistent and reliable manner, while meeting peak utilities demands imposed by the teaching and learning environment. Generally speaking these systems can provided needed capacity and peak demand now; and at "full Master Planned build-out". (See Appendix A)

However as also noted throughout this report, sections of the utilities are in poor to fair condition; and demand immediate attention for reasons of capacity, safety, reliability, and efficiency. In addition, because almost 1,000,000 sf of space is going to be added along Paseo San Carlos in the next 3 to 5 years, a utilities extension is required which will connect the new buildings to the remainder of the underground utilities network and to the campus central energy plant. In addition specific utilities issues relating to safety and reliability have been identified. For this reason an aggressive capital request plan has been developed. This request is comprised of eight separate Infrastructure groups as follows:

1. CIP 2014/15: includes extension of utilities for new building construction in short term (next 2 to 4 years); also necessary multiple-utility upgrades for campus critical buildings and to complete chw looping (Appendix Y – Campus Critical Buildings)
2. CIP 2015/16: staff legacy critical maintenance projects
3. CIP 2016/17: recycled water utilities and irrigation controller upgrade in support of landscape master plan. See, also, Appendix AA.
4. CIP 2017/18: energy management systems utilities upgrade (platform, and obsolete infrastructure)
5. CIP 2018/19: safety related fire alarm system infrastructure upgrades (see also, Appendix W – Fire Alarm Master Plan).
6. CIP 2020/21: safety and energy related exterior lighting (277v underground) utilities upgrade
7. CIP 2021/22: extension of underground utilities and central plant in support of planned Academic building per Appendix A.
8. CIP 2023/24: it is anticipated that the central plant cogeneration system will be replaced or upgrade with zero-fossil-fuel and/or zero-carbon-footprint technology. See also Appendix M.

Fiscal Yr.	Priority	Area	Cost	Description
2015	1	3	$8,123,748	a) New/impacted upgrades to minimize risk; while constructing Campus Village; Spartan Expansion
2016	2	4	$10,707,604	b) Existing utilities risk-related upgrades also impact capacity, deficiencies and expansion
2017	3	5	$5,920,293	
2018	4	6	$4,290,670	
2019	**5**	campus wide	**$3,818,225**	**Staff Legacy (infrastructure maintenance)**
2016/17	6	campus wide	$597,500	Irrigation Controllers & Piping Modifications
2017/18	7	campus wide	$1,237,500	Energy Management System
2018/19	8	campus wide	$3,032,000	Fire Alarm Central System & IT Infrastructure Upgrades
2019/20	9	campus wide	$2,848,529	Exterior Lighting Infrastructure
2021/22	10	7	$8,618,020	Future extension Humanities & Academic Bldg
2023/24	11	8	$18,041,000	Cogen Replacement & Central Plant Upgrade

Details associated with the 8 infrastructure projects are provided, in Appendix H – Proposed Project Concepts, and are summarized on the following pages . . . . .

PROJECT SUMMARY				
5-Year Utility Request with 20-Year Utility Vision				
Fiscal Yr.	**Priority**	**Area**	**Cost**	**Description**
2015	**1**	3	$8,123,748	a) New/impacted upgrades to minimize risk; while constructing Campus Village; Spartan Expansion
2016	**2**	4	$10,707,604	b) Existing utilities risk-related upgrades also impact capacity, deficiencies and expansion
2017	**3**	5	$5,920,293	
2018	4	6	$4,290,670	
2019	**5**	campus wide	**$3,818,225**	**Staff Legacy (infrastructure maintenance)**
2016/17	6	campus wide	$597,500	Irrigation Controllers & Piping Modifications
2017/18	7	campus wide	$1,237,500	Energy Management System
2018/19	8	campus wide	$3,032,000	Fire Alarm Central System & Telecom Upgrades
2019/20	9	campus wide	$2,848,529	Exterior Lighting Infrastructure
2021/22	10	7	$8,618,020	Future extension Humanities & Academic Bldg
2023/24	11	8	$18,041,000	Cogen Replacement & Central Plant Upgrade
			$67,235,089	TOTAL INFRASTRUCTURE PROJECT from this UMP
		total risk r'pt	$32,860,539	

Note: Estimates include Project Soft Costs

MASTER PROJECT LIST

UMP projects	Type		Project Identification and Name	Area	Year	1 DW	2 FW	3 RW	4 SS	5 SD	6 E	7 ST	8 CHW	9 G	10 IT	11 C	12 FA	13 UT	Comments
	Ux	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	Infra-1 Area3	2013/14	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				
	FW	2	Fire Hydrant Improvements	Infra-1 Area 3,4,5,6	2013/14		Y												
PLANNED	DW	3	7th & Paseo SC / San Salvador/9th Water Main Repl'nt	Infra-1 Area3	2013/14	Y													
	RW	4a	Recycled Water (down San Carlos to Ph-Ii Hsg & SPX and Cit)	Infra-1 Area3	2013/14			Y											
	RW	4b	Recycled Water for Central Plant makeup wtr	Infra-2	2013/14			Y											
	ChW	4c	Expand CHW to Dudley MH (reno & addition)	Infra-1 Area 4	2013/14								Y						
	DW	5	Main Campus Well #2 Relocation	Infra-1 Area 3	2013/14	Y													
	CHW	5a	Extend CHW to Science	Infra-1 Area 4	2013/14								Y						
	S	6	Ph-1 Steam to Student Health (SHC) inc. bottleneck btw. DBH and Student Union/Engr tee	Infra-1 Area 4	2013/14							Y							
	S	6a	installation of isolation valve to maintain service to east campus	Infra-1 Area 4	2013/14							Y							
	S	6b	include high risk steam piping replacment and isolation valve addition	Infra-1 Area 4	2013/14							Y							
	S	6c	replace and relocate steam manhole (part of CV-2)	Infra-1 Area 4	2013/14							Y							
	S	7	PH-2 Steam from SHC to 'mini-tunnel'	Infra-1 Area 4	2013/14							Y							
	S	7a	Steam Manhole Re-design and Relocation for Risk Mitigation (included as part of CV-2)	Infra-1 Area 3	2013/14							Y							
	S	7b	6" Steam Line Valve Upgrade/Replacement	Infra-1 Area 3	2013/14							Y							
	Ux	8a	Computer Center Backup Power Upgrade	Infra-1 Area 4	2013/14						Y								
	CHW	8b	Computer Center chilled water upgrade	Infra-1 Area 4	2013/14								Y						
	ChW	9	MacQuarrie Hall CHW Upgrade	Infra-1 Area 6	2013/14								Y						
	ChW	10	DBH to WSQ CHW upgrade	Infra-1 Area 4	2013/14								Y						
	CHW	10a	Locate 12" Gate Valves	Infra-1 Area 4	2013/14								Y						
	ChW	11	North CHW lines replacement (HGH)	Infra-1 Area 4	2013/14								Y						
	Ux	12	Utilities to Future Academic Bldg (B-16)	Infra-7	2020/21	Y	Y	Y	Y	Y	Y	Y	Y						
	Ux	13	Nursing Utilities Upgrade (MH-4 Music/Art)	Infra-1 Area5	2013/14							Y	Y						
	ChW	14a	ChW pressure reduction upgrade (McQ)	Infra-1 Area 6	2013/14								Y						
PROPOSED	CHW	14b	Extend chilled water to complete campus loop from PhII Ext to SC Tunnel	Infra-1 Area3	2013/14								Y						
	ChW	15	Demolition of abandoned chillers at Engineering, HGH (absorber), FoB, IRC. Include new ChW connection to existing mains at Tower Lawn.	Infra-1 Area 4	2013/14								Y						
	CP	16	Boiler emissions and control upgrade B-3; inc. pressure reset, & stack econo'	Infra-2	2013/14							Y							
	ST	16a	Upgrade roof of condensate tank at CP	Infra 2	2013/14	MAINTENANCE													
		16b	Repair steam line btwn CP and BBC	Infra-7	2020/21							Y							
	CP	17	Cogen system replacement			DUPLICATE OF #66-#68													
	Ux	18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	Infra-1 Area5	2013/14							Y	Y		Y				
	ST	18a	Isolation Valves for Nursing	Infra-1 Area 5	2013/14							Y	Y		Y				
	ST	19	Repair re-direct steam under genset at IS	Infra-1 Area5	2013/14							Y							
	IT	20	Extend tunnel along 9th	Infra-7	2020/21										Y				
	IT	21	Relocate/ Replace Microwave Antenna Receiver and phone switch at Joe West Hall	Infra-5	2018/19										Y				
		22	Manhole Main't Project (trap, trap metering, repl't std, 5 holes/yr; anchor point, expansion/connection) (7 & 9)	Infra-2	2013/14	MAINTENANCE													
	S	23a	Rework and reroute DH and McQ steam system	Infra-1 Area 6	2013/14							Y							
	S	23b	Remove steam/CHW lines to UPD includes UPD HVAC	Infra-1 Area 6	2013/14							Y	Y						
	RW	24	Irrigation System Controller Upgrade (inc. weather station)	Infra-3	2016/17			Y											
	RW	25	Irrigation System upgrade mains and valves	Infra-3	2016/17	PART OF YOSH PROJECT													
	ELEC *	26a	Transfer 4kV load to 12kV system - Area 3	Infra-1 Area 3	2013/14						Y								Projects #26-37 came from: HV/MV Sys Master Plan Update Revised 9/6/06
	ELEC *	26b	Transfer 4kV load to 12kV system - Area 4	Infra-1 Area 4	2013/14						Y								
	ELEC *	26c	Transfer 4kV load to 12kV System - Area 5	Infra-1 Area 5	2013/14						Y								
		26d	Central Plant 4kV Redundancy	Infra-1 Area 3	2013/14						Y								
	ELEC *	27	Manhole 5A Replacement to larger manhole	Infra-1 Area5	2013/14						Y								
	ELEC *	28	12kV Feed for future Parking Garage near Corp. Yard (ATM Pavilion);			Included in #12													
	ELEC *	29	Replace any under-rated equipment per 2006 Short Circuit Study (inc. Tower Hall)	Infra-1 Area 4	2013/14						Y								Project #29 is in the Campus HV/MV List but may inc. equip. inside buildings...
	ELEC *	30	Separate 12.47kv and 4.8kV feeder in same manhole/conduit near 4th street garage	Infra-1 Area 6	2013/14						Y								
	ELEC *	31	Consolidation of engineering building transformers and PM of gear in Bldg			WORK INSIDE BUILDING. NIC IN UMP													
	IT	32	Relocate overhead telephone line between Royce Hall and Dining Commons to underground	Infra-1 Area3	2013/14	WITH BUILDING PROJECT													
	ELEC *	33	Service of Event Center Substation			WORK INSIDE BUILDING. NIC IN UMP													
	ELEC *	34	Duncan Hall Connection - Overheating of Cables	Infra-1 Area 6	2013/14						Y								
	ELEC *	35	Provide 12KV service to Campus Village Housing Phase 2	Infras-1 Area 3	2013/14	Included in #1													
	ELEC *	36	Preventative Maintenance on all 12kV and 4kV equipment	Infra 2	2015/16	MAINTENANCE													
	ELEC *	37	Add 115kV V-break switches and 15kV switches on load side of transformer T1 and T2; modify bus connections	Infra-8	2023/2024						Y								
	ELEC *	38	Reliability Improvement at Manhole 27: May be affected by Palm Trees; This is the Main area that all feeders go through.	Infra-1 Area 5	2013/14						Y								
	ELEC *	39	Add condensate receivers for future solar to steam	Infra-7	2020/21							Y							
	Sustain	40	Add gas distribution network: main trunk at 9th, and San Carlos	Infra-7	2020/21	INCLUDED IN PRPOJECT #1 & 12													
	Sustain	41	Replace non operational valve at Hugh Gills			COMPLETE													Project #41-65 Projects identified during trades meeting on 4/15
	S	42	Problem Vault A2SMH009- Excessive Steam			COMPLETE													
	SD	43	Drainage Issue at MLK - Assess and Reconnect			NON-UTILITIES PROJECT - INCLUDE IN BLDG													
	SD	44	Install SD near Faculty Offices - Ponding Issues			PART OF SPX PROJECT													
	SD	45	Upsize drains at Plaza in front of Central Classroom to reduce ponding	Infra-1 Area 5	2013/14					Y									
	SD	46	Replace SD between Student Union and Music			PART OF STUDENT UNION PROJECT													
	SD	47	Install SD near Trades Bldg./Corp Yard	Infra-2	2015/16					Y									
	SD	48	Upsize drains along 9th in front of future Humanities Bldg.	Infra-2	2015/16					Y									
	SD	49	Assess Sump Pump in Business	Infra-2	2015/16					Y									
	SD	50	Install SD in between 7th St. Garage and Duncan Hall	Infra-2	2015/16					Y									
	SD	51	Address Root Intrusion in SD in front of 7th St. Garage	Infra-2	2015/16					Y									
	SD	52	Address Ponding near Fountain	Infra-2	2013/14	MAINTENANCE													
	SS	53	Address poor grade and root intrusion on SS at Sweeney Hall	Infra-2	2015/16				Y										
	SS	54	Replace SS between Washington Sq. Hall and YUH			PART OF SPX PROJECT													
	SS	55	Install city approved cleanout at Science/4th St	Infra-1 Area4	2013/14				Y										
	SS	56	Install Cleanout at Hugh Gills Hall	Infra-2	2015/16				Y										
	SS	57	Assess SS Condition from Tower Hall in between DMH and HGH	Infra-2	2015/16				Y										
	RW	58	Repair Irrigation System at Business	Infra-2	2016/17	Y													
		59	Add T and Replace Box at Music	Infra-2	2015/16	Y													
	DW	60	Demo DW line and T, install cap at Dwight Bentel	Infra-2	2015/16	Y													
	RW	61	Botany Garden: Convert to DW instead of RW	Infra-3	2016/17	Y													
	RW	62	Convert DW to RW along 4th St. Garage	Infra-3	2016/17			Y											
	DW	63	Replace main DW line along Art/Music	Infra-2	2015/16	Y													
	DW	64	Assess DW at South Tower - Always Wet	Infra-2	2015/16	Y													
	ELEC *	65	Site Lighting Upgrades	Infra-6	2014/15						Y								
	ELEC *	66	Cogen System Replacement - Electrical	Infra-8	2023/24						Y								
	ELEC *	67	Cogen System Replacement - Steam	Infra-8	2023/24							Y							
	ELEC *	68	Cogen System Replacement - CHW	Infra-8	2023/24								Y						
	DW	69	Install Water Storage tank			NOT A PROJECT													Projects #69-70 from ORSA 1993
	ELEC *	70	Install Master Telemetry Unit			NOT A PROJECT													
	SS	71	Address Sanitary Issues (smell) near Pool	Infra-2	2015/16				Y										
	CP	72	Upgrade Selected Controls Bacnet	Infra-4	2017/18											Y			
	CP	73	Upgrade Controls Subnet	Infra-4	2017/18											Y			
	CP	74	Upgrade Central Plant Controls Platform	Infra-4	2017/18											Y			
	FA	75	Fire Alarm Central System Upgrades	Infra-5	2018/19												Y		See Appendix W
	IT	76	Add new copper and fiber from Comp Center to Student Union; Install new fiber from MacQuarrie to Student Union; include (10) 4" conduits to replace existing infrastructure to Music			THIS MAY BE PART OF STUDENT HEALTH PROJECT/STUDENT UNION PROJECT													
	IT	77	Replace existing Systimax Fiber with current technology; Remove abandoned fiber campus wide	Infra-5	2018/19										Y				
	IT	78	Provide equipment replacement for campus Data Center and Secondary MDF	Infra-5	2018/19										Y				
	ELEC *	79	Provide assessment and upgrades of backup generators for campus IT network	Infra-5	2018/19										Y				
	DW	80	Upsize DW pipes after each meter	Infra 1 Area 3,5, Infra-8	2013/14; 2023	Y													
	DW	81	Upsize 8" DW in between Duncan and 10th St Garage to 10" to Support 2500 GPM	Infra 1 Area 3	2013/14	Y													
	NG	82	Add Gas to Science	Infra 1 - Area 6	2013/14									Y					
	NG	83	Gas Consolidation - Addition of Meters	Infra 1 Area 3, 4, 5, 6 Infra 7 Infra 8	2013/24									Y					
	SS	84	Replace Sanitary Piping (General R&R) due to age of pipe	Infra 1 Area 4	2013/16				Y										
	S	85	Replace Steam Piping (General R&R) due to age of pipe	Infra 1 Area 4, 5	2013/17							Y							
	S	86	Replace steam piping and refeed Industrial Studies	Infra 7	2020/2021							Y							
	Ux	87	Utility Tunnel Urethane Grout Injection and Seismic Upgrades	Infra 2	2015/16													Y	
	SD	88	Storm Drain Lift Station Upgrades	Infra 2	2015/16				Y										
	SD	89	Storm Drain Piping Replacements	Infra 2	2015/16				Y										

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PROJECTS BY INFRASTRUCTURE GROUP

Note these projects to be spread, proportionately between all 5 elements		
3-7	2	Fire Hydrant Improvements
3-7	22	Manhole Main't Project (trap, trap metering, repl't std, 5 holes/yr; anchor point, expansion/connection) (7 & 9)
3-7	36	Preventative Maintenance on all 12kV and 4kV equipment

Risk Priority
(1) Campus wide
(2) Partial campus
(3) HIgh Impact (criticla) Bldg
(4) Low impact bldg.
Probability
High,Med, Low (H,M,L)

No Risk =

Chancellor's Criteria

	Infra	Mproj	Project Description	Risk Priority	Weighted Risk	Probability	Weighted Prob.	Overall		
1	1 -Area 3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	2	3	M	3	6		
2		2	Fire Hydrant Improvements	2	3	H	4	7		
3		3	7th & Paseo SC / San Salvador/9th Water Main Repl'nt	2	3	H	4	7		
4		4a	Recycled Water (down San Carlos to Ph-Ii Hsg & SPX and Cit)	4	1	L	1	2		
5		5	Main Campus Well #2 Relocation	1	4	H	4	8		
		7a	Steam Manhole Re-design and Relocation for Risk Mitigation (included as part of CV-2)	3	2	H	4	6		
		7b	6" Steam Line Valve Upgrade/Replacement	2	3	H	4	7		
6		14b	Extend chilled water to complete campus loop from PhII Ext to SC Tunnel	1	4	H	4	8		
		26a	Transfer 4KV Load to 12KV System - Area 3	3	2	H	4	6		
		26d	Central Plant 4KV Redundancy	1	4	H	4	8		
7		80	Upsize DW pipes after each meter	3	2	M	3	5		
8		81	Upsize 8" DW in between Duncan and 10th St Garage to 10" to Support 2500 GPM	3	2	M	3	5		
		84	SS Piping Replacement in Area 3	2	3	H	4	7		
9		83	Gas Consolidation - Addition of Meters	4	1	L	1	2		
					2.643		**3.36**	**6**		
1	1-Area 4	2	Fire Hydrant Improvements	2	3	H	4	7		
2		4c	Expand CHW to Dudley MH (reno & addition)	1	4	M	3	7		
3		5a	Extend CHW to Science	1	4	M	3	7		
4		6	Ph-1 Steam to Student Health (SHC) inc. bottleneck btw. DBH and Student Union/Engr tee	1	4	H	4	8		
		6a	installation of isolation valve to maintain service to east campus	1	4	H	4	8		
		6b	include high risk steam piping replacment and isolation valve addition	1	4	H	4	8		
5		7	PH-2 Steam from SHC to 'mini-tunnel'	1	4	H	4	8	n/a	n/a
6		8a	Computer Center Backup Power Upgrade	3	2	H	4	6	n/a	n/a
7		8b	Computer Center chilled water upgrade	3	2	H	4	6	n/a	n/a
8		8	DBH to WSQ CHW upgrade	3	2	M	3	5	n/a	n/a
		10a	Locate 12" Gate Valves	1	4	H	4	8		
9		11	North CHW lines replacement (HGH)	4	1	L	1	2	n/a	n/a
10		15	Demolition of abandoned chillers at Engineering, H (Science & Morris Dailey, Hugh Gillis, Dudley Moorehead, Admin)	3	2	L	1	3	n/a	n/a
11		26b	Transfer 4KV Load to 12 KV System - Area 4	3	2	H	4	6	n/a	n/a
12		29	Replace any under-rated equipment per 2006 Short Circuit Study (inc. Tower Hall)	3	2	H	4	6	n/a	n/a
13		55	Install city approved cleanout at Science/4th St	3	2	H	4	6	Y	n/a
14		83	Gas Consolidation - Addition of Meters	4	1	L	1	2	n/a	n/a
15		84	SS Piping Replacement in Area 4	2	3	H	4	7	Y	n/a
16		85	Replace Steam Piping (General R&R) due to age of pipe	1	4	H	4	8	Y	n/a
					2.842		**3.368**	**6.211**		
1	1-Area 5	2	Fire Hydrant Improvements	2	3	H	4	7	Y	n/a
2		13	Nursing Utilities Upgrade (MH-4 Music/Art)	1	4	M	3	7	n/a	n/a
3		13	Nursing Utilities Upgrade (MH-4 Music/Art)	1	4	M	3	7	n/a	n/a
4		18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	1	4	M	3	7	n/a	n/a
5		18	Tunnel and Piping Upgrade between Event Center/ (Music, Art, Health)	1	4	M	3	7	n/a	n/a
6		18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	1	4	M	3	7	n/a	n/a
		18a	Isolation Valves for Nursing	3	2	M	3	5		
7		19	Repair re-direct steam under genset at IS	1	4	H	4	8	n/a	n/a
8		26c	Transfer 4KV Load to 12KV System - Area 5	3	2	H	4	6	n/a	n/a
9		27	Manhole 5A Replacement to larger manhole	2	3	H	4	7	n/a	n/a
10		38	Reliability Improvement at Manhole 27: May be affected by Palm Trees; This is the Main area that all feeders go through.	2	3	H	4	7	n/a	n/a
11		80	Upsize DW pipes after each meter	3	2	M	3	5	n/a	n/a
12		83	Gas Consolidation - Addition of Meters	4	1	L	1	2	n/a	n/a
		84	SS Piping Replacement in Area 5	2	3	H	4	7		
13		85	Replace Steam Piping (General R&R) due to age of pipe	1	4	H	4	8	Y	n/a
					3.133		**3.333**	**6.467**		
12	1-Area 6	2	Fire Hydrant Improvements	2	3	H	4	7	Y	n/a
3		9	MacQuarrie Hall CHW Upgrade	3	2	H	4	6	n/a	n/a
4		14a	ChW pressure reduction upgrade (McQ)	3	2	M	3	5	n/a	n/a
5		23a	Rework and reroute DH and McQ steam system	1	4	H	4	8	Y	n/a
6		23b	Remove steam/CHW lines to UPD includes UPD HVAC	1	4	M	3	7	n/a	n/a
7		23b	Remove steam/CHW lines to UPD includes UPD HVAC	1	4	M	3	7	n/a	n/a
8		30	Separate 12.47kv and 4.8kV feeder in same manhole/conduit near 4th street garage	2	3	H	4	7	n/a	n/a
9		34	Duncan Hall Connection - Overheating of Cables	3	2	H	4	6	n/a	n/a
10		83	Gas Consolidation - Addition of Meters	4	1	L	1	2	n/a	n/a
					2.778		**3.333**	**6.111**		
	Infra-2		**Staff Legacy & Maintenance**							
1		4b	Recycled Water for Central Plant makeup wtr	3	2	H	4	6	n/a	n/a
2		16	Boiler emissions and control upgrade B-3; inc. pressure reset, & stack econo'	4	1	M	3	4	n/a	n/a
3		16a	Upgrade roof of condensate tank at CP	4	1	M	3	4	n/a	n/a
4		22	Manhole Main't Project (trap, trap metering, repl't s (Yoshiro Uchida)	4	1	L	1	2	n/a	n/a
5		36	Preventative Maintenance on all 12kV and 4kV equipment	1	4	H	4	8	n/a	n/a
6		45	Upsize drains at Plaza in front of Central Classroom to reduce ponding	4	1	M	3	4	n/a	n/a
7		47	Install SD near Trades Bldg./Corp Yard	4	1	M	3	4	n/a	n/a
8		48	Upsize drains along 9th in front of future Humanities Bldg.	4	1	M	3	4	n/a	n/a
9		49	Assess Sump Pump in Business	4	1	L	1	2	n/a	n/a
10		50	Install SD in between 7th St. Garage and Duncan Hall	3	2	M	3	5	n/a	n/a
11		51	Address Root Intrusion in SD in front of 7th St. Garage	3	2	M	3	5	n/a	n/a
12		52	Address Ponding near Fountain	3	2	M	3	5	n/a	n/a
13		53	Address poor grade and root intrusion on SS at Sweeney Hall	4	1	M	3	4	n/a	n/a
14		56	Install Cleanout at Hugh Gills Hall	4	1	M	3	4	n/a	n/a
15		57	Assess SS Condition from Tower Hall in between DMH and HGH	2	3	H	4	7	Y	n/a
16		59	Add T and Replace Box at Music	4	1	M	3	4	n/a	n/a
17		60	Demo DW line and T, install cap at Dwight Bentel	4	1	L	1	2	n/a	n/a
18		63	Replace main DW line along Art/Music	2	3	M	3	6	n/a	n/a
19		64	Assess DW at South Tower - Always Wet	2	3	M	3	6	n/a	n/a
20		71	Address Sanitary Issues (smell) near Pool	2	3	H	4	7	Y	n/a
21		87	Utility Tunnel Urethane Grout Injection and Seismic Upgrades	1	4	H	4	8	Y	n/a
		88	Storm Drain Lift Station Upgrade Projects	3	2	H	4	6		
		89	Storm Drain Piping Replacement Projects	3	2	H	4	6		
					1.87		**3.043**	**4.81**		
	Infra-3		**Irrigation Infrastructure Repairs and Modifications**							
1		24	Irrigation System Controller Upgrade (inc. weather station)	4	1	L	1	2	n/a	n/a
2		25	Irrigation System upgrade mains and valves	4	1	L	1	2	n/a	n/a
3		58	Repair Irrigation System at Business	4	1	M	3	4	n/a	n/a
4		61	Botany Garden: Convert to DW instead of RW	4	1	M	3	4	n/a	n/a
5		62	Convert DW to RW along 4th St. Garage	4	1	M	3	4	n/a	n/a
					1.00		**2.20**	**3.20**		
	Infra-4		**Energy Management System**							
1		72	Upgrade Selected Controls Bacnet	4	1	M	3	4	n/a	n/a
2		73	Upgrade Controls Subnet	4	1	M	3	4	n/a	n/a
3		74	Upgrade Central Plant Controls Platform	4	1	M	3	4	n/a	n/a
					1.00		**3.00**	**4.00**		
	Infra-5		**Fire Alarm Central System & IT Infrastructure Upgrades**							
1		75	Fire Alarm Central System Upgrades	1	4	H	4	8	Y	n/a
2		77	Replace existing Systimax Fiber with current technology; Remove abandoned fiber campus wide	2	3	H	4	7	n/a	n/a
3		78	Provide equipment replacement for campus Data Center and Secondary MDF	2	3	H	4	7	n/a	n/a
4		79	Provide assessment and upgrades of backup generators for campus IT network	2	3	H	4	7	n/a	n/a
5		21	Relocate/ Replace Microwave Antenna Receiver and phone switch at Joe West Hall	4	1	M	3	4	n/a	n/a
					2.80		**3.80**	**6.60**		
	Infra-6		**Exterior Lighting Infrastructure**							
1		65	Site Lighting Upgrades	2	3	H	4	7	Y	n/a
					3.00		**4.00**	**7.00**		
	Infra-7		**Utility Expansion for Future Academic Buildings**							
1		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
2		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
3		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
4		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
5		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
6		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
7		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
8		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
9		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
10		12	Utilities to Future Academic Bldg (B-16)	2	3	M	3	6	n/a	n/a
11		16b	Repair steam line btwn CP and BBC	1	4	H	4	8	n/a	n/a
12		20	Extend tunnel along 9th	4	1	M	3	4	n/a	n/a
13		39	Add condensate receivers for future solar to steam	3	2	M	3	5	n/a	n/a
14		40	Add gas distribution network: main trunk at 9th, and San Carlos	2	3	M	3	6	n/a	n/a
15		80	Upsize DW pipes after each meter	3	2	M	3	5	n/a	n/a
16		83	Gas Consolidation - Addition of Meters	4	1	L	1	2	n/a	n/a
17		86	Replace steam piping and refeed Industrial Studies	1	4	H	4	8	Y	n/a
					2.765		**3.00**	**5.765**		
	Infra-8		**Cogeneration System Replacement and Central Plant Upgrade**							
1		37	Add 115kV V-break switches and 15kV switches on load side of transformer T1 and T2; modify bus connections	2	3	H	4	7	n/a	n/a
2		66	Cogen System Replacement - Electrical	4	1	M	3	4	n/a	n/a
3		67	Cogen System Replacement - Steam	4	1	M	3	4	n/a	n/a
5		68	Cogen System Replacement - CHW	4	1	M	3	4	n/a	n/a
6		80	Upsize DW pipes after each meter	3	2	M	3	5	n/a	n/a
7		83	Gas Consolidation - Addition of Meters	4	1	L	1	2	n/a	n/a
					1.50		**2.833**	**4.333**		

PROJECTS BY UTILITY

Type	Infra #	Proj #	Name	Cost	Type	Priority	Safety	Payback
DW	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$638,517				
1	1-area3	3	7th & Paseo SC / San Salvador/9th Water Main Repl'nt	$0				
	1-area3	5	Main Campus Well #2 Relocation	$2,197,000				
	1-area3	80	Upsize DW pipes after each meter	$20,000				
	1-area3	81	Upsize 8" DW in between Duncan and 10th St Garage to 10" to Support 2500 GPM	$60,345				
	1-area5	80	Upsize DW pipes after each meter	$60,000				
	2	59	Add T and Replace Box at Music	$88,000				
	2	60	Demo DW line and T, install cap at Dwight Bentel	$88,000				
	2	63	Replace main DW line along Art/Music	$165,000				
	2	64	Assess DW at South Tower - Always Wet	$55,000		H		M
	3	58	Repair Irrigation System at Business	$41,250				
	3	61	Botany Garden: Convert to DW instead of RW	$48,125				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	7	80	Upsize DW pipes after each meter	$80,000				
	8	80	Upsize DW pipes after each meter	$40,000				
			SUBTOTAL	$3,997,139				
FW	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$415,902				
2	1-area3	2	Fire Hydrant Improvements	$0				
	1-area4	2	Fire Hydrant Improvements	$120,000				
	1-area5	2	Fire Hydrant Improvements	$120,000				
	1-area6	2	Fire Hydrant Improvements	$120,000				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
			SUBTOTAL	$1,191,804				
RW	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$1,226,521				
3	1-area3	4a	Recycled Water (down San Carlos to Ph-Ii Hsg & SPX and Cit)	$0				
	2	4b	Recycled Water for Central Plant makeup wtr	$750,000				
	3	24	Irrigation System Controller Upgrade (inc. weather station)	$185,000				
	3	25	Irrigation System upgrade mains and valves	$275,000				
	3	62	Convert DW to RW along 4th St. Garage	$48,125				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
			SUBTOTAL	$2,900,548				
SS	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$232,736				
4	1-area4	55	Install city approved cleanout at Science/4th St	$122,000				
	1-area4	84	SS Piping Replacement Projects	$1,549,125				
	2	53	Address poor grade and root intrusion on SS at Sweeney Hall	$110,000				
	2	56	Install Cleanout at Hugh Gills Hall	$55,000				
	2	57	Assess SS Condition from Tower Hall in between DMH and HGH	$55,000				
	2	71	Address Sanitary Issues (smell) near Pool	$77,000				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
			SUBTOTAL	$2,616,763				
SD	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$234,500				
5	2	52	Address Ponding near Fountain	$32,500				
	2	45	Upsize drains at Plaza in front of Central Classroom to reduce ponding	$125,000				
	2	47	Install SD near Trades Bldg./Corp Yard	$55,000				
	2	48	Upsize drains along 9th in front of future Humanities Bldg.	$132,000				
	2	49	Assess Sump Pump in Business	$55,000				
	2	50	Install SD in between 7th St. Garage and Duncan Hall	$55,000				
	2	51	Address Root Intrusion in SD in front of 7th St. Garage	$110,000				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	2	88	Storm Drain Lift Station Upgrade Projects	$49,350				
	2	89	Storm Drain Piping Replacement Projects	$420,000				
			SUBTOTAL	$1,214,902				
E	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$465,759				
6	1-area4	8a	Computer Center Backup Power Upgrade	$0				
	1-area3	26a	Transfer 4KV Load to 12KV System - Area 3	$250,000				
	1-area4	26b	Transfer 4KV Load to 12 KV System - Area 4	$1,250,000				
	1-area5	26c	Transfer 4KV Load to 12KV System - Area 5	$750,000				
	1-area3	26d	Central Plant 4KV Redundancy	$125,000				
	1-area4	29	Replace any under-rated equipment per 2006 Short Circuit Study (inc. Tower Hall)	$140,000				
	1-area5	27	Manhole 5A Replacement to larger manhole	$269,700				
	1-area5	38	Reliability Improvement at Manhole 27: May be affected by Palm Trees; This is the Main area that all feeders go through.	$224,700				
	1-area6	30	Separate 12.47kv and 4.8kV feeder in same manhole/conduit near 4th street garage	$375,000				
	1-area6	34	Duncan Hall Connection - Overheating of Cables	$30,000				
	2	36	Preventative Maintenance on all 12kV and 4kV equipment	$280,000				
	6	65	Exterior Lighting Infrastructure	$2,848,529		H	H	H
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	8	37	Add 115kV V-break switches and 15kV switches on load side of transformer T1 and T2; modify bus connections	$325,000				
	8	66	Cogen System Replacement - Electrical	$7,560,000				
			SUBTOTAL	$15,309,590				
ST	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$610,179				
7	1-area4	6	Ph-1 Steam to Student Health (SHC) inc. bottleneck btw. DBH and Student Union/Engr tee	$440,000				
7	1-area4	6a	installation of isolation valve to maintain service to east campus	$10,504				
7	1-area4	6b	include high risk steam piping replacment and isolation valve addition	$5,060,000				
7	1-area4	6c	replace and relocate steam manhole (part of CV-2)	$0				
	1-area4	7	PH-2 Steam from SHC to 'mini-tunnel'	$645,000				
7	1-area3	7a	Steam Manhole Re-design and Relocation for Risk Mitigation (included as part of CV-2)	$380,000				
7	1-area3	7b	6" Steam Line Valve Upgrade/Replacement	$100,000				
	1-area4	85	Replace Steam Piping (General R&R) due to age of pipe	$140,000				
	1-area5	13	Nursing Utilities Upgrade (MH-4 Music/Art)	$0				
	1-area5	18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	$1,800,000				
	1-area5	19	Repair re-direct steam under genset at IS	$470,000				
	1-area5	85	Replace Steam Piping (General R&R) due to age of pipe	$241,000				
	1-area6	23a	Rework and reroute DH and McQ steam system	$480,000				
	1-area6	23b	Remove steam/CHW lines to UPD includes UPD HVAC	$785,000				
	2	16a	Upgrade roof of condensate tank at CP	$48,000				
	2	16	Boiler emissions and control upgrade B-3; inc. pressure reset, & stack econo'	$775,000				
	2	22	Manhole Main't Project (trap, trap metering, repl't std, 5 holes/yr; anchor point, expansion/connection) (7 & 9)	$522,000				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	7	16b	Repair steam line btwn CP and BBC	$3,250,000				
	7	39	Add condensate receivers for future solar to steam	$350,000				
	7	86	Replace steam piping and refeed Industrial Studies	$320,000				
	8	67	Cogen System Replacement - Steam	$5,880,000				
			SUBTOTAL	$22,722,585				
CHW	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$930,826				
8	1-area3	14b	Extend chilled water to complete campus loop from PhII Ext to SC Tunnel	$930,826				
	1-area4	4c	Expand CHW to Dudley MH (reno & addition)	$310,000				
	1-area4	5a	Extend CHW to Science	$280,000				
	1-area4	8b	Computer Center chilled water upgrade	$320,000				
	1-area4	10	DBH to WSQ CHW upgrade	$275,000				
	1-area4	10a	Locate 12" Gate Valves	$52,600				
	1-area4	11	North CHW lines replacement (HGH)	$375,000				
	1-area4	15	Demolition of abandoned chillers at Engineering, HGH (absorber), FoB, IRC. Include new ChW connection to existing mains at Tower Lawn.	$570,000				
	1-area5	13	Nursing Utilities Upgrade (MH-4 Music/Art)	$0				
	1-area5	18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	$1,250,000				
	1-area6	9	MacQuarrie Hall CHW Upgrade	$450,000				
	1-area6	14a	ChW pressure reduction upgrade (McQ)	$1,303,895				
	1-area6	23b	Remove steam/CHW lines to UPD includes UPD HVAC	$634,775				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	8	68	Cogen System Replacement - CHW	$4,200,000				
			SUBTOTAL	$12,298,824				
G	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$111,462				
9	1-area3	83	Gas Consolidation - Addition of Meters	$18,000				
	1-area4	83	Gas Consolidation - Addition of Meters	$45,000				
	1-area5	83	Gas Consolidation - Addition of Meters	$39,000				
	1-area6	82	Add Gas to Science	$67,000				
	1-area6	83	Gas Consolidation - Addition of Meters	$45,000				
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
	7	40	Add gas distribution network: main trunk at 9th, and San Carlos	$420,000				
	7	83	Gas Consolidation - Addition of Meters	$39,000				
	8	83	Gas Consolidation - Addition of Meters	$36,000				
			SUBTOTAL	$1,236,364				
IT	1-area3	1	Housing Utility; Aquatic Center and Student Rec Expansion (in Quad D)	$125,000				
10	1-area5	18	Tunnel and Piping Upgrade between Event Center/Music/Art/Eng (1,2,3a,3b) and etc (8)	$325,000				
	5	77	Replace existing Systimax Fiber with current technology; Remove abandoned fiber campus wide	$1,200,000				
	5	78	Provide equipment replacement for campus Data Center and Secondary MDF					
	5	79	Provide assessment and upgrades of backup generators for campus IT network					
	5	21	Relocate/ Replace Microwave Antenna Receiver and phone switch at Joe West Hall					
	7	12	Utilities to Future Academic Bldg (B-16)	$415,902				
			SUBTOTAL	$2,065,902				
Controls	4	72	Upgrade Selected Controls Bacnet	$612,500				
11	4	73	Upgrade Controls Subnet	$175,000				
	4	74	Upgrade Central Plant Controls Platform	$450,000				
			SUBTOTAL	$1,237,500				
FA	5	75	Fire Alarm Central System Upgrades	$1,507,000				
UT	2	87	Utility Tunnel Urethane Grout Injection and Seismic Upgrades	$185,725				
			GRAND TOTAL	**$67,235,089**				

Shutdown Risk
(1) Campus wide
(2) Partial campus
(3) Critial Bldg
(4) Low impact bldg.
Priority
High,Med, Low (H,M,L)

No Risk =

SALASO'BRIEN
| expect a difference |

Project No. 130791

PROJECT SUMMARY: UTILITY BREAKDOWN

Projects		Domestic Water & Well (DW)	Fire Water (FW)	Recycled Water (RW)	Sanitary Sewer (SS)	Storm Drain (SD)	Electrical (E)	Steam (ST)	Chilled Water (CHW)	Gas (G)	Telecom (T)	Controls (C)	Fire Alarm (FA)	Utility Tunnel (UT)	Totals	
Infra 1-3	Utility Expansion (Quad D)	$2,915,862	$415,902	$1,226,521	$232,736	$234,500	$465,759	$610,179	$1,861,652	$129,462	$125,000	$0	$0	$0	$8,217,574	
Infra 1-4	Utility Expansion (Quad A)	$0	$120,000	$0	$1,671,125	$0	$2,515,000	$6,775,504	$2,182,600	$45,000	$0	$0	$0	$0	$13,309,229	
Infra 1-5	Utility Expansion (Quad B)	$60,000	$120,000	$0	$0	$0	$494,400	$2,511,000	$1,250,000	$39,000	$325,000	$0	$0	$0	$4,799,400	
Infra 1-6	Utility Expansion (Quad C)	$0	$120,000	$0	$0	$0	$405,000	$1,265,000	$2,388,670	$112,000	$0	$0	$0	$0	$4,290,670	
Infra-2	Staff Legacy (infrastructure maintenance)	$396,000	$0	$750,000	$297,000	$564,500	$280,000	$1,345,000	$0	$0	$0	$0	$0	$185,725	$3,632,500	
Infra-3	Irrigation Controllers & Piping Modifications	$89,375	$0	$508,125	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$597,500	
Infra-4	Energy Management System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,237,500	$0	$0	$1,237,500	
Infra-5	Fire Alarm Central System & IT Infrastructure Upgrades	$0	$0	$0	$0	$0	$0	$0	$0		$1,200,000	$0	$1,507,000	$0	$2,707,000	
Infra-6	Exterior Lighting Infrastructure	$0	$0	$0	$0	$0	$2,848,529	$0	$0	$0	$0	$0	$0	$0	$2,848,529	
Infra-7	Future extension Humanities & Academic Bldg	$495,902	$415,902	$415,902	$415,902	$415,902	$415,902	$4,335,902	$415,902	$874,902	$415,902	$0	$0	$0	$8,618,020	
Infra-8	Cogen Replacement & Central Plant Upgrade	$40,000	$0	$0	$0	$0	$7,885,000	$5,880,000	$4,200,000	$36,000	$0	$0	$0	$0	$18,041,000	
2013	Totals	$3,997,139	$1,191,804	$2,900,548	$2,616,763	$1,214,902	$15,309,590	$22,722,585	$12,298,824	$1,236,364	$2,065,902	$1,237,500	$1,507,000		$68,298,922	$68,298,922
	Project Implementation Budget (by year)	2014	2015	2016	2017	2018	Year 6 to 10		Year 11 to 20							
	Fiscal Year															
	Budget															
	Project															