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CSU San Bernardino

MEP Utilities Master Plan

December 15, 2016

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EXECUTIVE SUMMARY

Background and Scope

Founded in 1960, California State University, San Bernardino is a 430-acre campus set at the foothills of the San Bernardino in inland Southern California. Currently, the main campus is composed of 66 buildings, totaling almost 2.6 million gross square feet of campus building space. The Palm Desert campus is composed of 5 buildings, totaling approximately 100,000 gross square feet of campus building space. The University is home to about 20,000 students.

The proposed implemenration of the master plan will add approximately 1.25million of academic and lab spaces and approximately 1.35million of residential and support spaces. A total of approximately 2.5 million square feet of gross space is being added to the campus existing inventory excluding parking structures. A campus map and table showing the proposed master planned facilities that are being added at the campus is provided at the end of the chapter. The map also indicates buildings that are being replaced under the proposed plan.

P2S Engineering Inc. was contracted to evaluate the existing utilities currently serving the campus and provide specific recommendations to alter/upgrade/modify the existing utility infrastructure to support the facilities proposed as part of the master plan and provide an updated utility master plan for the campus.

The utilities evaluated as part our risk assessment and utility master plan update are:

- Chilled Water Distribution System
- Heating Hot Water Distribution System
- Natural Gas Systems
- Electrical Service and Distribution System

- Critical Data/Telecommunications for security

The utilities within the campus boundaries are comprised of domestic and fire water, sewer, storm drain, irrigation water, chilled and hot water distribution, gas, electrical and telecommunications systems, and are all owned and operated by the campus. Southern California Gas & Southern California Edison provide gas and power to the campus respectively. Verizon is the local exchange carrier (LEC) for the telecommunication services.

The University has its own electrical distribution system which receives 12kV service from Southern California Edison and distributes to each building on campus.

The University also has a central heating and cooling plant with a thermal energy storage system that provides heating and cooling to a majority of the buildings on campus. The thermal energy storage system reduces the peak electrical loads and saves the University substantial costs by shifting the cooling production to off peak hours.

The University has a combined electric and gas expenditures of about $3.9 million annually. The University's total annual energy consumption is approximately 26,300,000 kWh with a total energy usage of 56.46 kBTU's per square feet each year.

The total domestic water and sewer costs at the University total to about $259,000 and $125,000 respectively per year. The sanitation costs for the campus are approximately $188,000 per year.

Objective

The objective of this utility master plan study is to evaluate the existing utilities currently serving the existing CSUSB Campus and provide cost-effective and specific recommendations to alter/upgrade/modify the existing utility infrastructure to support new buildings, major renovations, and building replacements that form part of the proposed master plan.

Methodology

The following methodology was adopted in formulating our utility infrastructure master plan.

A critical aspect in the evaluation of the existing utility systems serving a facility is a detailed and accurate field investigation of the current systems. A detailed survey of the existing utility systems that currently serve the facilities at the CSUSB campus was undertaken, and existing conditions, together with potential problems, were identified. The surveyed information was verified through available record drawings and meetings with the campus facilities management staff.

Each utility system was then evaluated for capacity, functionality, reliability, ease of maintenance, age, and its ability to serve the present and future needs of the campus.

Alterations/upgrade/modifications necessary to support new buildings, major renovations, and building replacements that form part of the proposed near term development plan were identified.

Costs associated with each of the required utility upgrades were then developed based on our recommendations.

Report Overview

Our following Utility Infrastructure Master Plan update report provides an analysis of the existing utilities currently serving the facilities, identifies alterations/upgrade/modifications necessary to support new buildings, major renovations, and building replacements that form part of the proposed master plan and outlines recommended solutions and costs to implement the same. The utility systems that were evaluated and included in our report are: Chilled and Heating Hot Water Systems, Electrical Systems, Telecommunication Systems and Natural Gas System.

Summary of Our Analysis and Recommendations

The following report summarizes our analysis and our recommended solutions for each of the existing utility systems to support the proposed master plan development. Estimated cost to upgrade each of these systems to support the near term development is also included following our recommendations.

NEW / EXPANDED ACADEMIC FACILITIES					
Bld. No.	Building Name or Type	Campus Facility or Type	ASF	Floors	GSF
10A.	Physical Education Addition	Physical Education	28,600.00	2	57,200
22A.	Santos Manuel Student Union Addition	Student Center	37,400.00	3	112,200
32B.	Museum of Art Expansion	Gallery / Teaching Lab (Dry)	11,300.00	1	11,300
33A.	Theater Arts Building Addition	Assembly / Teaching Lab (Dry)	46,600.00	1	46,600
34A.	Health and Physical Education Center (Kinesiology)	Teaching Lab (Dry)	23,000.00	3	69,000
39A.	Student Recreation and Fitness Center Addition	Rec Center / Gym	34,500.00	1	34,500
29.	Alumni and Faculty Center	Assembly / Office	14,900.00	1	14,900
42.	Children's Center Addition	Childcare	21,000.00	1	21,000
53.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000
54.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000
400A.	Ground Floor of CSI Laboratory	Research Lab (Wet)	25,000.00	1	25,000
56.	Classroom Building	Classrooms	20,200.00	3	60,600
57.	Classroom Building	Classrooms	20,300.00	3	60,900
58.	Classroom Building	Classrooms	20,100.00	3	60,300
59.	Classroom Building	Classrooms	20,000.00	3	60,000
60.	CEL + Knowledge Hub (See Reference Table for Uses)	Classrooms	23,400.00	3	70,200
61.	John M. Pfau Library Addition (See Reference Table for Uses)	Library	33,100.00	6	198,600
62.	Dining Hall 1 Plant	Food Service (Shared Kitchen)	3,900.00	1	3,900
63.	Dining Hall 2 Plant	Food Service (Shared Kitchen)	4,500.00	1	4,500
76.	Physical Plant Addition	Utility Plant	12,000.00	2	24,000
69.	Collaboration Pavillions	Classroom (Temporary or Modular)	400.00	7	2,800
26.	*University Hall Re-Use*	*Administrative Office (Remodel)*	*34,500.00*	*3*	*103,500*
26.	*Ground Floor Academic Uses in New Housing (20% of Ground Floors)*	Classrooms	*61,700.00*	*1*	*61,700*
					1,240,700

NEW / EXPANDED CAMPUS LIFE FACILITIES						
Group or Bldg. No.	Project Name or Location Description	Dwelling Unit Type	Phase	Floorplate	Floors	GSF
44	Living and Learning Community (Phase 1)	Residence Halls	1	34,000.00	4	136,000
45	Residential Suites Near Athletics Fields	Residential Suites	2	34,800.00	4	139,200
45	Serrano Village Replacement	Residence Halls	3	55,500.00	4	222,000
66	Gateway Village (near garages)	Residential Suites	4 & 5	23,800.00	4	95,200
66	Gateway Village (around gateway)	Apartments	4 & 5	90,200.00	4	360,800
46	Residential Halls Replacing Administration	Residence Halls	6	33,700.00	4	134,800
46	Residential Halls at Far Northwest End	Residential Suites	7	36,300.00	4	145,200
48.	Dining Hall 1		1	47,100.00	1.5	70,650
50.	Dining Hall 2		6	35,900.00	1.5	53,850
						1,357,700

ENTREPRENEURIAL FACILITIES			
Bld. No.	Building Name or Type	Floorplate	Floors
400A.	Discovery Park A (Sheriff Dept. Partnership CSI Laboratory, Ground Floor Classrooms)	25,000.00	2
400B.	Discovery Park B	20,000.00	3
400C.	Discovery Park C	20,000.00	3
401.	Hotel and Conference Center	21,900.00	3

PARKING FACILITIES				
Bld. No.	Building Name or Type	Floorplate	Floors	GSF
103.	Athletics Parking Structure	92,600.00	4	370,400.00
104.	East Gateway Parking Structure	107,500.00	4	430,000.00
105.	West Gateway Parking Structure	120,000.00	4	480,000.00
106	North Parking Structure	75,600.00	6	453,600.00
107.	Discovery Park Parking Structure	75,600.00	6	453,600.00
108	Lot N Parking Structure	113,000.00	6	678,000.00
Lot N	Lot N (Not Including Footprint of Lot N Structure)	*Note: Parking supply based on visual count in final CAD drawing*		*N/A*

DESCRIPTION OF EXISTING SYSTEMS

CHILLED WATER AND HEATING HOT WATER SYSTEMS

The Central Plant located at the HVAC Central Plant building was completed in 1967 and serves the campus' s heating and cooling needs. The chilled water production is accomplished via (3) chillers, (1) 800 ton centrifugal that was installed in 2005 and (2) 1,200 ton centrifugals that were installed in 2008 when the chilled water side of the plant underwent a major renovation. The renovation included the installation of a CHW thermal energy storage (TES) system that assists the campus in generating and storing chilled water during the off peak periods. The (3) chillers are capable of supplying an instantaneous cooling capacity of 3,200 tons and feeding the TES tank which can store 30,000 ton-hrs of chilled water. Based on the discussions had and data received from the campus, the campus has a maximum cooling load of approximately 3,000 tons or 18,000 ton-hours based on a 6-hour peak period.

The campus' s heating needs are serviced by the heating hot water (HHW) system housed at the Central Plant. The Central Plant utilizes (2) 25 MMBH and (1) 10 MMBH output high temperature hot water generators to handle the campuses heating load. The campus also receives approximately 2 MMBH of constant heat from the Fuel Cell located next to the Central Plant which is sufficient to handle the vast majority of the summer heating loads. Based on the discussions had and data received from the campus, the campus has a maximum heating load of approximately 30 MMBH.

There is an existing Schneider Electric Building Automation energy management system on campus. This system controls central plant operation, as well as the majority of HVAC systems within each building, and meters BTU consumption in approximately 80% of the buildings.

The campus also has a few facilities that have dedicated chillers/AC Package units and boilers that meet the cooling and heating demands of these facilities respectively.

CHW Generation

The chilled water generation at the plant is accomplished via three (3) chillers. Chiller CH-1 was an absorption chiller that was removed earlier this year due to AQMD compliance issues. Chiller CH-2 is an 800-ton Trane CVHF centrifugal chiller. Chillers CH-3 and CH-4 are both 1200-ton Trane CVHF centrifugal chillers. All (3) machines operate on 480V power and utilize R123 refrigerant.

Chillers CH-3 and CH-4 are piped in series, with CH-3 as the upstream chiller and CH-4 as the downstream chiller. CH-2 is piped in parallel with CH-3 and CH-4 and has a bypass loop to help it match the 24°F change in temperature that CH-3 and CH-4 produce in order to effectively charge the TES tanks.

Chillers CH-2, CH-3, and CH-4 can operate simultaneously, providing an instantaneous cooling capacity of 3,200 tons. The chillers are typically operated during the off peak and mid peak periods to charge the TES tank and chilled water is supplied from the tank to each of the facilities during the peak periods. This helps the campus offset their demand charges during the peak periods and save operating costs. The chillers are in good condition.

There are four (4) existing cooling towers (CT-1, CT-2, CT-3, and CT-4) that serve the central plant. All the tower fans have variable frequency drives (VFDs). Cooling towers CT-1 and CT-2 are wooden Marley towers. CT-1 was used to operate the absorption chiller CH-1, which has been removed. As such, CT-1 is drained and no longer in use. CT-2 is used to operate CH-2. These towers are run down with clear signs of deterioration and are at the end of their lifespan. CT-3 is a BAC cooling tower that serves as a stand-by tower to CT-4. CT-3 cannot be run at the same time as CT-4 as the basin’s for these units are at different elevations. CT-3 appears to be in fair condition but has not been run in several years. CT-4 is a Marley cooling tower built with steel construction. This is the main operating cooling tower for the central plant and serves CH-3 and CH-4.

There are two (2) above ground, insulated, welded-steel, thermally stratified, thermal energy storage tanks (TES) located adjacent to the HVAC Central Plant building. These tanks are 68 feet in diameter and have a height of 52 feet. Each tank has a volumetric storage capacity of 1,080,000 gallons. With a 39°F CHWS temperature and a 63°F CHWR temperature (24°F ΔT), each tank provides approximately 15,300 ton-hours of cooling, assuming 85% TES efficiency.

Chillers

	Chiller Tag	Chiller Type	Mfgr	Year Installed	Primary Source of Energy	Refrigerant	Capacity (Tons)	Published Efficiency (kW/ton)	CHW Flow (GPM)	CHW Range Temp (F)	CHW Delta T (F)
Main Central Plant	CH-1	Removed	-	-	-	-	-	-	-	-	-
	CH-2	Centrifugal	Trane	2005	Electric	R-123	800	N/A	1,045	39°F - 56°F	17°F
	CH-3	Centrifugal, piped in series	Trane	2008	Electric	R-123	1,200	0.437	2,400	51°F - 63°F	12°F
	CH-4	Centrifugal, piped in series	Trane	2008	Electric	R-123	1,200	0.574	2,400	39°F - 51°F	12°F
	TES Tanks: (Qty-2, 15,000 Ton-Hours Each)										
Campus Grand Total (Excluding TES)							4,300	-------	7,345	-------	-------

Cooling Towers

	Tag No.	Type	Manufacturer	Year Installed	Water Pressure Drop (Ft)	Flow Rate (GPM)	Design ECWT (Deg. F)	Design LCWT (Deg. F)	Motor Power (HP)	Tower Fan VFD
Central Plant	CT-1A/1B (Shutdown)	Crossflow, Draw Thru	Marley Series 15	N/A	73	3,650	101.5	85	2 @ 30	Y
	CT-2A/2B (Shutdown)	Crossflow, Draw Thru	Marley Series 15	N/A	73	3,650	101.5	85	2 @ 30	Y
	CT-3A/3B (Backup)	Crossflow, Draw Thru	BAC IMT	N/A	75	4,200	95	85	2 @ 25	Y
	CT-4A/4B/4C	Crossflow, Draw Thru	Marley NC8310H	2008	72	7,200	90	80	3 @ 60	Y

CHW Pumping

The chilled water pumping system comprises of three (3) primary CHW pumps (CHP-2, CHP-3, and CHP-4) serving the central plant chillers. CHP-2 is dedicated to CH-2 and is constant volume, delta T through the chiller is maintained by a bypass loop around the chiller. CHW pumps CHP-3 and CHP-4 are piped in parallel to serve both chillers CH-3 or CH-4 and operate on variable speed drives. In addition, there are four (4) variable-speed secondary CHW pumps (CHPS-1, CHPS-2, CHPS-3 and CHPS-4) that are piped to share a common header. CHPS-3 however does not match the other pumps and is locked out from use leaving the remaining three pumps to carry the load.

There are four (4) condenser pumps (CDP-1, CDP-2, CDP-3, and CDP-4) associated with the plant. CDP-1 and CDP-2 are turbine pumps that serve CH-2 and are piped in parallel. These pumps are constant volume. CDP-3 and CDP-4 are horizontal split case pumps that operate on variable speed drives and are each dedicated to CH-3 and CH-4, respectively.

TES Tanks

	Tag No.	Manufacturer	Year Installed	Dimensions (D x H, ft)	Capacity (Gallons)	Capacity in Ton-hours (Design ΔT)	Design ΔT	Max. Charge (GPM)	Max. Discharge (GPM)
Central Plant	TES-1	CBI	1993	52 x 68	1,080,000	15,000	39°F - 63°F	4,945	5,040

	TES-2	CBI	2008	52 x 68	1,080,000	15,000	39°F - 63°F	4,945	5,040
Total					2,160,000	30,000		9,890	10,080

CHW Pumps

	Tag No.	Manufacturer	Service (Loop)	Head (Ft.)	Flow (GPM)	Motor Power (HP)	VFD
Central Plant	CHP-1	Removed	-	-	-	-	-
	CHP-2	-	Primary CH-2	40	1,500	25	N
	CHP-3	Bell & Gossett	Primary CH-3. CH-4	60	1,800	50	Y
	CHP-4	Bell & Gossett	Primary CH-3. CH-4	60	1,800	50	Y
	CHPS-1	Bell & Gossett	Secondary	100	2,520	125	Y
	CHPS-2	Bell & Gossett	Secondary	100	2,520	125	Y
	CHPS-3 (Locked Out)	Bell & Gossett	Secondary	180	2,000	150	Y
	CHPS-4 (Stand-by)	Bell & Gossett	Secondary	100	2,520	125	Y

CW Pumps

	Tag No.	Manufacturer	Service (Loop)	Head (Ft.)	Flow (GPM)	Motor Power (HP)	VFD
Central Plant	CDP-1	-	Chiller CH-1	-	-	-	-
	CDP-2	-	Chiller CH-2	-	-	-	-
	CDP-3	Bell & Gossett	Chiller CH-3	60	3600	75	Y
	CDP-4	Bell & Gossett	Chiller CH-4	60	3600	75	Y

CHW Distribution

The chilled water is distributed via a combination of insulated SCH 10 and SCH 40 steel piping and pre-insulated C-900 piping. Steel piping is used in the underground utility tunnels while C900 piping is used in the direct-buried main distribution. The utility tunnel starts at the HVAC Central Plant and terminates at Student Union (Bldg. 22) with the rest of the loop utilizing direct buried piping. The tunnel piping is SCH 10 from the Central Plant up to AV-4 where it continues onward with SCH 40 piping. The central CHW loop has 16-inch piping with laterals originating from these mains to serve each of the buildings on campus.

In speaking with the campus facilities staff, the following topics were mentioned about the CHW distribution.

- The main campus chilled water lines are steel and pre-insulated C-900 pipes, with some steel pipes close to 50 years old. There is concern that the SCH 10 pipes will fail due to their age. Below is a summary of the older pipe sections on campus.
  - SCH 10 main campus distribution within the utility tunnels up to AV-4, circa 1967.
  - Distribution main to Biological Sciences (Bldg. 7), Physical Sciences (Bldg. 8), circa 1967.
- There have been the following reported issues with chilled water piping at the following locations:
  - Lateral piping to Performing Arts (Bldg. 21) undersized.
  - Failures at pipe hanger locations within utility tunnel.
  - The SCH 10 16" and 18" piping is beginning to collapse upon itself and become "oblong".
  - There have been failures in the SCH 10 piping at AV-4 which serves as an anchor point for the lines.
- There is a lack of isolation valves on the CHW distribution, particularly on the mains.
- There are several vaults where the isolation valves are old and do not seat properly.

A chilled water distribution piping plan providing chilled water pipe routing and sizes is provided at the end of the section.

CHW Load Analysis

Building No.	Building	Principal Operation Type	Year Built	Area (SF)	SF/Ton	Estimated Average Peak Load (Tons)	Adjusted Average Peak Load (Tons)	Design ΔT (˚F)	Peak Flow (GPM)	Connection Size (in)
1	Administration	Office	1965	22,259	850	26	19	24.0	19	4
2	Sierra Hall	Office	1965	21,237	850	25	18	24.0	18	4
3	Chaparral Hall	Classroom	1964	22,611	500	45	32	24.0	32	3
5	Central Plant	Central Plant	1967	13,510	1000	14	10	24.0	10	18/16
6	Animal Plant / Vivarium	Lab	1968	9,370	350	27	19	24.0	19	
7	Biological Sciences	Lab	1968	52,700	350	151	107	24.0	107	8
8	Physical Sciences	Lab	1967	51,450	350	147	105	24.0	105	6
9	Library	Library	1994	167,816	350	479	341	24.0	341	8
9a	Library Addition	Library	1994	129,600	350	370	264	24.0	264	6
10	Physical Education	Gym	1968	42,309	250	169	121	24.0	121	4
19	Commons	Cafeteria	1972	31,812	500	64	45	24.0	45	5
20	Performing Arts	Theater	1977	54,858	450	122	87	24.0	87	4
21	Health Center	Health Center	1979	22,600	600	38	27	24.0	27	2
22	Student Union	Multi Use	1977	86,414	850	102	72	24.0	72	
25	Faculty Office Building	Office	1988	22,263	850	26	19	24.0	19	2-1/2
26	University Hall	Office	1991	138,831	850	163	116	24.0	116	8
28	Brown Hall	Office	1993	131,496	850	155	110	24.0	110	8
32	Visual Arts Center/Museum of Art	Classroom	1996	92,676	500	185	132	24.0	132.0	6
32a	Fullerton Museum of Art	Classroom	1996	6,660	500	13	9	24.0	9.5	BLDG 32
34	Health & Physical Education A	Gym	1995	155,174	250	621	442	24.0	442	8
34a	Health & Physical Education B	Lab	2009	2,649	350	8	5	24.0	5	BLDG 34
36	Social & Behavioral Sciences	Classroom	2002	138,700	500	277	198	24.0	198	
37	Chemical Sciences	Lab	2006	57,587	350	165	117	24.0	117	

38	College of Education	Classroom	2008	130,000	500	260	185	24.0	185	6
	Total			1,604,582		3,651	2,600	24.0	2,600	

CHW Age and Reliability

CH-2 was installed in 2005 and was completely renovated in the last few years by Trane leaving it in good condition. Chillers CH-3 and CH-4 were both installed in 2008 and are in good condition. Per industry standards, chillers/boilers have a life expectancy of approximately 25 years with regular maintenance.

Cooling Towers CT-1A/B and CT-2A/B are wooden towers that are outdated and have visible signs of deterioration and need to be replaced. CT-1A/B is no longer in operation as CH-1 is no longer in operation due to AB32 and AQMD restrictions and has not been run in at least 5 years. If CT-2A/B were to fail CH-2 would be lost. CT-3 serves as a back-up to CT-4 and is in fair condition but has not been run in several years. CT-4 was installed in 2008 and is in good condition.

The original 1960's CHW mains within the utility tunnel are insulated steel pipes, as mentioned in the distribution section the SCH 10 sections are beginning to fail and should be replaced. The direct-buried CHW lines are pre-insulated C900 piping and are in good condition

Chilled Water Redundancy

The existing three chillers are capable of providing a total of 3,200 tons instantaneous cooling capacity and are able to meet the peak cooling demands of the campus. Should one of the in-series chillers fail, the campus does not have adequate capacity to meet their peak cooling demands and charge the TES tank during the off-peak hours. Should CH-2 fail the campus would still be able to sustain the cooling load assuming the TES tanks are fully charged over the weekend and during non-peak periods.

The primary chilled water pumps serving the CH-3 and CH-4 are piped in parallel and are each sized for 1,800 GPM. Should one of the pumps fail, they would not be able to meet the peak CHW flow rate of 2,400 GPM. The secondary pumps are piped in parallel with all chillers and are adequate to meet the needs of the system if one should fail.

The condenser water pumps serving CH-3 and CH-4 are piped directly to the chiller. Should one of these pumps fail, the respective chiller would not be able to operate and the campus would not have adequate capacity to meet their peak cooling demands and charge the TES tank during the off-peak hours. This issue can be mitigated by installing a header between the two feeds on the discharge side of the pumps.

The condenser water pumps serving CH-2 are piped in parallel with a common header. Should one of the pumps fail, the remaining pump can meet the flow requirements of the chiller and thus offer redundancy.

Cooling tower CT-1 is no longer in operation and should be replaced to provide the Central Plant with additional capacity and redundancy as CT-2 is currently in very poor condition compromising the redundancy available at CH-2.

In the event that the 16” or 18” SCH 10 CHW mains burst the chilled water service to the entire campus will be interrupted for most likely a day and potentially for a longer time span. Buildlings 6, 7, 8 and 37 will potentially be interrupted for up to 3-4 days until temporary services or repairs may be established.

CHW History of Outages / Disruption of Service

There have been failures at the SCH 10 piping in the tunnel by AV-4 in the past where the piping was ruptured due to the thin walls and age of the pipe. No other failures have been noted.

HHW Generation

The heating hot water generation at the plant comprises of three (3) Simoneau Aquatube high temperature hot water generators (HWG) installed in 2011. Hot water generators HWG-1 and HWG-2 are rated for 25 MMBH output and HWG-3 is rated for 10 MMBH output. The boilers have a rated efficiency of 83% and are in good condition.

The HHW system also feeds a heat exchanger located at the plant that produces domestic hot water (DHW) for the majority of the office/classroom buildings that are located off the utility trench on campus (the science buildings have their own heat exchangers to produce DHW).

There is a fuel cell that was installed by the utility company in 2013. The fuel cell generates hot water as a by-product that is used to pre-heat the water by approximately 2 MMBH which is sufficient to carry the campus load during the summer months. The fuel cell is not operated by the campus but is in good condition.

HHW Pumping

The heating hot water pumping system at the plant comprises of three (3) variable-speed Concoran high temperature hot water pumps (HTWP-1, HTWP-2, HTWP-3). The pumps are operated as constant speed pumps due to the high minimum flow requirements of the boiler manufacturer and are piped in parallel with a common header.

Boilers

	Tag No.	Boiler Type	Mfr	Year Installed	Primary Source of Energy	Input (BTUH)	Output (BTUH)	Published Efficiency	Turn down Ratio	Blower HP	Flow rate (GPM)	HHW EWT (F)	HHW LWT (F)	HHW Delta T (F)
Central Plant	HWG -1	Forced Circulation - Water Tube	Simoneau Aquatube	2011	Natural Gas	30,100,000	25,000,000	83.6	N/A	40	516	300° F	450°F	150°F
	HWG -2	Forced Circulation - Water Tube	Simoneau Aquatube	2011	Natural Gas	30,100,000	25,000,000	83.6	N/A	40	516	300° F	450°F	150°F
	HWG -3	Forced Circulation - Water Tube	Simoneau Aquatube	2011	Natural Gas	12,200,000	10,000,000	83.3	N/A	15	206	300° F	450°F	150°F
Campus Grand Total						72,400,000	60,000,000							

HHW Pumps

	Tag No.	Manufacturer	Service (Loop)	Head (Ft)	Flow (GPM)	Motor Power (HP)	VFD
Central Plant	HTWP-1	R.S. Corcoran	High Temp HW	200	516	50	Y
	HTWP-2	R.S. Corcoran	High Temp HW	200	516	50	Y
	HTWP-3	R.S. Corcoran	High Temp HW	200	206	30	Y

HHW Distribution

The heating hot water is distributed via insulated steel piping, direct buried and in underground utility tunnels. The piping in the tunnels is SCH 40 black steel pipe with Class 300 fittings and is insulated. The direct buried piping is of the same construction but is ran in a conduit system which utilizes insulation and an air gap to minimize thermal energy losses. Within the utility tunnel ball joints are mainly used to accommodate thermal expansion whereas hard piping loops are used where the pipe is direct buried with the conduit system. Thermal expansion has become less of an issue since the implementation of the Fuel Cell as the piping system is never truly allowed to cool down keeping it in a warm "expanded" state and relieving stress from the system.

The utility tunnel starts at the HVAC Central Plant and terminates at the Student Union (Bldg. 22). The central HHW loop has 10-inch piping with laterals originating from these mains to serve each of the buildings on campus.

In speaking with the campus facilities staff, the following topics were mentioned about the HHW distribution.

- The main campus heating hot water lines are steel pipes, with some sections close to 50 years old. There is concern that these pipes will fail due to their age. Below is a summary of the older pipe sections.

  - Main campus distribution within the utility tunnels.
  - Distribution main to Biological Sciences (Bldg. 7), Physical Sciences (Bldg. 8), circa 1967.
  - Lateral piping to John M. Pfau (Bldg. 9), circa 1971.
  - Lateral piping to Commons (Bldg. 19), circa 1972.
  - Lateral piping to Performing Arts (Bldg. 20), circa 1977.
  - Lateral piping to Health Center (Bldg. 21), circa 1979.
- There have been the following reported issues with heating hot water piping:
  - Direct buried lateral piping to Visual Arts Center (Bldg. 32) has an air casing failure.
  - Direct buried lateral piping to Performing Arts (Bldg. 20) has an air casing failure.
  - Ball joints are being replaced due to failure, currently approximately 90% of the ball joints have been replaced in the last 5 years but the remaining ball joints should be replaced.
- There is a lack of isolation valves on the HHW distribution, particularly on the mains.
- There are several vaults where the isolation valves are old and do not seat properly.

A heating hot water distribution piping plan providing pipe routing and sizes is provided at the end of the section.

HHW Age and Reliability

All (3) boilers were installed in 2011 and are in good condition.

The original 1960's HHW mains within the utility tunnel are insulated steel pipes. The direct-buried HHW lines are steel piping ran in a conduit system; the oldest section installed in the 1970's. There have been reported HHW pipe failures at the pipe hangers due to expansion/contraction of the pipes, as well as a few ball joint failures. Continual maintenance/replacement of said hanger and ball joints will considerably relieve stress on the system.

HHW Redundancy

The existing boilers are capable of providing adequate capacity to meet the peak demands of the campus and are adequately sized to meet the heating demands of the campus. Should one of the boilers fail, the remaining boilers can meet the peak heating demands of the facilities. In addition, should one of the heating hot water pumps fail, the remaining pumps can meet the flow requirements of the facilities and thus offer redundancy.

HHW History of Outages / Disruption of Service

Aside from leaks at ball joints which have led to disruptions in service to the campus facilities there have been no major failures in the HHW system.

There are however cycling issues with the generators caused by failure of the makeup water pump which feeds the expansion tank system. The system may be manually reset without issue but causes interruptions in service that the operators must attend to and should be repaired.

Dedicated Building Systems

In addition to the Central Plant, a few of the facilities have dedicated chillers and boilers that meet the cooling and heating needs of these facilities. These systems are summarized below by each facility:

Student Recreation Center (Bldg. 39)

There are two (2) 135-ton Carrier 30HXC chillers and two (2) 1,140-input MBH natural gas-fired Parker HHW boilers that meet the cooling and heating demands of the facility respectively. The boilers were installed in 2005. The boilers and chillers are in good condition.

NATURAL GAS SYSTEMS

Natural gas is supplied to the University by The Southern California Gas Company (SCG) through a long term transportation agreement with the Department of General Services (DGS). There are several utility-owned natural gas meters on campus. The following is a summary and description of these utility meters.

One (1) meter to service the Central Plant equipment and the other meter to provide gas to individual buildings on campus. Both meters are located at the Central Plant.

One (1) meter serving the Health & Physical Education Complex. This meter also serves the campus pool.

One (1) meter serving the Administration Building, Children’s Center, Chaparral Hall, and Sierra Hall

One (1) meter serving the Commons

One (1) meter serving the Student Recreation & Fitness Center

In addition, there are several utility meters for student housing on campus. The following is a summary of these meters

Three (3) meters serving the Visual Arts Center.

One (1) meter serving Yasuda Center for Extended Learning

One (1) meter serving the Arrowhead Village

One (1) meter serving the Serrano Village

Four (4) meters serving the University Village and Clubhouse

There are two (2) connections to the SCG’ s high pressure mains on W. Northpark Blvd; one on Sierra Drive and the other on Coyote Drive.

Gas downstream of the meter is distributed at high pressure, approximately 10 psig throughout the campus. The high pressure gas is reduced to low-pressure gas at building connections via gas pressure regulators installed either above grade or in underground vaults. The low-pressure gas is then piped to serve hot water boilers and domestic water heaters that provide space heating in certain buildings and domestic hot water needs of the facilities respectively. Natural gas is also used for dedicated boilers at various campus buildings for generating steam and industrial hot water.In speaking with the campus facilities staff, the following gas distribution issues were discovered.

- The main campus natural gas lines are steel pipes, with some sections are close to 50 years old. Below is a summary of the older pipe sections.
    - Main campus distribution from the central plant and within the utility tunnels.
    - Distribution piping to Administration (Bldg. 1), Sierra Hall (Bldg. 2) and Chaparral Hall (Bldg. 3), circa 1965.
    - Distribution main to Biological Sciences (Bldg. 7), circa 1968.
    - Distribution main to Physical Sciences (Bldg. 8), circa 1967.
    - Lateral piping to the Library (Bldg. 9), circa 1971.

  - Lateral piping to Performing Arts (Bldg. 20), circa 1977
  - Lateral piping to Physical Education (Bldg. 10), circa 1968.
  - Distribution piping to Serrano Village
- The campus does not have a preventative maintenance schedule to exercise the campus gas isolation valves. There have been reported leaks on campus at the following locations:
  - Campus main adjacent to Animal House (Bldg. 6)
  - Lateral piping on steel and polyethylene (PE) lines serving Facilities Management buildings.
- Polyethylene (PE) has been used as the pipe material for all gas line replacements and new installations

Dedicated Boilers are provided in the Student Recreation and Fitness Center for generating domestic hot water. Dedicated boilers are also provided in the Arrowhead Village and the Yasuda Center for Extended Learning for water-source heat pump applications.

A natural gas distribution plan providing pipe sizes and routing of gas lines is provided at the end of the section.

A model for the overall natural gas piping infrastructure system has been generated and was evaluated for the system capacity. From this model it was calculated that piping segments serving buildings consume approximately twenty-five (25%) percent of the piping capacity. The buildings that are included within this range are Environmental Health and Safety, Auto Fleet Services, Facilities Services Storage, Animal House/Vivarium, San Manuel Residence Hall, Serrano Hall, Badger Residence Hall, Children's Center, Yasuda Center For Extended Learning, Arrowhead Village A, and Arrowhead Village B.

The piping segments that are above the twenty-five (25%) percent of the piping capacity are Administration, Sierra Hall, Chaparral Hall, Facilities Management, University Public Safety, Plant/Central Warehouse, HVAC Central Plant, Biological Sciences, Physical Sciences, Physical

Education, Today Residence Hall, Johshua Residence Hall, Mojave Residence Hall, Morongo Residence Hall, Water man Residence Hall, Shadin Residence Hall, Commons, Performing Arts, Santos Manuel Student Union, Coyote Bookstore, Visual arts, Health & Physical Education A, Chemical Sciences, Student Recreation & Fitness Center, and Administration Services.

Age and Reliability

The core of the campus gas infrastructure was installed in the 1960's. These original gas lines are steel pipes and are located within the original utility tunnel. The distribution system throughout the campus has undergone extensions over the years to accommodate campus expansions and additions. These additions are direct-buried and within vaults utilizing a combination of steel and polyethylene (PE) pipes. Sections of the old steel lines are experiencing leakages and are at the end of their useful life.

The campus has performed periodic leak surveys on the campus gas infrastructure. There have been a few leaks discovered and repairs made on each leak. The most recent leaks were repaired adjacent to Animal House.

The newer buildings on campus have earthquake valves installed; observed at the Student Recreation & Fitness Center. The older buildings do not have earthquake valves and need the same to meet current codes.

There are limited isolation valves on the gas infrastructure. The absence of isolation valves results in shutting down majority of the gas infrastructure and associated facilities to isolate a portion of the gas line in event of a leakage. Provision of new isolation valves and replacement of existing valves will help the campus isolate a section of the piping in event of its leakage.

Currently, the campus does not have a maintenance schedule to exercise the gas isolation valves.

Redundancy

There is a single utility-owned gas meter located at the central plant that serves the majority of the buildings on campus. In addition, there are several individual utility-owned gas meters throughout the campus.

History of Outages / Disruption of Service

There have been no reported failures or disruption of service from SCG for the last five years. However, the campus has had leaks on the older steel gas line distribution over the years due to its age and condition.

Existing Natural Gas Loads

Based on utility meter data from June 2012 through May 2013, the total campus gas usage was approximately 1,155,000 therms. The cost to the campus over the same period is approximately $852,000. See Table 1 for campus gas usage by utility meter.

Table 1 – Utility Meter Loads

Meter Name	Meter No.	Load (Therms)
Main Campus - Non Core		
DGS Main Meter	5026253	383,949
Bldgs: BI, BK, CS, FM,PA, PL, PS, SB, SU	13983470	15,045
Main Campus Utility Meters		
Bldgs: HP, PE, Pools	13485652	68,319
Bldgs: AD, CC, CH, SH	12992806	8,386
Commons	10583237	4,744
Student Recreation & Fitness Center	10139508	11,845
Visual Arts Center - Building 1	11006023	975
Visual Arts Center - Building 2	04168610	297
Visual Arts Center - Building 3	10575958	36,133
Yasuda	05024681	795
Total		530,488

Table 2 provides a summary of building heating and domestic connected load demands. For non-metered buildings, the demand load is estimated based on building square footage and building usage type.

Bldg No.	Building Name	Building Tag	Occupancy Type	Gross Area (Sq. Ft.)	Heating Load Factor (BTUH/sq.ft .)	Estimated Heating Load (CFH)	Estimated Domestic Load (CFH)	Total Gas Load (CFH)
Main Campus Utility Meter:								
1	ADMINISTRATION	`	Administration	22,259	15	334	33	367
2	SIERRA HALL	SH	Administration	21,237	15	319	32	350
3	CHAPARRAL HALL	CH	Humanities	22,611	15	339	34	373
4	FACILITIES MANAGEMENT	FM	Corporation Yard	22,969	15	345	34	379

4A	ENVIRONMENTAL HEALTH AND SAFETY	ES	Corporation Yard	3,115	15	47	5	51
4B	UNIVERSITY PUBLIC SAFETY	UP	Corporation Yard	7,483	15	112	11	123
4C	AUTO FLEET SERVICES	AF	Corporation Yard	2,851	15	43	4	47
4D	PLANT/CENTRAL WAREHOUSE	PW	Corporation Yard	12,390	15	186	19	204
4E	FACILITIES SERVICES STORAGE	FS	Corporation Yard	1,212	15	18	2	20
5	HVAC CENTRAL PLANT	HA	Central Plant	13,510	15	203	20	223
6	ANIMAL HOUSE/VIVARIUM	AH	Science	9,370	15	141	14	155
7	BIOLOGICAL SCIENCES	BI	Science	52,700	15	791	79	870
8	PHYSICAL SCIENCES	PS	Science	51,450	15	772	77	849
9	JOHN M. PFAU LIBRARY	PL	Library	167,816	15	2,517	252	2,769
9A	PFAU LIBRARY ADDITION	PL	Library	129,600	15	1,944	194	2,138
10	PHYSICAL EDUCATION	PE	Physical Education	42,309	15	635	63	698
10A	PHYSICAL EDUCATION	PE	Physical Education	800	15	12	1	13
11	TOKAY RESIDENCE HALL	TR	Dormitories	13,234	15	199	20	218
12	SAN MANUEL RESIDENCE HALL	SMR	Dormitories	13,234	15	199	20	218
13	JOHSHUA RESIDENCE HALL	JR	Dormitories	13,234	15	199	20	218
14	MOJAVE RESIDENCE HALL	MR	Dormitories	13,234	15	199	20	218
15	MORONGO RESIDENCE HALL	MRR	Dormitories	13,234	15	199	20	218
15A	SERRANO VILLAGE	SR	Nonstate	1,552	15	23	2	26
16	WATERMAN RESIDENCE HALL	WTR	Dormitories	13,234	15	199	20	218
17	BADGER RESIDENCE HALL	BR	Dormitories	13,234	15	199	20	218
18	SHANDIN RESIDENCE HALL	SHR	Dormitories	13,234	15	199	20	218
19	COMMONS	CO	Cafeteria	31,812	15	477	48	525
20	PERFORMING ARTS	PA	Theater Arts	54,858	15	823	82	905
22	SANTOS MANUEL STUDENT UNION	SU	Coll/Univ Union	86,414	15	1,296	130	1,426
23	COYOTE BOOKSTORE	BK	Bookstore	12,679	15	190	19	209
23A	BOOKSTORE ADDITION	BK	Bookstore	4,872	15	73	7	80
24	CHILDREN'S CENTER	CC	Day Care Center	2,732	15	41	4	45
30	YASUDA CENTER FOR EXTENDED LEARNING	YC	Extended Education	19,000	15	285	29	314

31	ARROWHEAD VILLAGE A	AV	Apartments	103,142	15	1,547	155	1,702
31A	ARROWHEAD VILLAGE B	AV	Apartments	107,501	15	1,613	161	1,774
32	VISUAL ARTS CENTER	VA	Art	92,676	15	1,390	139	1,529
32A	ROBERT AND FRANCES FULLERTON MUSEUM OF ART	VA	Art	6,660	15	100	10	110
34	HEALTH & PHYSICAL EDUCATION A	HP	Physical Education	155,174	15	2,328	233	2,560
34A	HEALTH & PHYSICAL EDUCATION B	HP	Science	2,649	15	40	4	44
37	CHEMICAL SCIENCES	CS	Science	57,587	15	864	86	950
39	STUDENT RECREATION & FITNESS CENTER	SR	Auxilliary	34,400	15	516	52	568
43	ADMINISTRATIVE SERVICES	AS	Corporation Yard	14,090	15	211	21	232
50A	MURILLO FAMILY OBSERVATORY	OB	Science	2,690	15	40	4	44
75	UNIVERSITY VILLAGE HOUSING	UV	Apartments	170,306	15	2,555	255	2,810
209	TEMPORARY MODULARS - FACULTY	TO	Faculty Office	6,336	15	95	10	105
212	TEMPORARY MODULARS - FACULTY	TC	Classroom - General	4,032	15	60	6	67

ELECTRICAL SYSTEM

California State University, San Bernardino is currently served from a 12kV distribution system. The campus derives its power from Southern California Edison from an underground 12kV distribution located on the south west side of the campus. The service serves 12kV switchgear located in an enclosure on the south west side of the campus. The switchgear is located inside a walk in enclosure and is equipped with a 2500A main breaker and two 1200A feeder breakers.

The switchgear is equipped with a 2500A main beaker, SQ-D 7550 metering sections, relays and two 1200A feeder breakers. Two 12kV feeders (Feeders '1' and '2') originating from this switchgear provide a primary selective system through 15kV selector switches and serve power to various buildings and facilities on campus. Dual feeders originating from 15kV selector switches serves substation(s) in each building on campus that meet the power demands of the building.

An electrical site plan showing locations of substations, manholes and routing of circuits throughout the campus is provided at the end of this section. All conduits are 4" and are encased in concrete. Table 1 summarizes the installed capacities in kVA of each substation feeder. The University owns and maintains the 12kV switchgear, 15kV substations, 15kV distribution network, and the substations located in each building. A single line diagram of the campus is also enclosed at the end of this section.

The main 12kV switchgear was installed at campus inception and is over 45 years old. The switchgear is at the end of its life and the main and feeder breakers are at the end of their life. Majority of the selector switches are located in underground tunnel vaults. The selector switches are old and have outlived their life. A few of the selector switches are located above ground and in manholes.

The campus also has a ground mount 750kW PV system installed on the north-west side of the campus and roof mounted PV systems on Buildings 10, 34 and 38 amounting to approximately 460kW. The campus also has a 1.4MW Fuel Cell Plant that is installed on the north side of the existing Central Plant. These systems offset the overall peak demand of the campus.

Electrical Distribution System

The campus main 15kV distribution system is made up of 15kV, ‘3’ conductor 500MCM EPR cables installed in 5’ concrete encased duct banks that traverse through conduits and manholes to serve 15kV SF6 selector switches located on campus. Dual feeders originating from these selector switches and sized to individual building loads serve each building’s substation. Feeder ‘1’ was installed at campus inception and is over 45 years old. Feeder ‘2’ was installed in early 1990’s and is over 20 years old. The 15kV feeders thus are at the end of their life. The campus conducted a partial discharge test on their existing 15kV feeders in October 2013. The tests revealed that sections of both the existing feeders showed partial discharges higher than normal thus indicating that the existing medium voltage distribution system is old and will thus need to be replaced. Table 1 provides the installed capacities in kVA on each of the feeders originating from the 12kV switchgear. Similarly, the existing emergency generators and the facilities they serve are shown in Table 3. The campus has standardized on SQ-D ION 7350 meters for each of their substations in individual buildings to monitor energy consumption.

The campus has a primary selective system and majority of the buildings at the campus are served from two feeders. In case of a failure of one of the feeders, the current system allows the campus to switch over to the alternate feeder. A few of the buildings on campus are served from radial feeders and do not have the option of being served from an alternate feeder in event of a failure of one of the feeders. A few of the campus distribution system on the east side comprises of old transite conduits. The existing distribution system is adequately sized to meet the current demands of the campus. Substations and Main distribution boards in few of the buildings were found to be old, had experienced maintenance issues and need to be replaced. These include buildings ‘09’, ‘17’, ‘19’, ‘20’. ‘24’ and ‘25’. The substations in these buildings are over 40years old, spare parts are difficult to find and are at the end of their useful life. A fault on an older substation will result in the tripping of the main 15kV breaker since the substation breakers are old and are unable to trip on a fault. This will result in either a campus wide shut down or shuts down power to a group of buildings depending on the actual fault.

A few of the selector switches installed in manholes get flooded and provide an unsafe condition to the maintenance personnel accessing these switches for either switching of feeders.

Current Campus Connected Load and Demand

The current installed capacity of the campus is 36,625kVA and the maximum demand of the campus is approximately 4,7MVA which occurred in 2013 during the month of Ma. Approximately 2.1MW of the total demand is currently met by the existing Photovoltaic system and the Fuel Cell Plant. The existing distribution system is adequately sized to meet the current demands of the campus.

Table 1 provides the installed capacities and demand in kVA for each of the facilities on the two 12kV feeders originating from the 15kV switchgears. Similarly, the existing emergency generators and the facilities they serve are shown in Table 3. The campus currently has one electrical meter and is under the TOU-8 rate offered by Southern California Edison.

The total energy consumption of the campus per year for year 2012-2013 was approximately 26.3million kWh.

The charts below provide the purchased kWh over the past year, main meter peaks and total electrical cost variation from June 2012 to May 2013.

A single line diagram for the campus is enclosed at the end of the section for your reference.

Age and Reliability

The main 15kV switchgear and majority of the associated medium voltage cables that form part of the distribution system have outlived their useful life and are in need of replacement. Majority of the electrical distribution system and the main switchgear was installed in 1970's and thus is susceptible to failures and does not provide a reliable means of service to each of the buildings on campus. A few of the older buildings also have old substations and associated main service switchboards that are at the end of their useful life and spare breakers for these equipment are difficult to find. These substations do not provide a reliable means of service to the facilities they currently serve.

Discussions with campus personnel revealed that the campus undertook a formal Preventive Maintenance program for their main switchgear in 2008. However, this did not include individual building substations/transformers.

A survey of the existing substations in each of the buildings revealed that the campus has conducted a short circuit and arc flash study of their existing system and currently has arc flash labels on each of the electrical equipment.

History of Outages

Discussions with facilities staff revealed that the campus had experienced a fault in 2011 from a fault in their medium voltage distribution. The campus has not experienced any fault from the utility company in the last five years.

Redundancy

The campus currently has a primary selective system comprising of two 15kV feeders originating from the main switchgear and traversing through dual 15kV switches located in individual buildings to serve power to various buildings and facilities on campus. The circuits traverse through manholes and duct banks to serve each of the facilities on campus. Majority of the facilities on campus have the ability to be served from either of the feeders through existing selector switches and the system offers redundancy should one of the feeder fails or is taken down for maintenance.

Although, the campus has a single feed from the utility company, there have been no outages from the utility side over the past one and a half years and hence the utility service is considered reliable.

Existing Installed Capacities by substation/feeder

Feeders	Installed Capacity in KVA
Feeder '1'	17,400
Feeder '2'	19,225

Location	Meter Number	Account Number	Tariff
Electrical Enclosure	C37468	4887162489-5	E2OP
Tree Farm	397A41	4680433720	A-1
Gas Engine Control	3A261	4961470930	A-1

Existing Generators

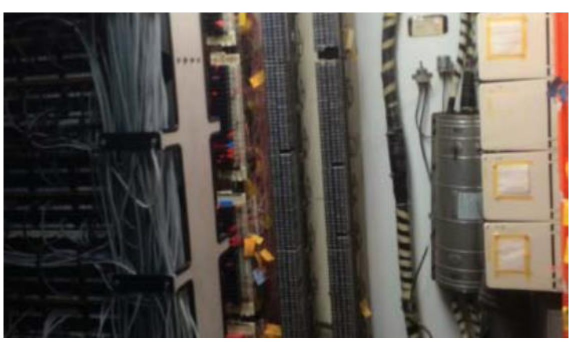
Building/Area	Make and Model	Type	Year	Size
Student Health Center	Onan	Diesel Generator	1999	53.6kW
Central Plant	Generac	Diesel Generator	1986	20kW
University Police	Onan	Diesel Generator	1998	23.5kW
Icardo Center	Generac	Diesel Generator	1986	15kW
Library	Caterpillar	Diesel Generator	2003	250kW
Science 2	Olympian	Diesel Generator	2005	20kW
Education	Onan	Diesel Generator	1999	6.5kW

Bldg #	ID	Building Name	Installed Capacity In KVA	Approximate Max. Demand in KVA	Feeder
1,2, 23, 24 and 3	AD, SH, BK, CC and CH	Administration, Sierra Hall, Coyote Bookstore, Children's Center and Chaparral Hall	750	150	Feeder 2
31	AV	Arrowhead Village	3,750	750	Feeder 2
7	BI	Biological Sciences	1,000	200	Feeder 2
37	CS	Chemical Sciences	1,500	300	Feeder 2
38	CE	College of Education	2,000	400	Feeder 2
19	CO	Commons	500	100	Feeder 2
25	FO	Faculty Office Building	225	45	Feeder 2
41	FB	Foundation Building	300	60	Feeder 1
4, 4A, 4B, 4C, 4D and 43	Fm, EHS, UP, AF, PW and AS	Facilities Management, EHS, University Police, Auto Fleet, Plant/Central Warehouse, Administrative Services	1,000	200	Feeder 2
34	HP	Health and PE Complex/Coussoulis Arena	1,500	300	Feeder 2
21	HC	Health Center	300	60	Feeder 1
5	HA	HVAC Central Plant, Animal House/Vivarium	4,500	900	Feeder 1
28	JB	Jack H. Brown Hall	1,500	300	Feeder 1
9	PL	John M Pfau Library	3,000	600	Feeder 2
102	PK1	Parking Structure East	300	60	Feeder 1
101	PK1	Parking Structure West	1,000	200	Feeder 1
20	PA	Performing Arts/Theater/Recital Hall	750	150	Feeder 1
10	PE	Physical Education	1,500	300	Feeder 1
8	PS	Physical Sciences	1,000	200	Feeder 1
22	SU	Santos Manuel Student Union	750	150	Feeder 1
15A	SV	Serano Village	1,500	300	Feeder 2
36	SB	Social and Behavioral Sciences	2,500	500	Feeder 1
39	SB	Student Recreation and Fitness Center	1,000	200	Feeder 1
201-209	TC and TO	Temporary classrooms and Offices	500	100	Feeder 2
26	UH	University Hall	2,000	400	Feeder 2
32	VA	Visual Arts Center/Robert V. Fullerton Art Museum	2,000	400	Feeder 1
Total Capacity/Demand			36,625	6,010	

TELECOMMUNICATIONS

CSUSB completed the construction of a campus-wide telecommunications infrastructure upgrade project in compliance with the CSU Telecommunications Infrastructure Planning Standards (TIP) in 2005 . This project provided for the construction of new underground conduit, copper, and fiber cable systems from each campus building to the MDF location in the Pfau Library. During the completion of the infrastructure project, the University also replaced the data electronics with a Cisco based data network.

The project provided for telecommunications infrastructure improvements inside the state-owned buildings. It provided new or upgraded telecommunications rooms to house cable terminations and electronic equipment for the voice and data networks. Both copper cable and fiber cable riser systems were provided between the main telecommunications room (BDF) of each building and the satellite rooms (IDFs) in each building. Existing voice and data outlets with obsolete cables were replaced with new outlets containing category 5e horizontal station cables. A baseline criterion for new outlets was implemented in lieu of the CSU TIP standards due to limited funding. Pathway systems consisting of j-hook support hangers, conduits, and wiremold were included to support the new station cables. After each building was cutover from the existing to new infrastructure systems, the obsolete cables and equipment were removed.



Telecommunications Applications

Voice Telephone System

Voice telephone service is provided over a campus owned and operated Cisco VoIP system that was first installed over 7 years ago. CSUSB was one of the first CSU universities to migrate to a VoIP system. During the implementation of telecommunications infrastructure upgrade project, the majority of equipment was reconfigured and relocated to the Main Distribution Frame (MDF) in the Pfau Library. The voice switching system currently has more than 5,000 working devices. The voice telephone system provides service to all campus buildings over the existing data network and associated backbone outside plant fiber cable system. The cable network connects the voice services in each campus building to the MDF building that houses the Cisco call manager.

Verizon is the Local Exchange Carrier (LEC) that provides off site service. The interconnection of the campus switching system and the Verizon network occurs in the MDF. Verizon fiber cables is extended to the MDF from a location at the south side of the campus at Northpark Boulevard. Verizon copper cable extends from Northpark Boulevard to the Administration Building, Building 1. Verizon provides T-1 and other trunk line services to the University over both copper and fiber cables from the local central office. The voice services are provided by Windstream over the Verizon fiber. Windstream will transport and complete all originating and terminating calls that are in the local service area. Long distance calls will be handed off to an inter-exchange carrier.

Additional incoming services include a Verizon fiber extended to the Facilities Management Building (Building 4) and a Charter fiber extended to the MDF location. This fiber is dedicated to the University’s Cenic internet network connection. Cenic equipment is located within the Building 4 BDF room. The Cenic connection is extended to the MDF over existing campus fiber cabling.

Emergency Telephone System

The University has an emergency telephone system that is connected to the University Public Safety building for continuous monitoring. The system includes Code Blue emergency telephones mounted in parking lot locations that can be used to report emergencies. There are also wall mounted emergency telephones normally located in corridors inside the buildings. Calls not answered by the University Public Safety are transferred to Riverside Community College (RCC) Police. The University has a contract with RCC to provide Public Safety coverage at the campus.

Data Communications System

The University' s data system originates at the Pfau Library and is distributed to all campus buildings. The major intra-campus network currently consists of Cisco 6509 and 6513 core switches and smaller 4500 series switches and 2900 series switches in the buildings. The University will undergo a data network equipment refresh over the summer of 2014. During this time all network equipment and wireless installations will be upgraded. The wireless system will be a new Aruba solution. The network equipment will be an Alcatel-Lucent solution to provide for 10 Gigabit speeds between the MDF and buildings. Alcatel-Lucent equipment will include OS6900 core switches with 10 and 40 Gigabit connectivity and OS4500 access layer switches. The data network will continue to utilize the existing fiber cable system to interconnect the campus buildings. The only exception to the use of fiber backbone cabling connectivity is the use of a wireless microwave system connection to the University Village Housing buildings. The University is using the microwave connection to route over Northpark Boulevard as there is no conduit path for fiber in this location.

Video System

The University has limited broadband video distribution on campus. An incoming service from Charter Communications is located at a Residence Hall location and is back fed to the campus serving only 4 or 5 buildings. The University has a dedicated broadcast video feed from Building 34 to Charter Communications.

Video surveillance for campus safety is run over the existing data network. IP cameras are connected to the network and available for live or recorded image viewing. Data traffic from cameras is on a dedicated VPN. Recorded images are stored on dedicated servers located in the data center.

Centralized Switching Facilities

The centralized switching facilities that support the voice and data networks are located in the Data Center in the Pfau Library. All campus buildings are connected to the MDF for connection to the campus wide network. All of the electronic equipment is typically connected between the buildings with underground fiber optic cables.

The MDF is located in the basement of the Pfau Library building. The building is multi-story with one level below grade and five levels above grade. The building is constructed with concrete and CMU type walls. The building supports library, administrative, classroom and data center functions. The MDF and data center house telecommunications equipment and contain all support systems to operate for 24 hours a day and seven days per week. The data center is equipped with dedicated floor mounted air conditioning units. The units operate in a scheduled sequence to provide redundancy and to maintain controlled environments.

The MDF and Data Center areas are connected to the campus electrical system that provides AC power to the telecommunications equipment and support systems. A dedicated emergency backup generator is installed with a capacity for operating the equipment up to 72 hours during a power outage.

Although the data center and MDF are located in a subterranean location, there is no significant concern with water infiltration or possible flooding.

MDF, Building #9, Pfau Library

The MDF, located in the basement of the Pfau Library, is collocated with the campus data center. There is a separate entrance room for the campus backbone copper and fiber cabling within the mechanical and electrical room areas and at a lower basement level. However all cabling is extended to the MDF racks located within the data center. This combined space includes approximately 3,500 square feet of raised floor space. Backbone cabling extends from the MDF entrance room to the underground tunnel via multiple 4" conduits. The conduit routes extend to two sections of the tunnel. One route extends to the tunnel section running east/west and the second route connects to the tunnel section running north/south.

This building also contains the Minimum Point of Entry (MPOE) that is the demarcation with Verizon Communications.

Interbuilding Pathways

The campus has a new underground conduit system that was constructed as part of the Telecommunications Infrastructure Upgrade Project that interconnects the MDF with the campus buildings. It also replaced or enhanced the original conduit system that was installed during the construction of the original campus buildings. The updated conduit system meets current CSU standards and it has sufficient capacity to meet the cable requirements for the proposed master plan building additions as well as the growth requirements for the next twenty-five years. However, the conduits that extend to the MDF are congested. There is minimal space in these conduit paths to support the installation of new cabling.

The installed conduit system was designed and constructed to the following standards:

1. Four inch diameter, PVC, conduits were installed between the new cable vaults. Conduits were encased in 2500 PSI concrete and covered with a minimum 24 inches of slurry or compacted dirt backfill.

2. A minimum of (4), four inch diameter conduits were installed into each existing, state-owned, building for cables terminated in the new telecommunications rooms. For some buildings, only two new conduits were provided if the existing conduits were reusable.

3. For building entrance conduits, PVC conduits outside the building transitioned to galvanized rigid conduits (GRC) at a location twenty-four inches from the building foundation. The GRC extended under the building foundation and penetrated the concrete building floor in the telecommunications room.

4. Conduits were terminated in new vaults designed for communications. The standard size vault was 6 ' wide x 12' long x 7 ' high. Each new vault was equipped with a traffic rated cover, permanent metal ladder, unistrut cable supports on the side walls, and a grounding rod.

The student housing on the south side of Northpark Boulevard, University Village Housing, is the only buildings without a direct conduit connection for communications cabling. The University currently connects to these buildings through the use of a wireless microwave solution.

The impacted conduit at the MDF is the most critical item associated with the inter-building pathways. The installation of new pathway conduit from the tunnel to the MDF would be expensive and potentially disruptive. It will be possible to gain space in the existing conduit by removing abandoned cabling or by consolidating multiple cables by splicing them in the tunnel and allowing for the installation of a single cable into the MDF.

Interbuilding Copper Cable

A new underground copper cable system was constructed as part of the Telecommunications Infrastructure Upgrade Project from each campus building to the MDF location. This new cable system was required to connect the telephones in each campus building with the centralized switching equipment prior to migrating to the use of VoIP. The copper cable system was designed for two cable pairs for each outlet which was the original CSU design standard. The cables are gel-filled outside plant cables with a polyethylene sheath. Table T1 in this Chapter shows cable sizes for the existing building entrance cables for all the campus buildings. All cables in the buildings and the MDF are terminated on Circa type protector panels. The typical installations in the buildings included protector panels wall-mounted on plywood backboards or in floor-mounted equipment racks.

The current backbone cabling is used mostly for analog circuit connectivity delivering dedicated POTS lines for fire alarm, elevator phones or other emergency services that require dedicated phone lines.

Interbuilding Fiber Cables

A new underground fiber cable system was constructed as part of the Telecommunications Infrastructure Upgrade Project from most campus buildings the MDF building. Each building is served with an underground hybrid fiber cable containing both singlemode and multimode fibers under one cable sheath. The average size cable is twenty-four optics with 12 singlemode optics and 12 multimode optics (62.5 micron). Cable sizes do vary with some of the larger buildings having 24 singlemode and 24 multimode. The fiber cables are installed in one inch diameter innerducts in the underground conduit system. Typically, four, one inch diameter innerducts are installed in one, four inch diameter conduit.

The table below shows fiber cable sizes for the existing building entrance cables for all campus buildings.

Existing Fiber Optic Entrance Cables, Cable Schedule

Bldg No.	Building Name	Bldg. Abbrev.	Building Entrance Cable Size (Pairs)
1	ADMINISTRATION	AD	
2	SIERRA HALL	SH	12MM/12SM
3	CHAPARRAL HALL	CH	24MM/24SM
4	FACILITIES MANAGEMENT	FM	24MM/24SM
4A	ENVIRONMENTAL HEALTH AND SAFETY	ES	
4B	UNIVERSITY PUBLIC SAFETY	UP	
4C	AUTO FLEET SERVICES	AF	
4D	PLANT/CENTRAL WAREHOUSE	PW	
4E	FACILITIES SERVICES STORAGE	FS	
5	HVAC CENTRAL PLANT	HA	12MM/24SM
6	ANIMAL HOUSE/VIVARIUM	AH	12MM/12SM
7	BIOLOGICAL SCIENCES	BI	24MM/24SM
8	PHYSICAL SCIENCES	PS	24MM/24SM
9	JOHN M. PFAU LIBRARY	PL	
9A	PFAU LIBRARY ADDITION	PL	
10	PHYSICAL EDUCATION	PE	12MM/12SM
10A	PHYSICAL EDUCATION	PE	24MM/24SM
11	TOKAY RESIDENCE HALL	TR	
12	SAN MANUEL RESIDENCE HALL	SMR	
13	JOHSHUA RESIDENCE HALL	JR	
14	MOJAVE RESIDENCE HALL	MR	
15	MORONGO RESIDENCE HALL	MRR	
15A	SERRANO VILLAGE	SR	
16	WATERMAN RESIDENCE HALL	WTR	

17	BADGER RESIDENCE HALL	BR	
18	SHANDIN RESIDENCE HALL	SHR	
19	COMMONS	CO	
20	PERFORMING ARTS	PA	24MM/24SM
21	HEALTH CENTER	HC	12MM/12SM
22	SANTOS MANUEL STUDENT UNION	SU	
23	COYOTE BOOKSTORE	BK	
23A	BOOKSTORE ADDITION	BK	
24	CHILDREN'S CENTER	CC	
25	FACULTY OFFICE BUILDING	FO	12MM/12SM
26	UNIVERSITY HALL	UH	24MM/24SM and 12MM/12SM
28	JACK H. BROWN HALL	JB	36MM/36SM
30	YASUDA CENTER FOR EXTENDED LEARNING	YC	
31	ARROWHEAD VILLAGE A	AV	
31A	ARROWHEAD VILLAGE B	AV	
32	VISUAL ARTS CENTER	VA	12MM/12SM
32A	ROBERT AND FRANCES FULLERTON MUSEUM OF ART	VA	
34	HEALTH & PHYSICAL EDUCATION A	HP	12MM/12SM
34A	HEALTH & PHYSICAL EDUCATION B	HP	
36	SOCIAL & BEHAVIORAL SCIENCES	SB	
37	CHEMICAL SCIENCES	CS	
38	COLLEGE OF EDUCATION	CE	24MM/36SM
39	STUDENT RECREATION & FITNESS CENTER	SR	36MM/36SM
41	FOUNDATION BUILDING	UE	
41A	FOUNDATION BUILDING ADDITION	UE	
43	ADMINISTRATIVE SERVICES	AS	
47	INFORMATION SERVICES BUILDING	IC-1	

49	HANDBALL COURTS	-	
50A	MURILLO FAMILY OBSERVATORY	OB	
51	INFORMTION SERVICES BUILDING B	IC-2	
72	UNIVERSITY CENTRAL STORAGE	-	
74	GEOLOGY LAB FACILITY	-	
75	UNIVERSITY VILLAGE HOUSING	UV	
101	PARKING STRUCTURE	PK1	24MM/24SM
102	PARKING STRUCTURE	PK2	
115	UNIVERSITY CENTER FOR DEVELOPMENTAL DISABILITIES A	DD	
115A	UNIVERSITY CENTER FOR DEVELOPMENTAL DISABILITIES B	DD	
209	TEMPORARY MODULARS - FACULTY	TO	
212	TEMPORARY MODULARS - FACULTY	TC	
216	TEMPORARY RECREATION	TK	
301	TEMPORARY MODULARS - FACULTY	TC	
302	TEMPORARY MODULARS - FACULTY	TC	

ANALYSIS OF FUTURE NEEDS

This chapter provides an overview of the campus future growth, impact of the growth on the existing utilities that currently serve the campus and the modifications required to the utility system to accommodate the proposed new buildings on campus. Information from this chapter was collected from general demand projections, review of proposed building uses, and review of proposed master plan.

Campus Future Growth

The proposed implemenration of the master plan will add approximately 1.25million of academic and lab spaces and approximately 1.35million of residential and support spaces. A total of approximately 2.5 million square feet of gross space is being added to the campus existing inventory excluding parking structures. A campus map showing the proposed master planned facilities that are being added at the campus is provided at the end of the chapter. Table below provides a list of new facilities and associated square footage being added to the campus as part of the proposed master plan.

NEW / EXPANDED ACADEMIC FACILITIES					
Bld. No.	Building Name or Type	Campus Facility or Type	ASF	Floors	GSF
10A.	Physical Education Addition	Physical Education	28,600.00	2	57,200
22A.	Santos Manuel Student Union Addition	Student Center	37,400.00	3	112,200
32B.	Museum of Art Expansion	Gallery / Teaching Lab (Dry)	11,300.00	1	11,300
33A.	Theater Arts Building Addition	Assembly / Teaching Lab (Dry)	46,600.00	1	46,600
34A.	Health and Physical Education Center (Kinesiology)	Teaching Lab (Dry)	23,000.00	3	69,000
39A.	Student Recreation and Fitness Center Addition	Rec Center / Gym	34,500.00	1	34,500
29.	Alumni and Faculty Center	Assembly / Office	14,900.00	1	14,900
42.	Children's Center Addition	Childcare	21,000.00	1	21,000
53.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000
54.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000
400A.	Ground Floor of CSI Laboratory	Research Lab (Wet)	25,000.00	1	25,000
56.	Classroom Building	Classrooms	20,200.00	3	60,600
57.	Classroom Building	Classrooms	20,300.00	3	60,900
58.	Classroom Building	Classrooms	20,100.00	3	60,300
59.	Classroom Building	Classrooms	20,000.00	3	60,000
60.	CEL + Knowledge Hub (See Reference Table for Uses)	Classrooms	23,400.00	3	70,200
61.	John M. Pfau Library Addition (See Reference Table for Uses)	Library	33,100.00	6	198,600
62.	Dining Hall 1 Plant	Food Service (Shared Kitchen)	3,900.00	1	3,900
63.	Dining Hall 2 Plant	Food Service (Shared Kitchen)	4,500.00	1	4,500
76.	Physical Plant Addition	Utility Plant	12,000.00	2	24,000

69.	Collaboration Pavillions	Classroom (Temporary or Modular)	400.00	7	2,800
26.	*University Hall Re-Use*	*Administrative Office (Remodel)*	*34,500.00*	*3*	*103,500*
26.	*Ground Floor Academic Uses in New Housing (20% of Ground Floors)*	Classrooms	*61,700.00*	*1*	*61,700*
					1,240,700

NEW / EXPANDED CAMPUS LIFE FACILITIES						
Group or Bldg. No.	Project Name or Location Description	Dwelling Unit Type	Phase	Floorplate	Floors	GSF
44	Living and Learning Community (Phase 1)	Residence Halls	1	34,000.00	4	136,000
45	Residential Suites Near Athletics Fields	Residential Suites	2	34,800.00	4	139,200
45	Serrano Village Replacement	Residence Halls	3	55,500.00	4	222,000
66	Gateway Village (near garages)	Residential Suites	4 & 5	23,800.00	4	95,200
66	Gateway Village (around gateway)	Apartments	4 & 5	90,200.00	4	360,800
46	Residential Halls Replacing Administration	Residence Halls	6	33,700.00	4	134,800
46	Residential Halls at Far Northwest End	Residential Suites	7	36,300.00	4	145,200
48.	Dining Hall 1		1	47,100.00	1.5	70,650
50.	Dining Hall 2		6	35,900.00	1.5	53,850
						1,357,700

ENTREPRENEURIAL FACILITIES			
Bld. No.	Building Name or Type	Floorplate	Floors
400A.	Discovery Park A (Sheriff Dept. Partnership CSI Laboratory, Ground Floor Classrooms)	25,000.00	2
400B.	Discovery Park B	20,000.00	3
400C.	Discovery Park C	20,000.00	3
401.	Hotel and Conference Center	21,900.00	3

PARKING FACILITIES				
Bld. No.	Building Name or Type	Floorplate	Floors	GSF
103.	Athletics Parking Structure	92,600.00	4	370,400.00
104.	East Gateway Parking Structure	107,500.00	4	430,000.00
105.	West Gateway Parking Structure	120,000.00	4	480,000.00
106	North Parking Structure	75,600.00	6	453,600.00
107.	Discovery Park Parking Structure	75,600.00	6	453,600.00
108	Lot N Parking Structure	113,000.00	6	678,000.00
Lot N	Lot N (Not Including Footprint of Lot N Structure)	*Note: Parking supply based on visual count in final CAD drawing*		*N/A*

CHILLED WATER AND HEATING HOT WATER SYSTEMS

An analysis of the existing chilled and heating hot water distribution system was conducted to support the proposed master plan development at the campus. The following is an analysis of the proposed buildings and the impact they will cause to the existing central chilled water and heating hot water distribution system. A table of analysis is provided at the end of the section.

Central Plant Capacity

Generation Capacity

Based on an evaluation of the proposed buildings being added, an additional 4500-5000tons of cooling and approximately 39 MMBH BTU of heating load being added to the system with the proposed building additions and new buildings.

The current cooling capacity of the central plant is approximately 3200tons. A current Utility Infrastructure project that is currently in design will add another 1250tons of chiller capacity for a total of approximately 4500 tons at the current plant, A peak demand of 3000tons is currently seen by the campus. To meet the cooling demands of the facilities being added as part of the proposed master plan, additional chillers will be required to be added to meet the peak campus loads and maintain redundancy. A review of the various options revealed that the most effective means to meet the campus peak cooling loads resulting from the facilities being added as part of the master plan would be to add two additional 1250ton chillers at the main central plant. This will bring the capacity of the plant to approximately 6000tons.

The current Thermal Energy Storage is able to handle the peak load of the campus. To meet the peak demand of the proposed facilities and offset the peak demand of the campus during the months of June-through October, the existing storage capacity will need to be expanded. We recommend that two additional 15,000ton hours thermal energy storage tanks be added adjacent to the existing thermal energy storage tanks able to accommodate the additional tonhours required to meet the peak demands of the proposed buildings. This will bring the total ton hour capacity of the thermal energy storage system to 60,000tonhours with a peak demand capacity of 10,000tons for 6hours and will help provide the cooling capacity required to meet the demands of the existing and future facilities.

The current heating capacity of the central plant is approximately 60 MMBH. A current Utility Infrastructure project that is currently in design will replace the existing high temperature boilers with low temperature boilers of approximately 40MMBH., A peak demand of 30MMBH is currently seen by the campus. To meet the heating demands of the facilities being added as part of the proposed master plan, additional boilers will be required to be added to meet the peak campus loads and maintain redundancy. A review of the various options revealed that the most effective means to meet the campus peak heating loads resulting from the facilities being added as part of the master plan would be to add approximately 40MMBH of boiler capacity at the main central plant. This will bring the capacity of the plant to approximately 80MMBH and will help provide the heating capacity required to meet the demands of the existing and future facilities.

Hydraulic Analysis

A hydraulic model of the existing HHW and CHW distribution systems on campus was developed to simulate the flow conditions throughout the existing system. The model was developed using Pipe-Flo Professional 2012 by Engineered Software Inc. and was used to illustrate flow rates based upon cooling and heating loads, system delta T and the physical piping systems as they are shown on the CHW and HHW distribution maps shown at the end of this section.

Chilled Water Analysis

The hydraulic analysis of the chilled water system showed that the current secondary pumps are at capacity and will be insufficient to meet the campus loads and the proposed future loads with full N+1 redundancy (currently one secondary pump is needed to meet peak loads). The velocities of the system however were found to be within reasonable levels with the highest velocity at the upper threshold limit of 5ft/s at the 14-in line leaving the Central Plant the remainder of the campus distribution lines do not exceed 5ft/s which shows sufficient capacity for future growth.

Based upon the analysis conducted the proposed buildings being provided as part of the master plan will push the existing pumps to the end of their curve, nearly requiring additional pumps to be brought online when additional buildings are added.

Heating Hot Water Analysis

The hydraulic analysis of the heating hot water system showed that the boiler secondary pumps being added as part of the current Utility Infrastructure project will have sufficient capacity to meet the campus loads with full N+1 redundancy (currently one secondary pump in each plant is needed to meet peak loads). The velocities of the system were found to be within reasonable levels. The analysis was run assuming a 40 degree temperature differential showing what should be attainable once the campus switch the system completely to low temperature boilers.

Based upon the analysis conducted the proposed buildings, additional pumps will ned to be brought online when additional buildings are added.

A review of the pumping capacity thus revealed that new pumps will be required to handle the additional gpm requirements of the proposed buildings. Additional primary and secondary pumps will need to be added as part of the chiller and bolier additions as the campus demand continues to grow.

The entrepreneurial services facilities will be served from dedicated chillers and boilers located with in the facility and will not be connected to the central plant.

NEW / EXPANDED ACADEMIC FACILITIES						Cooling Demand	Heating Demand
Bld. No.	Building Name or Type	Campus Facility or Type	ASF	Floors	GSF	Tons	Btu
10A.	Physical Education Addition	Physical Education	28,600.00	2	57,200	104	858,000
22A.	Santos Manuel Student Union Addition	Student Center	37,400.00	3	112,200	204	1,683,000
32B.	Museum of Art Expansion	Gallery / Teaching Lab (Dry)	11,300.00	1	11,300	21	169,500
33A.	Theater Arts Building Addition	Assembly / Teaching Lab (Dry)	46,600.00	1	46,600	85	699,000
34A.	Health and Physical Education Center (Kinesiology)	Teaching Lab (Dry)	23,000.00	3	69,000	125	1,035,000
39A.	Student Recreation and Fitness Center Addition	Rec Center / Gym	34,500.00	1	34,500	63	517,500
29.	Alumni and Faculty Center	Assembly / Office	14,900.00	1	14,900	27	223,500
42.	Children's Center Addition	Childcare	21,000.00	1	21,000	38	315,000
53.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	125	1,035,000
54.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	125	1,035,000
400A.	Ground Floor of CSI Laboratory	Research Lab (Wet)	25,000.00	1	25,000	45	375,000
56.	Classroom Building	Classrooms	20,200.00	3	60,600	110	909,000
57.	Classroom Building	Classrooms	20,300.00	3	60,900	111	913,500
58.	Classroom Building	Classrooms	20,100.00	3	60,300	110	904,500
59.	Classroom Building	Classrooms	20,000.00	3	60,000	109	900,000
60.	CEL + Knowledge Hub (See Reference Table for Uses)	Classrooms	23,400.00	3	70,200	128	1,053,000
61.	John M. Pfau Library Addition (See Reference Table for Uses)	Library	33,100.00	6	198,600	361	2,979,000
62.	Dining Hall 1 Plant	Food Service (Shared Kitchen)	3,900.00	1	3,900	7	58,500

63.	Dining Hall 2 Plant	Food Service (Shared Kitchen)	4,500.00	1	4,500	8	67,500
76.	Physical Plant Addition	Utility Plant	12,000.00	2	24,000	-	360,000
69.	Collaboration Pavillions	Classroom (Temporary or Modular)	400.00	7	2,800	5	42,000
26.	*University Hall Re-Use*	*Administrative Office (Remodel)*	*34,500.00*	*3*	*103,500*	188	1,552,500
26.	*Ground Floor Academic Uses in New Housing (20% of Ground Floors)*	Classrooms	*61,700.00*	*1*	*61,700*	112	925,500
					1,240,700	2256	18,610,500

NEW / EXPANDED CAMPUS LIFE FACILITIES							Cooling Demand	Heating Demand
Group or Bldg. No.	Project Name or Location Description	Dwelling Unit Type	Phase	Floorplate	Floors	GSF	Tons	Btu
44	Living and Learning Community (Phase 1)	Residence Halls	1	34,000.00	4	136,000	247	2,040,000
45	Residential Suites Near Athletics Fields	Residential Suites	2	34,800.00	4	139,200	253	2,088,000
45	Serrano Village Replacement	Residence Halls	3	55,500.00	4	222,000	404	3,330,000
66	Gateway Village (near garages)	Residential Suites	4 & 5	23,800.00	4	95,200	173	1,428,000
66	Gateway Village (around gateway)	Apartments	4 & 5	90,200.00	4	360,800	656	5,412,000
46	Residential Halls Replacing Administration	Residence Halls	6	33,700.00	4	134,800	245	2,022,000
46	Residential Halls at Far Northwest End	Residential Suites	7	36,300.00	4	145,200	264	2,178,000
48.	Dining Hall 1		1	47,100.00	1.5	70,650	128	1,059,750
50.	Dining Hall 2		6	35,900.00	1.5	53,850	98	807,750
						1,357,700	2469	20,365,500

ENTREPRENEURIAL FACILITIES					Cooling Demand	Heating Demand
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	Tons	Btu
400A.	Discovery Park A (Sheriff Dept. Partnership CSI Laboratory, Ground Floor Classrooms)	25,000.00	2	50,000.00	91	750,000
400B.	Discovery Park B	20,000.00	3	60,000.00	109	900,000
400C.	Discovery Park C	20,000.00	3	60,000.00	109	900,000
401.	Hotel and Conference Center	21,900.00	3	65,700.00	119	985,500

PARKING FACILITIES					Cooling Demand	Heating Demand
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	Tons	Btu
103.	Athletics Parking Structure	92,600.00	4	370,400.00	0	0
104.	East Gateway Parking Structure	107,500.00	4	430,000.00	0	0
105.	West Gateway Parking Structure	120,000.00	4	480,000.00	0	0
106	North Parking Structure	75,600.00	6	453,600.00	0	0
107.	Discovery Park Parking Structure	75,600.00	6	453,600.00	0	0
108	Lot N Parking Structure	113,000.00	6	678,000.00	0	0
Lot N	Lot N (Not Including Footprint of Lot N Structure)	*Note: Parking supply based on*		*N/A*	*N/A*	0

	visual count in final CAD drawing		

NATURAL GAS SYSTEM

The existing natural gas system was analyzed to support the proposed master plan development at the campus. The natural gas load was estimated based on the domestic hot water demand using the instantaneous method. The domestic hot water demand was calculated by determining the amount of fixture units based on the number of occupants in the building. The table below provides a summary of the proposed new buildings and their estimated load in CFH on the existing natural gas distribution system.

NEW / EXPANDED ACADEMIC FACILITIES						Gas Demand in CFH
Bld. No.	Building Name or Type	Campus Facility or Type	ASF	Floors	GSF	CFH
10A.	Physical Education Addition	Physical Education	28,600.00	2	57,200	286
22A.	Santos Manuel Student Union Addition	Student Center	37,400.00	3	112,200	561
32B.	Museum of Art Expansion	Gallery / Teaching Lab (Dry)	11,300.00	1	11,300	57
33A.	Theater Arts Building Addition	Assembly / Teaching Lab (Dry)	46,600.00	1	46,600	233
34A.	Health and Physical Education Center (Kinesiology)	Teaching Lab (Dry)	23,000.00	3	69,000	345
39A.	Student Recreation and Fitness Center Addition	Rec Center / Gym	34,500.00	1	34,500	173
29.	Alumni and Faculty Center	Assembly / Office	14,900.00	1	14,900	75
42.	Children's Center Addition	Childcare	21,000.00	1	21,000	105
53.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	345
54.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	345
400A.	Ground Floor of CSI Laboratory	Research Lab (Wet)	25,000.00	1	25,000	125
56.	Classroom Building	Classrooms	20,200.00	3	60,600	303
57.	Classroom Building	Classrooms	20,300.00	3	60,900	305
58.	Classroom Building	Classrooms	20,100.00	3	60,300	302
59.	Classroom Building	Classrooms	20,000.00	3	60,000	300
60.	CEL + Knowledge Hub (See Reference Table for Uses)	Classrooms	23,400.00	3	70,200	351

61.	John M. Pfau Library Addition (See Reference Table for Uses)	Library	33,100.00	6	198,600	993
62.	Dining Hall 1 Plant	Food Service (Shared Kitchen)	3,900.00	1	3,900	20
63.	Dining Hall 2 Plant	Food Service (Shared Kitchen)	4,500.00	1	4,500	23
76.	Physical Plant Addition	Utility Plant	12,000.00	2	24,000	120
69.	Collaboration Pavillions	Classroom (Temporary or Modular)	400.00	7	2,800	14
26.	*University Hall Re-Use*	*Administrative Office (Remodel)*	*34,500.00*	*3*	*103,500*	518
26.	*Ground Floor Academic Uses in New Housing (20% of Ground Floors)*	Classrooms	*61,700.00*	*1*	*61,700*	309
					1,240,700	6,204

NEW / EXPANDED CAMPUS LIFE FACILITIES							Gas Demand in CFH
Group or Bldg. No.	Project Name or Location Description	Dwelling Unit Type	Phase	Floorplate	Floors	GSF	CFH
44	Living and Learning Community (Phase 1)	Residence Halls	1	34,000.00	4	136,000	680
45	Residential Suites Near Athletics Fields	Residential Suites	2	34,800.00	4	139,200	696
45	Serrano Village Replacement	Residence Halls	3	55,500.00	4	222,000	1,110
66	Gateway Village (near garages)	Residential Suites	4 & 5	23,800.00	4	95,200	476
66	Gateway Village (around gateway)	Apartments	4 & 5	90,200.00	4	360,800	1,804
46	Residential Halls Replacing Administration	Residence Halls	6	33,700.00	4	134,800	674
46	Residential Halls at Far Northwest End	Residential Suites	7	36,300.00	4	145,200	726
48.	Dining Hall 1		1	47,100.00	1.5	70,650	353
50.	Dining Hall 2		6	35,900.00	1.5	53,850	269
						1,357,700	6,789

ENTREPRENEURIAL FACILITIES					Gas Demand in CFH
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	CFH
400A.	Discovery Park A (Sheriff Dept. Partnership CSI Laboratory, Ground Floor Classrooms)	25,000.00	2	50,000.00	250
400B.	Discovery Park B	20,000.00	3	60,000.00	300
400C.	Discovery Park C	20,000.00	3	60,000.00	300
401.	Hotel and Conference Center	21,900.00	3	65,700.00	329

PARKING FACILITIES					Gas Demand in CFH
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	CFH
103.	Athletics Parking Structure	92,600.00	4	370,400.00	0
104.	East Gateway Parking Structure	107,500.00	4	430,000.00	0
105.	West Gateway Parking Structure	120,000.00	4	480,000.00	0
106	North Parking Structure	75,600.00	6	453,600.00	0

107.	Discovery Park Parking Structure	75,600.00	6	453,600.00	0
108	Lot N Parking Structure	113,000.00	6	678,000.00	0
Lot N	Lot N (Not Including Footprint of Lot N Structure)	*Note: Parking supply based on visual count in final CAD drawing*		*N/A*	0

An analysis of the existing natural gas distribution system revealed that the existing system capacity will need to be upgraded to support the replacement buildings. New meters will be provided at each building to monitor consumption.

To reduce gas consumption at the campus, we recommend installing point of use electric water heaters in buildings in place of existing gas water heaters. All proposed buildings that are in the vicinity of the tunnel should be served from the main domestic water heating hot water piping along with a heat exchanger to meet their domestic water heating loads.

Site plan showing connections to proposed replacement buildings is provided following this section.

ELECTRICAL SYSTEM

The existing electrical distribution system was analyzed to support the proposed master plan development at the campus.

The campus current electrical demand peaks during the months of September and October and is about 5,000 kVA. A review of the proposed master plan revealed that the campus would add an additional demand of approximately 7500-8000kVA to the current demand of the campus.

A review of the existing electrical distribution system revealed that additional 15kV feeders will be required to feed the proposed buildings provided as part of the master plan. The main 15kV switchgear is currently being upgraded as part of the current Utility Infrastructure Project and will be equipped with (4) 15kV spare breakers. New 15kV feeders originating from this new switchgear should be added as facilities are added to the campus to meet their power demands. Additional 5" concrete encased conduit duct banks should be added and extended to new facilities to route the new feeders to each of the facilities. 15kV selector switches should be added in the vicinity of the proposed facilities to serve the new facilities. Dual feeders originating from the new 15kV main switchgear will form a loop system around the campus and radial feeder originating from each of these selector switches will serve the proposed facilities.

The table below provides a summary of the proposed new buildings and their estimated load and demand in kVA on the existing electrical distribution system.

NEW / EXPANDED ACADEMIC FACILITIES						Installed Capacity	Demand
Bld. No.	Building Name or Type	Campus Facility or Type	ASF	Floors	GSF	kVA	kVA
10A.	Physical Education Addition	Physical Education	28,600.00	2	57,200	858	172
22A.	Santos Manuel Student Union Addition	Student Center	37,400.00	3	112,200	1,683	337
32B.	Museum of Art Expansion	Gallery / Teaching Lab (Dry)	11,300.00	1	11,300	170	34
33A.	Theater Arts Building Addition	Assembly / Teaching Lab (Dry)	46,600.00	1	46,600	699	140
34A.	Health and Physical Education Center (Kinesiology)	Teaching Lab (Dry)	23,000.00	3	69,000	1,035	207
39A.	Student Recreation and Fitness Center Addition	Rec Center / Gym	34,500.00	1	34,500	518	104
29.	Alumni and Faculty Center	Assembly / Office	14,900.00	1	14,900	224	45
42.	Children's Center Addition	Childcare	21,000.00	1	21,000	315	63
53.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	1,035	207
54.	Science + Engineering Lab	Teaching or Research Lab (Wet or Dry)	23,000.00	3	69,000	1,035	207
400A.	Ground Floor of CSI Laboratory	Research Lab (Wet)	25,000.00	1	25,000	375	75
56.	Classroom Building	Classrooms	20,200.00	3	60,600	909	182
57.	Classroom Building	Classrooms	20,300.00	3	60,900	914	183
58.	Classroom Building	Classrooms	20,100.00	3	60,300	905	181
59.	Classroom Building	Classrooms	20,000.00	3	60,000	900	180
60.	CEL + Knowledge Hub (See Reference Table for Uses)	Classrooms	23,400.00	3	70,200	1,053	211
61.	John M. Pfau Library Addition (See Reference Table for Uses)	Library	33,100.00	6	198,600	2,979	596
62.	Dining Hall 1 Plant	Food Service (Shared Kitchen)	3,900.00	1	3,900	59	12
63.	Dining Hall 2 Plant	Food Service (Shared Kitchen)	4,500.00	1	4,500	68	14
76.	Physical Plant Addition	Utility Plant	12,000.00	2	24,000	360	72
69.	Collaboration Pavillions	Classroom (Temporary or Modular)	400.00	7	2,800	42	8
26.	*University Hall Re-Use*	*Administrative Office (Remodel)*	*34,500.00*	*3*	*103,500*	1,553	311

26.	*Ground Floor Academic Uses in New Housing (20% of Ground Floors)*	Classrooms	*61,700.00*	*1*	*61,700*	926	185
					1,240,700	18,611	3,722

NEW / EXPANDED CAMPUS LIFE FACILITIES						Installed Capacity	Demand
Group or Bldg. No.	Project Name or Location Description	Dwelling Unit Type	Floorplate	Floors	GSF	kVA	kVA
44	Living and Learning Community (Phase 1)	Residence Halls	34,000.00	4	136,000	2,040	408
45	Residential Suites Near Athletics Fields	Residential Suites	34,800.00	4	139,200	2,088	418
45	Serrano Village Replacement	Residence Halls	55,500.00	4	222,000	3,330	666
66	Gateway Village (near garages)	Residential Suites	23,800.00	4	95,200	1,428	286
66	Gateway Village (around gateway)	Apartments	90,200.00	4	360,800	5,412	1,082
46	Residential Halls Replacing Administration	Residence Halls	33,700.00	4	134,800	2,022	404
46	Residential Halls at Far Northwest End	Residential Suites	36,300.00	4	145,200	2,178	436
48.	Dining Hall 1		47,100.00	1.5	70,650	1,060	212
50.	Dining Hall 2		35,900.00	1.5	53,850	808	162
					1,357,700	20,366	4,073

ENTREPRENEURIAL FACILITIES					Installed Capacity	Demand
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	kVA	kVA
400A.	Discovery Park A (Sheriff Dept. Partnership CSI Laboratory, Ground Floor Classrooms)	25,000.00	2	50,000.00	750	150
400B.	Discovery Park B	20,000.00	3	60,000.00	900	180
400C.	Discovery Park C	20,000.00	3	60,000.00	900	180
401.	Hotel and Conference Center	21,900.00	3	65,700.00	986	197

PARKING FACILITIES					Installed Capacity	Demand
Bld. No.	Building Name or Type	Floorplate	Floors	GSF	kVA	kVA
103.	Athletics Parking Structure	92,600.00	4	370,400.00	1,852	370
104.	East Gateway Parking Structure	107,500.00	4	430,000.00	2,150	430
105.	West Gateway Parking Structure	120,000.00	4	480,000.00	2,400	480

106	North Parking Structure	75,600.00	6	453,600.00	2,268	454
107.	Discovery Park Parking Structure	75,600.00	6	453,600.00	2,268	454
108	Lot N Parking Structure	113,000.00	6	678,000.00	3,390	678
Lot N	Lot N (Not Including Footprint of Lot N Structure)	*Note: Parking supply based on visual count in final CAD drawing*		*N/A*	*N/A*	0

Site plan showing connections to proposed replacement buildings is provided following this section.

TELECOMMUNICATIONS SYSTEM

The following is an analysis of the proposed buildings and the impact they cause to the existing systems. This section describes the future requirements for major telecommunications systems and the requirements for each of the proposed building projects.

Voice and Data Network

The University will continue utilizing the existing Cisco data switches over the interbuilding fiber cable system for providing data service to the campus. Data electronics will continue to be upgraded when required for the introduction of new applications or additional capacity to meet the voice and data services requirements of the proposed facilities.

Future Needs

The new buildings will require connections to the campus voice and data network through the campus fiber optic cable systems. The requirements for each building were based on the following criteria:

Underground Conduit

Each typical state-owned building will be provided with a minimum of two, four inch diameter conduits from the serving manhole to the building entrance room. The allocation of the conduits will be as follows: (1) fiber optic cables for voice/data services and copper cables for emergency services, and (2) spare for future dedicated cable networks.

Copper Cable

For a majority of the new buildings the number of copper cable pairs were based emergency services required for each of the facilities.

Fiber Optic Cable

The criteria for a typical building included the current campus standard of a hybrid fiber cable with 24 singlemode optics and 12 multimode optics under one cable sheath. The multimode optics will be the campus standard of 50 micron type. Each fiber cable will be installed in a one inch diameter innerduct to provide cable protection and to maximize the utilization of the underground conduit system. For buildings with a small utilization, the cable size was reduced to 12 singlemode optics and 6 multimode optics. For buildings with a high utilization, the typical forecast was increases to 48 singlemode optics and 24 multimode optics.

DOMESTIC FIRE & WATER SYSTEM

The California State University San Bernardino main campus is situated in a northern valley of the City of San Bernardino, tucked behind Little Mountain with the San Bernardino Mountain range looming overhead immediately to the north, with single and multi-family residential developments scattered between. The 441 acre site, founded on bedrock with only a thin alluvial soil cover, has a naturally occurring aquifer running approximately diagonally under the area, possibly fed from the large flood control facilities to the northwest and the adjacent creeks. The City, which provides domestic and fire water service, also takes care of sanitary sewer and storm drainage service for the area.

The University was established in 1965, and is one of the largest in the CSU system in means of size, which is 441 acres. In terms of registered students, at just over 18,000 the University sits in the middle of the 23 campuses. As with many of the CSU campuses, San Bernardino serves primarily as a commuter school, with only approximately 8% of students residing in campus housing. For this Utility Infrastructure Failure Analysis and Impact Assessment, Wheeler & Gray reviewed existing AutoCAD mapping files, Civil Utility systems and conducted field investigations with the University Planning Design and Construction (FPD&C) and the Facilities Services (FS) departments.

The University has combined domestic and fire water mains for most of the campus, with separate laterals for fire service connections and hydrants, especially around the newer buildings that are sprinklered. The system has only one connection to the City of San Bernardino 16" water main in West Northpark Blvd on the west side of campus that runs thru an 8" and 6" Double Connect Detector Assemblies (DCDAs) in series, before splitting off into 2 branches to serve the University. Previously believed to be installed correctly in parallel, the situation of the DCDAs connected in series was only discovered recently when Facilities Services staff shut down one DCDA and lost all water service to campus. Within the campus though, much of the water system is looped and appears to be adequately sized, though there is extensive transite asbestos concrete pipe (ACP) still in service dating back to the mid to late 1960's, when the University was founded. It should be noted that transite pipe may, in ideal conditions and if of high quality, last for up to 50 years, and would not need to be replaced until it began to show signs of fatigue or failure.

The Domestic Water System is looped around the large main central campus area, on the west side around the new P101 Parking Structure, out to the Facilities buildings and around the Visual Arts Center. The system is also internally looped with redundancy around the new College of

Education Building, Health & PE Complex and P102 in the north east area, and down around the student housing complexes on both sides of West Northpark Blvd. The outlying athletic areas and information booth to the east, and the rest of the central campus areas are feed off of branched tees, often sized for combined domestic and fire water usage. The existing system is approximately 80% to 90% ACP, with the newer water lines installed with C900 fire water rated plastic pipe.

Network Evaluation

Domestic and fire water is provided to the campus by the City of San Bernardino Water Department. Most of the irrigation is provided by a series of wells fed by the underground aquifer that runs approximately diagonally across the campus from the northwest corner to the southeast. There is currently only one service connection to the city water main for campus use in West Northpark Blvd on the east side. Campuses wide, where approximately 80% to 90% of the on-site waterlines are still aging ACP, the pipes are past their useful service life and will need to be replaced. But in the areas of the campus that the water mains, such as around the College of Ed, University Village, and the Health Complex, have been replaced with new fire rated C900 plastic pipe, they should be protected in place. A high level modeling analysis of the water system was conducted to identify critical failures in fire flow volumes and pressure, based on a 6" point of connection (POC) to the city water main. A computer model of the existing domestic water system was created in AutoCAD with HydrauliCAD version 7.1 and included all pipes, valves, backflow preventers, fire hydrants and building connections on campus. The water demand for each building was calculated by analyzing the previous 12-months of water usage along with a water/sewer demand analysis based on building type and use. The only buildings not included in the analysis were the two parking structures. Because the irrigation system is primarily fed by the underground aquifer and a series of wells that draw from it, it was not included in the modeling of the domestic water. A summary of the buildings and the water demands applied to each building is included in the appendix. The computer water model was analyzed for three different fire flow scenarios on campus to test the existing system’s ability to satisfy fire flow criteria set by the San Bernardino Fire Department, along with the maximum building demands. A fire flow demand of 4,500 gallons per minute (gpm) was determined to satisfy the requirements of the buildings on campus. A residual pressure of 20 pounds per square inch (psi) is required in the domestic water network while a fire flow demand was occurring. In the three different scenarios a total fire flow demand of 4,500 gpm was assigned to be drawn from three adjacent fire hydrants or buildings, at a rate of 1,500 gpm each.

Age and Reliability

Portions of the campus water system has been replaced and brought up to current code with C900 pipe as the University expanded, and added or replaced buildings. The exact age for all the waterlines is not known, except for those areas where it was just installed in the last few years as part of new construction projects.

Therefore, approximate dates of installation are assumed to be the same as the building construction dates, as shown in the list of buildings.

Redundancy

The University’s domestic water system does not have adequate redundancy or looping, and is further hampered by having only one undersized POC. In addition, aging ACP and broken valves limit the ability of the campus to provide ongoing service and redundancy when portions need to shut off for service.

History of Outages / Disruption of Service

As mentioned earlier in this report, recent maintenance at the POC proved that the DCDAs were connected improperly and shut down water service to the entire campus.

Vulnerabilities

Having only one 6" POC for the entire 441 acre site makes the University extremely vulnerable to shutting down the entire campus if there is ever a disruption in service, especially at the DCDAs out at West Northpark Blvd. Even a small drop in pressure at the service connection could hamper the reliability of fire water, especially at the far end of the campus and the top floors of the larger buildings. Servicing and repairs to the existing transite pipe is time consuming and expensive as the asbestos content, even in the small quantities normally found in this type of material, requires special certification to handle and exacting procedures to remove. In addition, transite AC pipe has only a limited service life, of approximately 50 years, in ideal conditions before it starts to breakdown. This makes the domestic and fire water systems very vulnerable, especially with the current drought conditions and higher fire danger.

Summary of Our Analysis and Recommendations

To meet the demands of the proposed facilities planned as part of the master plan, water demands were calculated for each of the facilities based on the function and square footage of each of the buildings. A spreadsheet providing water demands for each of the facilities is provided in Appendix.

Based on a review of the water model, a second 12" connection from the City of San Bernardino should be installed preferably at the east end of the campus at Northpark, near E Campus Circle or the Coyote Drive Entrance to form a loop at the campus and meet the future domestic water demands of the campus. New service laterals shall be constructed to connect the new buildings to meet their fire and domestic water needs. Service laterals shall be sized based on the function and size of the proposed buildings planned as part of the master plan. A few of the domestic water lines are in conflict with the proposed buildings and will need to be relocated to accommodate the proposed buildings. The relocated lines shall be C-900 and shall replace the existing AC transite piping that is in the way of the proposed building.

In addition, existing AC transite piping shall be replaced in phases as the campus undertakes the development of the proposed master plan.

A detailed fire flow model should be developed in the future to confirm the exact pipe sizes needed to serve the fire flow and domestic water needs of each of the planned buildings.

SANITARY SEWER

The sanitary sewer system on campus has three points of connection for the main campus and a fourth connection for the residential housing complex south of West Northpark Blvd. Though the sanitary sewer system primarily operates or drains by gravity, the campus has nine sewage lift stations, that are necessary to get enough fall for the sewage to flow out to the relatively shallow sewer main connection out in W Northpark Blvd. Each pump station houses a minimum of two ejector grinding pumps and an emergency back-up generator. Most of the central and west campus drains to the manhole just southeast of the residence Halls in W Northpark and is metered. The system starts at the upstream end at the western side of campus with a 4" line that snakes around the facilities buildings with a mix of original vitrified clay pipe (VCP) and plastic SDR-35 plastic sewer pipe and a 6" line that serves the Admin Services building. It heads east and then works its way between the Central Plant, Animal House and Geology Lab buildings and turns south to cut thru Chemical and Biological Sciences and the first pump station. The sewer then flows south past Physical Sciences and Social Sciences, each with a lift station, and then on past Faculty and Admin, where it picks up the 6” lateral that starts at Yasuda and served the Foundation, Visual Arts, Children’s Center, Sierra, Admin and Chaparral. The 10” VCP line then continues south and picks up the book Store and turns east again, picking up the lateral for Performing Arts, both with sewer lift stations. The 12” VCP continues east to connect a branch from the north that serves the Library, Student Union, University Hall, the Health Center and the Commons. And then on it goes, snaking between the University Apartments eastward to terminate at the manhole in Northpark. The second sewer reach serves the buildings in the central northeast portion of the campus, starting with a 6” over at the College of Education, which snakes south and then north around the building and up to the Health & PE Complex that houses a lift station. It then runs south and turns east to pick up a northerly branch that has another connection to (the east side of) the PE Complex, and then picks up the sewer line from the original PE building.

Further south it connects two laterals, the one from the west serves Jack Brown and the east one the service buildings just east of the pools, and then collects from a lateral off the Residence Hall buildings. The 12” VCP then makes a slight turn to the east to connect into the manhole in Northpark with a meter, same as the first POC.The third connection serves only the east most outlying buildings on campus, including the Student Rec Center and the Information Booth between Parking Lots F and H. This reach connects into a second manhole further east and may not be metered.The fourth and final reach of the University sewer system serves the Village Housing Complex, south of W Northpark Blvd and the main campus, and is installed with all SDR-35 pipe. This line connects to the City sewer main further west than the other three connections.The Observatory north of the main campus and on top of a hill is serviced by an independent septic system.

Network Evaluation

The existing sanitary sewer system was reviewed and evaluated with campus plumbing staff, by reviewing existing mapping and conducting numerous field reviews. The system has numerous problems with plant root intrusion, laterals that fail to drain properly due to lack of adequate or negative slope, and the numerous aging ejector lift stations.

Age and Reliability

Though most of the existing sewer system is from the early years of the campus (1960's-1970's) and constructed with VCP, this pipe has been known to have a useable service of life of 50-75 years, and even longer if not disturbed or broken. But if not installed or sloped correctly, or if impacted by construction or improper use, problems arise such as the zero to negative slope found on the San Bernardino campus. The aging sewerage ejector lift stations have also fallen into disrepair and problems, causing the plumbing staff to put their focus on the service and repair of the systems instead of performing preventative maintenance.

Capacity

The sewer system has plenty of capacity for the size and number of students, faculty and staff on campus.

History of Outages / Disruption of Service

Historically, the plumbing staff has to continually service the ejector lift pumps and generators, as well as keeping the lines clear of roots and debris.

Vulnerabilities

The existing sanitary sewer system is vulnerable to failure at any of the aging lift stations and along any of the identified pipes that have zero or negative slopes and chronic blockage.

Summary of Our Analysis and Recommendations

To meet the demands of the proposed facilities planned as part of the master plan, sewer demands were calculated for each of the facilities based on the function and square footage of each of the buildings.

Based on a review of the demands, new service laterals shall be constructed to connect the new buildings to meet their sewer needs. Service laterals shall be sized based on the function and size of the proposed buildings planned as part of the master plan. A few of the domestic sewer lines are in conflict with the proposed buildings and will need to be relocated to accommodate the proposed buildings. The relocated lines shall be SDR-35 and shall replace the existing VCP piping that is in the way of the proposed building.

The campus is currently undertaking an infrastructure project that is replacing the aging lift stations and the identified pipes that have zero or negative slopes and chronic blockage. These will therefore be addressed before the master plan development is underway.

STORM DRAIN

California State University San Bernardino sits at the base of the San Bernardino Mountain Range and National Forest, in the foothills at the northern edge of the city. The campus is surrounding by various flood control percolation and debris basins and channels. The University has a huge webbed network of storm drain pipes in the central and east portions of campus, with the west side that houses the facility buildings and operations sheet flowing east southeast to West

Northpark Blvd and the University Village (UV) Housing sheet flowing north to the boulevard. Besides the Facilities Complex at the west side and the UV sheet flow drainage, storm water enters the San Bernardino County Flood Control network at four, possibly five locations around the perimeter of campus. The campus recently installed the north perimeter road North Campus Circle with an open trapezoidal channel just north and parallel to the street. This channel collects all the stormwater that flows south of the foothills and drains east and then south to outlet to the City/County system south of the intersection of East Campus Circle and W Northpark Blvd.

The first and western most drainage area connection starts as an 18” reinforced concrete pipe (RCP) that picks up water from the West Northpark Blvd system just west of University Parkway. The campus system picks storm water from the new parking structure P101 and all the area drains and catch basins from Yasuda, Visual Arts, the Foundation, the Children’s Center, and Sierra Hall, then travels out to the perimeter of the University with a 36” RCP, turns south and then southeast to follow Northpark parallel on the north side as a 33” to University Parkway.

The second drainage area is for central portion of campus, and is drained by a 42” RCP that runs just west of student housing, but starts as a 6” at the very north end between the cooling towers and the Central Plant. It also serves drainage for the Animal House, Geology, Chemical, Biology, Social, and Physical Sciences buildings, as well at the Library, Faculty Offices, Admin, Chaparral Performing Arts, the Bookstore, Student Union, the Commons, Health Center , and University Hall buildings. Localized flooding occurs around many of the buildings in this drainage area that has been a chronic problem for the plumbing staff during the winter rainy season, and include ponding of the plaza area between the Admin and Chaparral Hall buildings, south of Chaparral Hall, north of the original portion of the Library, in the interior courtyards and south of the Performing Arts building, and north of the Commons.

The third drainage area is the northeast section of campus that includes the new P102 Parking Structure, the College of Educations, and the newer Health and PE Complex buildings to the north. This section of the main campus drains to the north, connecting into the large trapezoidal open channel just north of North Campus Circle Road with a 24" RCP. Localized ponding north of the new College of Ed building near the accessible parking stalls has been a chronic nuisance problem for the campus.

Drainage area four is at the south central side of campus and included all the student housing north or W Northpark Blvd, including the Residence Halls of Serrano Village and Arrowhead Village apartments. This storm drain starts as a 3" and snakes around the housing units and connects to the 51" main with a 12" and a 18" RCPs. Area five drains the original PE building and Jack Brown Hall. Historic flooding at Jack Brown have been alleviated by recent storm drain improvements and the addition of the service road off of Coyote Drive.

The sixth and final drainage area on the main campus with an underground system drains the far east area of campus, which includes portions of the east side of the north Health & PE Complex, the Athletic Fields, the new Student Rec Center, the Handball Courts, Temporary Recreation buildings and additional outlying buildings with a 27" RCP. This area drains south to the 54" perimeter RCP which in turn connects to the pipe coming south from the open channel and dumps into the City/County Flood control system at West Northpark Blvd and East Campus Circle Drive.

Network Evaluation

To evaluate the existing storm drainage system for the CSUSB campus a number of investigative measures were used. Firstly, meetings were held with campus maintenance personnel and administration to locate the problem areas. Field investigations were conducted on-site to get a better understanding of the problem areas. During these field investigations, the As-Built site plans of the campus were marked-up and areas of concern or high importance were located. These maps in turn were used to perform hydrologic and hydraulic studies. To perform the hydrologic and hydraulic studies, the San Bernardino County Hydrology Manual was used. To perform the hydrologic studies, the campus was divided into various subareas depending of the topography, direction of flow of water, tributary area, areas

Using the Modified Rational method provided in hydrology manual, the discharge (Q) was calculated for all the subareas on campus. These calculations were done for a 10-year storm. These discharge values were used in hydraulic studies (Using Hazen-Williams and Manning's equation) to check the sizes of pipes and catch basins for the respective subareas.

Based on the Hydrologic and Hydraulic studies, recommendations were made whether as to which of the existing pipes and catch basins should be kept in place which needed to be replaced with larger pipes and catch basins.

This high level Hydrology and Hydraulic analysis shows that the 441 acre campus generates approximately 500 cubic feet of storm water in a 10-year design storm. The existing system of open channels, underground pipes and surface flow can adequately handle the 10-year rainfall event, which is the design standard for both the City and County of San Bernardino in which the campus resides.

Usage and Cost

Similar to sanitary sewer, well-functioning storm drain systems are a basic necessity of any micro-community such as a campus like CSU San Bernardino and usage can be considered passive as there is no switch or gate valve to put it into service. When properly designed; when it rains the water drains to lower ground, and is collected into catch basins and area drains or sheet flows off-site to city street, where it eventually enters the San Bernardino Flood Control system. Costs associated with storm drainage are indirect, and paid from government collected permit costs and taxes.

Age and Reliability

Most of the storm drain system was built during the original building construction for the University in the 1960’s to 1970’s, and expanded along with the campus.

Redundancy/Capacity

Because the storm drain operates by gravity, redundancy is not built into to the system, and instead capacity is the primary measure of how well the utility is functioning. Full capacity for storm drains is considered for pipes to be flowing full for a 10-year storm, and based on our analysis the campus system is at 50% of capacity and well able to meet current drainage demands.

History of Outages / Disruption of Service

The campus experiences numerous localized flooding problems in the central part of campus, in part due to closing of the system and root intrusion. Other issues with drainage campus-wide appear to have been mitigated with the more aggressive cleaning and repair program implemented by the plumbing staff, and possibly aided by the 3-year drought. As one of the public universities named in the revised Stormwater MS4 Phase II Permit under the new Non-Traditional category, CSU San Bernardino has submitted the Boundary Map and Guidance Document required by the State Water Boards in July 2013. The university is also developing a map and establishing a system to routinely monitor service and maintain all drainage inlets, open channels and underground storm drains on the campus to minimize ponding and erosion.

Vulnerabilities

System vulnerability for the Storm Drainage System have been identified in six areas of the central campus and will need further investigation by videotaping the lines in question to determine if the culprit is root intrusion, broken and failing pipes, and/or lack of proper slope to carry the stormwater and associated debris through the system. The same are being addressed as part of an utility infrastructure project currently being undertaken by the campus.

Summary of Our Analysis and Recommendations

An analysis of the existing storm drain system was conducted to support the proposed development at the campus. Based on a review of the demands, new storm drain piping extensions shall be constructed to connect the new buildings to meet their drainage needs. Service laterals shall be sized based on the function and size of the proposed buildings planned as part of the master plan. A few of the storm drain lines are in conflict with the proposed buildings and will need to be relocated to accommodate the proposed buildings.

Water Quality

The campus must also adopt BMP for all new construction. The primary objectives of BMP are to:

- Effectively prohibit non-storm water discharges, and
- Reduce the discharge of pollutants from storm water conveyance systems to the maximum extent practicable.
- The Best Management Practices (BMPs) include, but are not limited to:

- Provide reduced width sidewalks and incorporate a landscape buffer between sidewalks and streets.
- Design streets for minimum required pavement widths.
- Use permeable materials for private sidewalks, driveways, parking lots, or interior roadway surfaces (e.g. hybrid lots, parking groves, permeable overflow parking, etc.).
- Use open space development that incorporates smaller lot sizes (e.g. multi-story construction)
- Use green roofs on top of buildings
- Reduce overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
- Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway or the storm water conveyance system.
- Vegetated swales and strips
- Extended/dry detention basins
- Infiltration basins
- Infiltration trenches
- Wet ponds
- Constructed wetlands
- Oil/water separators
- Catch basin and/or storm drain inserts
- Continuous flow deflection/separation systems
- Media filtration

- Bioretention facility
- Dry-wells
- Cisterns
- Foundation planting
- Normal flow storage/separation systems
- Clarifiers
- Filtration systems
- Primary waste water treatment systems BMP features shall be incorporated into existing buildings during remodeling when possible. In some cases it may be feasible to redirect rooftop drains to existing landscape areas. However in many cases it may be too costly or impractical to retrofit existing buildings.

The use of catch basin inserts is possible, but maintenance requirements would be substantial. Therefore, use of basins or ponds is considered the most cost effective approach when feasible.In-fill development on the developed portion of the existing campus is constrained by the lack of space and by the configuration of the existing infrastructure.

New buildings shall incorporate BMP features where possible, such as minimizing impermeable areas, the use of cisterns, and directing rooftop runoff to pervious areas.