Peralta Community College District

Laney College

Central Utility Plant Study

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1 Executive Summary

Taylor Engineering was engaged to evaluate the existing central utility plant serving the Laney College campus and provide a report of the condition and capacity of the plant and whether the plant can support the connection of the future Library and Learning Resource Center. This report summarizes our observations and recommendations.

The central plant consists of three 200-ton water-cooled chillers and three 7,200 KBTUH gas-fired hot water boilers and serves 15 buildings on the Laney College campus. The central plant is in a state of disrepair—two of the chillers and two of the boilers are not operational, the cooling towers have not had consistent water treatment for 2 years, and several the variable speed drives controlling equipment were not operational. The poor condition of the central plant inhibits the proper operation of every connected buildings' HVAC systems due to reduced heating and cooling capacity. This assertion is supported by interviews with the facilities engineers indicating that thermal comfort complaints on campus were common and there are often occasions when the operating chiller is overloaded. Repairing and/or upgrading the central plant is critical if mechanical systems are expected to provide appropriate conditioning and operate as designed. This position is consistent with the findings of the District Wide 2017 Facilities Technology Master Plan indicating that the HVAC systems for 14 of the buildings on campus are in "Bad Condition" and which lists "New/Replace Central Plant" as a priority project.

The alternative to repair or upgrade is abandoning the central plant and installing heating and cooling plants for individual buildings. We do not consider this a prudent approach, due to the increased maintenance burden, possibility of higher capital cost, and additional footprint required. Chilled and hot water piping infrastructure is already installed throughout the campus and appears to be in serviceable condition based on visual inspection, so it is rational to continue to use it.

Initial demand calculations indicate that the plant can accommodate the addition of the future Library and Learning Resource Center provided that all equipment is operational. We recommend proceeding with design to integrate the future Library into the central plant. The footprint of the library will overlap with the existing location of the cooling towers. This report contains five potential sites for relocation of the cooling towers along with pros and cons for each location.

Recommendations

In addition, we have included a list of recommended action items. These items are divided into two categories: Priority A and Priority B. Priority A recommendations require immediate attention and action to remedy a critical existing problem. Priority B recommendations require action within the near future (6 months – 1 year) to improve campus operation.

No.	Description	Priority
1	Retrofit central utility plant. Begin by assessing options for scope of plant retrofit including the following (this scope is included in Phase 2 of this study): 1. Repairing or replacing failing equipment 2. Replacing aged equipment 3. Updating controls and sequences of operation 4. Redesigning the central plant for improved efficiency 5. Repairing any leaking pipes	A
2	Perform regular water treatment for the condenser water system.	A
3	Retrofit existing buildings including HVAC equipment and controls. Begin by further assessing scope of retrofit.	A
4	Complete Phase 2 to determine electrification options for the central plant, energy efficiency recommendations, and detailed demand analysis.	B

2 Introduction

Taylor Engineering was engaged to evaluate the existing central utility plant serving the Laney College campus and provide a report of the condition and capacity of the plant and whether the plant can support connecting the future Library and Learning Resource Center. This report summarizes our observations and recommendations.

Laney College is currently in the design phase of adding a new Library and Learning Resource Center. Taylor Engineering suggested connecting the Library to the central plant for chilled and hot water service to reduce HVAC maintenance requirements, minimize the footprint of the mechanical system, and potentially reduce construction costs of the Library. No data on the central plant was readily available to provide a basis for assessing whether the plant could accommodate the additional heating and cooling load of the Library. Specifically, there was no information regarding the mechanical design of the central plant, the equipment condition, the plant's heating and cooling capacity, or the load that the plant served. Peralta Community College District (PCCD) engaged Taylor Engineering through Noll & Tam to provide foundational information on the central plant.

This report provides a description of the central plant design, a catalogue of the equipment, a first order approximation of the current demand on the central plant, and a description of the equipment condition. Record documents including available but outdated central plant design drawings, equipment submittals for the existing chillers, cooling towers, and boilers, and condenser water treatment reports can be found in by following this link. Up-to-date design drawings for the central plant could not be located in the PCCD drawing archive. Photos taken during the central plant survey can be found at this link. In addition, the footprint of the future library will conflict with the current location of the cooling towers serving the central plant chillers. The cooling towers will be relocated as a separate project. We propose 5 potential locations for the new location of the cooling towers.

3 Description of Central Plant

The Laney College central plant is in Building E. See Figure 1. The plant consists of a heating hot water system, a chilled water system, a domestic hot water system, and a high-pressure steam system serving food service spaces. Drawings for the central plant in the campus archives were out of date, so the following description is based on observations from our site visit, equipment submittals provided by the equipment manufacturers, and review of the campus energy management system interface.

The heating hot water system consists of three gas-fired, non-condensing, 80% efficient hot water boilers that each have an output of 7,200 KBTUH for a total plant capacity of 21,600 KBTUH. The plant was converted from low pressure steam operation to heating hot water in 1999, based on the date of the hot water boiler submittals. We were not able to find record drawings for this conversion in PCCD's plan archives; though, we have inquired with the Engineer-of-Record to see whether they have the plans on file.

The hot water distribution is primary-secondary-distributed tertiary. Three 7.5HP primary pumps designed for 480 GPM at 30 feet of head are located in the Building E boiler room. Two 30 HP secondary pumps designed for 600 GPM at 100 feet of head are located in the Building E chiller room. Tertiary pumps are located in each building served by the central plant. Design hot water supply temperature is 180°F per the original mechanical system design drawings (see Civic Center Site Mechanical Drawings).

The chilled water system was retrofitted in 1999, based on the date of the chiller submittals. The plant consists of three 200-ton water-cooled chillers with variable speed centrifugal compressors, three induced draft crossflow cooling towers with variable speed fans, 3 primary chilled water pumps, 2 secondary chilled water pumps, and 3 condenser water pumps.

The cooling towers are designed for 600 GPM with an 8.5°F approach at a design wet bulb temperature of 65°F and 9°F range. The condenser water pumps are located outside in the cooling tower enclosure and are each 15 hp designed for 600 GPM at 60 feet of head.

Chilled water distribution is primary-secondary. The primary pumping system consists of 3 centrifugal water pumps designed for 400 GPM at 40 feet of head located in the chiller room in Building E. Two secondary pumps are also located in the chiller room of Building E and are each designed for 600 GPM at 160 feet of head. Design chilled water supply temperature is 42°F per the original mechanical system design drawings (see Civic Center Site Mechanical Drawings).

The central plant equipment is controlled with direct digital controls (DDC) from Delta Controls. A central air compressor located in the boiler room provides control air to the pneumatic control systems in each building on campus.

See Table 1 for a summary of the central plant mechanical equipment.

Additionally, a high-pressure steam boiler serves food service spaces. Domestic hot water is provided by gas-fired hot water boilers paired with a 4,000-gallon hot water storage tank. This equipment is located in the boiler room.

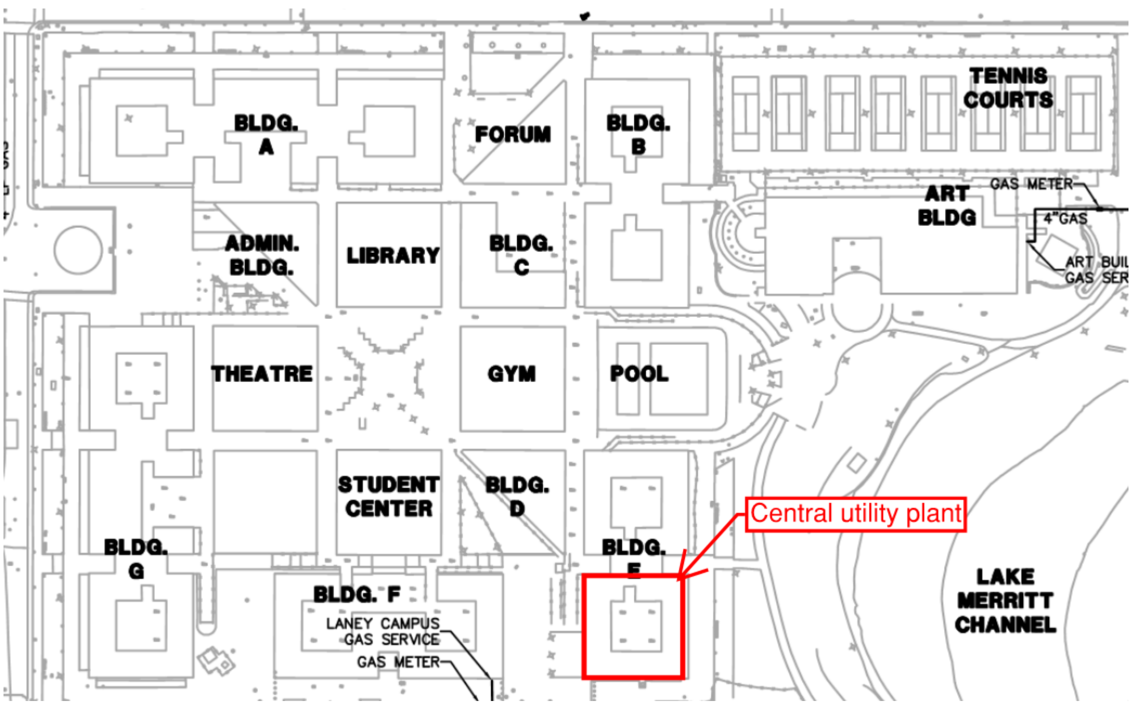

Figure 1. Location of Laney College central utility plant.

Table 1. Equipment List

Equipment	Tag	Make and Model	Serial Number	Capacity	Motor Size	Installation	Operational
Boiler	HWB-1	Cleaver-brooks FLX-700-900-160	BT-6429	Input = 9,000 KB Output = 7,200 KB	N/A	1999	Yes
Boiler	HWB-2	Cleaver-brooks FLX-700-900-160	BT-6430	Input = 9,000 KB Output = 7,200 KB	N/A	1999	No
Boiler	HWB-3	Cleaver-brooks FLX-700-900-160	BT-6431	Input = 9,000 KB Output = 7,200 KB	N/A	1999	Yes
Primary Hot Water Pump	PHWP-1	Taco CE3007E2KAB721D	?	480 GPM, 30 FT	7.5 HP	1999	?
Primary Hot Water Pump	PHWP-2	Taco CE3007E2KAB721D	?	480 GPM, 30 FT	7.5 HP	1999	?
Primary Hot Water Pump	PHWP-3	Taco CE3007E2KAB721D	?	480 GPM, 30 FT	7.5 HP	1999	?
Secondary Hot Water Pump	SHWP-1	Paco 29-40127-145001-X882	?	600 GPM, 100 FT	30 HP	?	?
Secondary Hot Water Pump	SHWP-2	Paco 29-40127-145001-X882	?	600 GPM, 100 FT	30 HP	?	?
Chiller	CH-1,	Carrier 19XR-1212231BEH64	58678	200 tons	N/A	1999	No
Chiller	CH-2	Carrier 19XR-1212231BEH64	58679	200 tons	N/A	1999	Yes
Chiller	CH-3	Carrier 19XR-1212231BEH64	58680	200 tons	N/A	1999	No
Primary Chilled Water Pump	CHP-1	Taco FE3008E2F1F2L0A	212034	400 GPM, 40 FT	7.5 HP	1999	Yes

Equipment	Tag	Make and Model	Serial Number	Capacity	Motor Size	Installation	Operational
Primary Chilled Water Pump	CHP-2	Taco FE3008E2F1F2L0A	?	400 GPM, 40 FT	7.5 HP	1999	Yes
Primary Chilled Water Pump	CHP-3	Taco FE3008E2F1F2L0A	?	400 GPM, 40 FT	7.5 HP	1999	Yes
Secondary Chilled Water Pump	SCHP-1	Paco 29-50159-145001-X912	99C178010B	600 GPM, 160 FT	60 HP	?	?
Secondary Chilled Water Pump	SCHP-2	Paco 29-50159-145001-X912	99C1780101A	600 GPM, 160 FT	60 HP	?	?
Cooling Tower	CT-1	BAC 15219-3	99205571	600 GPM, 82.68F to 73.49F at 65F EWB	20 HP	1999	Yes
Cooling Tower	CT-3	BAC 15219-3	99205581	600 GPM, 82.68F to 73.49F at 65F EWB	20 HP	1999	Yes
Cooling Tower	CT-3	BAC 15219-3	99205591	600 GPM, 82.68F to 73.49F at 65F EWB	20 HP	1999	Yes
Condenser Water Pump	CWP-1	Taco CE4008E2LAB110D	?	600 GPM, 60 FT	15 HP	1999	Yes
Condenser Water Pump	CWP-2	Taco CE4008E2LAB110D	?	600 GPM, 60 FT	15 HP	1999	Yes
Condenser Water Pump	CWP-3	Taco CE4008E2LAB110D	?	600 GPM, 60 FT	15 HP	1999	Yes
Note that we were unable to confirm information for items with a "?" listed in the cell.							

4 Demand Analysis

A demand analysis was performed to compare the current campus demand for chilled and hot water to the central plant capacity and assess whether the plant has sufficient capacity to support the future Library and other potential future projects.

The central plant provides hot water to all buildings on the Laney campus, except the Art Center, which is served by packaged rooftop units. The central plant provides chilled water to 60% of buildings on campus including: Building A, Building D, Building E, Building G, the administrative tower, the forum, the library, the student center, and the theatre. Some buildings that receive chilled water only provide cooling to a portion of the floor area.

We took two approaches to provide a first order approximation for the campus demand for hot and chilled water from the central plant. The first approach is to sum design waterflow for all chilled water coils and the design water flow for all tertiary hot water pumps on the campus. The second approach is to sum the conditioned floor area of the campus and compare the ratio of the conditioned area to the cooling and heating capacity with rule-of-thumb figures. See Table 2 for a summary of results.

4.1 Approach 1—Coils

We totaled the water flow for cooling coils and tertiary hot water pumps from the equipment schedules of all available drawings and used design entering and leaving water temperatures to provide an estimate of plant demand. It is important to note that designers are often conservative when performing heating and cooling load calculations, and this conservatism is reflected in oversized heating and cooling coils. Therefore, simply looking at the size of the coil overestimates the load. In addition, summing the coil design waterflow estimates the maximum demand on the plant without any diversity (e.g. assumes every coil is fully open at the same time). Diversity factors are applied at the plant level to account for asynchronous heating and cooling demand. Not all zones in each building will require full cooling or heating at the same time and not all buildings will require design cooling or heating at the same time. The value used for diversity is dependent upon each building's use and the size of the campus, but typically range from 0.7 to 0.9. We have included both figures as a basis for assessment.

Using this approach, the current cooling demand is 531 tons with no diversity applied, 478 tons with 0.9 diversity applied, and 372 tons with 0.7 diversity applied. The cooling capacity of the plant is 600 tons. We estimate that future Library will require 120 tons of cooling. We can reasonably expect that the current capacity of the plant can handle the additional Library cooling load of 120 tons when applying a conservative 0.9 diversity factor.

The heating demand is 26,550 KBTUH with no diversity applied, 23,895 KBTUH with 0.9 diversity applied, and 18,585 KBTUH with 0.7 diversity applied. The heating capacity of the plant is 21,600 KBTUH. We estimate the library will require 1,050 KBTUH of heating—4.2% of the undiversified heating demand. The plant capacity is below heating demand levels even when a 0.9 diversity factor is applied. Initially, this may seem like an issue, but as we noted that this is a maximum bound for heating demand. Note that these are design capacities and buildings operate at below design conditions for most of the year. In conditions where the demand is greater than the plant capacity, buildings will not experience catastrophic loss of temperature control—some spaces may experience temperatures roughly 1-2°F below setpoint for a few hours. This approach does not provide a conclusive determination for whether the plant has additional capacity to add the library into the central heating hot water loop.

4.2 Approach 2—Rule-of-thumb

Based on an area takeoff using the original campus drawings, the total floor area for all buildings receiving chilled water is approximately 340,030 ft^2. Note that this includes the full area of all buildings receiving chilled water, so the value is conservative because cooling is generally not provided to the full building. Note that there were no record drawings for the theatre, which we estimate at 500 ft^2/ton. The capacity of the chiller plant is 600 tons. The current campus cooling capacity ratio, i.e. the total conditioned floor area divided by the chilled water plant capacity, is 567 ft^2/ton. A common rule-of-thumb is to provide 1 ton of cooling for every 750 square feet (750 ft^2/ton). The plant has at least 150 tons of additional cooling capacity using 750 ft^2/ton. The cooling capacity requirements for the existing buildings may be even lower due to limited glazing and high thermal mass on many of the buildings on the campus.

The total floor area for all buildings receiving hot water is 455,000 ft^2. The capacity of the hot water plant is 21,600 KBTUH. The campus heating capacity ratio, i.e. the hot water plant capacity divided by the conditioned floor area, is 48 BTU/h-ft^2. For new buildings, a common rule-of-thumb is to provide 15 BTU/h-ft^2 of heating capacity. Laney College was constructed in 1968, so the envelope is likely leakier and less insulated when compared to new buildings. With that in mind, it is reasonable to provide 35 BTU/h-ft^2. The plant still has an excess capacity of roughly 5,700 KBTUH.

Table 2. Campus heating and cooling demand summary.

System	Conditioned Area	Approach 1				Approach 2	
		Plant Capacity	0.7 Diversity	0.9 Diversity	1 Diversity	Undiversified Ratio	Rule-of-Thumb Ratio
Heating	*sf*	*KBH*				*BTU/h-sf*	*BTU/h-sf*
	454,530	21,600	17,654	22,698	25,220	48	15-35
Cooling	*sf*	*tons*				*sf/tons*	*sf/tons*
	340,030	600	372	478	531	567	750

4.3 Conclusions

Based on first order approximations, the library can be tied into the central plant without additional capacity upgrades. Both demand calculation approaches indicate that the chillers are adequately sized for the additional load of the library. Demand calculation approach 1 does not provide conclusive direction as to whether the plant has enough heating capacity. Approach 2 indicates that the heating plant has a comfortable amount of additional capacity to handle the addition of the library.

Further demand analysis can be conducted by trending the plant supply and return hot water temperature and adding a flow meter to the hot water secondary distribution loop to provide empirical data on the operational load of the plant. Trending would need to occur during design heating months when the plant will be responding to maximum heating demand. Note that this analysis is based on fully operational plant equipment. As discussed in Section 4, 2 boilers are out of commission and 2 chillers are out of commission. Fixing this equipment is necessary for successfully operating the HVAC system on a campus-wide basis regardless of whether the library is connected to the central plant.

5 Equipment Condition

Central plant equipment is generally in poor condition. Two boilers and two chillers are not operational. The plant is operating at 1/3 of its design heating and cooling capacity, which severely limits the ability to provide mechanical conditioning to all buildings on campus served by the central plant. The building engineer noted multiple occasions of occupant discomfort in various buildings on campus due to limited cooling capacity. He did not discuss any regarding heating. The central plant requires immediate attention to repair failed equipment. We consider this a high priority item because 15 buildings on campus are served by the central plant. An alternative to repairing existing equipment is to replace the equipment with more efficient equipment. The plant would also benefit from an operational and energy efficiency standpoint by implementing state-of-the-art control sequences.

5.1 Hot Water Plant

A. *Boilers*

Two of the three boilers (B-1 and B-2) were not operational at the time of our visit. B-1 had a note on the control panel indicating that the boiler should not be operated. See Figure 2. B-2 had its burner assembly removed. See Figure 3. Further investigation is required to understand why the boilers are not operational. Per the ASHRAE Equipment Service Life database, the mean life expectancy for steel water-tube, forced draft, hot water boilers is 19.6 years. The existing boilers are 21 years old indicating that replacement is not uncommon in these circumstances. Note that this database provides a reference point for equipment life, but decisions on when to replace equipment are unique to every project.

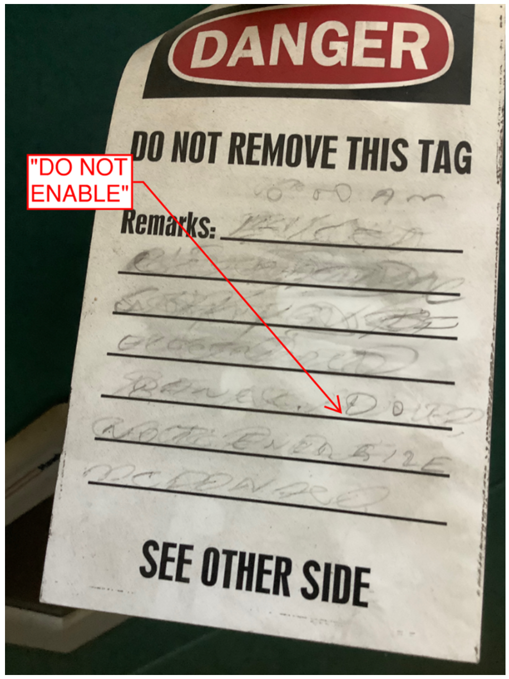

Figure 2. Tag on B-1 start/stop switch indicating boiler is out of service.

Figure 3. B-2 burner assembly.

B. *Hot Water Pumps*

Operation of all primary and secondary hot water pumps was not confirmed during the site visit and condition assessment is beyond the scope of Phase 1. At least 1 primary hot water pump and 1 secondary hot water pump was operational. Pumps did not appear to be leaking. Per the ASHRAE Equipment Service Life database, the mean life expectancy for base mounted end-suction pumps for hot water service (primary hot water pumps) is 24.5 years and the mean life expectancy for split-case centrifugal pumps used for hot water service (secondary hot water pumps) is 27.7 years. The existing pumps are at least 21 years old indicating that replacement is not uncommon in these circumstances. In addition, the tertiary pump serving Building E is leaking.

5.2 Chilled Water Plant

A. *Chillers*

Two of the three chillers (CH-2 and CH-3) are not operational. The condenser water has not been chemically treated for two years, so it is possible that the heat exchangers in the condenser barrels are significantly fouled leading to failure of the chillers. Further investigation is required to diagnose the issues with the chillers. Understanding the cause of the chiller failure is not within the scope of Phase 1 of this analysis. As a preliminary step, we recommend scheduling a visit with a Carrier technician to diagnose the cause of the chiller failures. Per the ASHRAE Equipment Service Life database, the mean life expectancy for centrifugal chillers is 17.9 years. The existing chillers are 21 years old indicating that replacement is not uncommon in these circumstances.

B. *Cooling Towers*

During our February 25 site visit, Matt Beauregard, a water treatment technician with Skasol, was treating the condenser water system. Campus Facility Engineer Jason Busby confirmed that this was the first time that Skasol had checked the system and added chemicals in two years. The condenser water system was running without any water treatment in the interim. The tower fill showed significant scaling. Plastic and leaf debris were stuck to the louvers and tower fill indicating that the towers have not been regularly cleaned. See Figure 4.

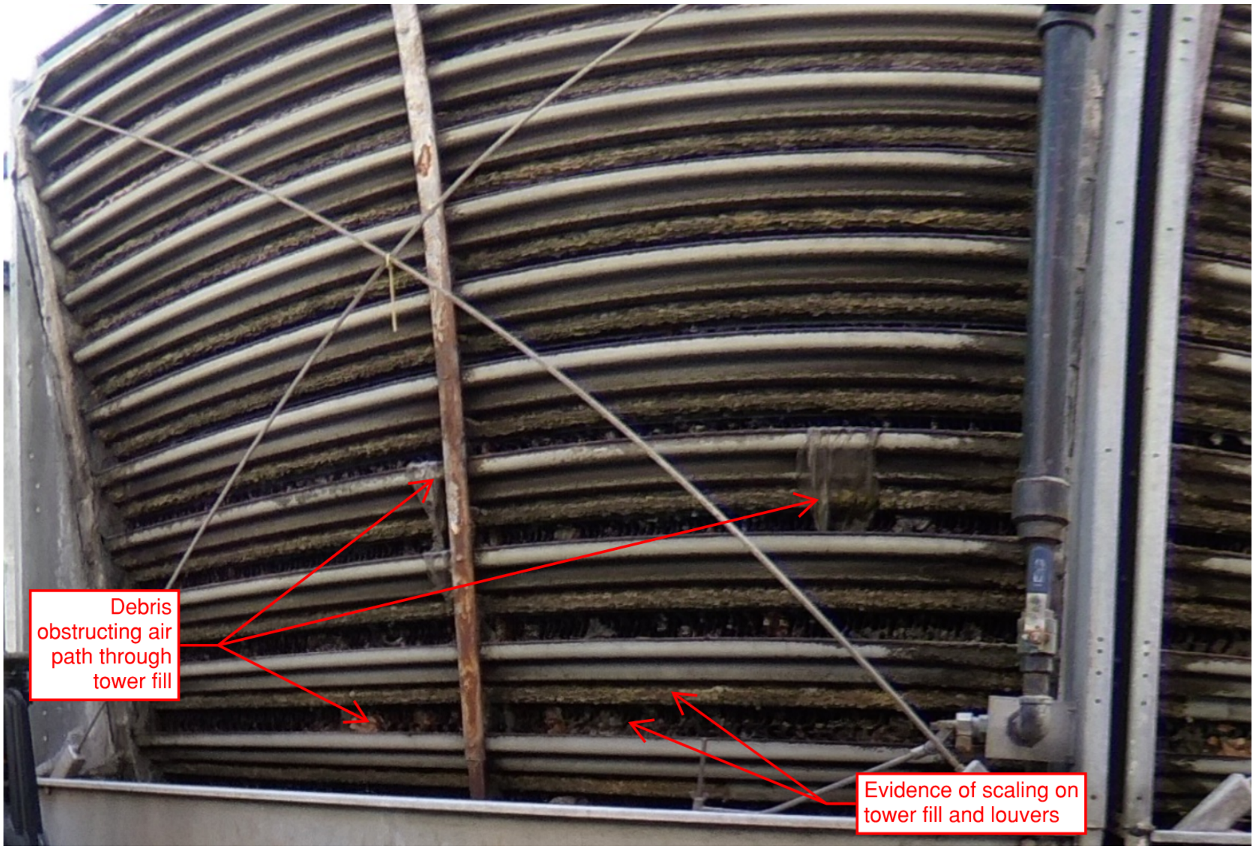

Figure 4. Cooling tower fill condition.

All cooling tower VFDs were switched to bypass, so the tower fans were running at constant speed. This is an abnormal condition, but the building maintenance staff will need to be further interviewed to understand why the VFDs are set to bypass—this could be a control issue or an issue with the VFD hardware.

Per the ASHRAE Equipment Service Life database, the mean life expectancy for cooling towers is 17.4 years. The existing cooling towers are 21 years old indicating that replacement is not uncommon in these circumstances. Based on the water treatment history and visual inspection, our recommendation is to demolish the existing cooling towers and replace with new equipment. This will also provide flexibility regarding cooling tower height and footprint when relocating the equipment.

C. *Chilled Water and Condenser Water Pumps*

Operation of all primary and secondary chilled water pumps and condenser water pumps was not confirmed during the site visit and condition assessment is beyond the scope of Phase 1. At least 1 primary chilled water pump and 1 secondary chilled water pump was operational. Pumps did not appear to be leaking. Per the ASHRAE Equipment Service Life database, the mean life expectancy for base mounted end-suction pumps for chilled water service (primary chilled water pumps and condenser water pumps) is 19.1 years and the mean life expectancy for split-case centrifugal pumps used for chilled water service (secondary chilled water pumps) is 20.6 years. The existing pumps are at least 21 years old indicating that replacement is not uncommon in these circumstances.

5.3 Control System

No sequences of operation were available for the plant equipment, so it is unclear whether the equipment is being controlled appropriately. The building engineer stated that Syserco had provided some troubleshooting work in the recent past but has not provided regular maintenance or service visits due to a lack of financial resources. Key pieces of equipment were witnessed to be operating "in hand", including the cooling tower fans and secondary chilled water pumps. The equipment is not being controlled appropriately or with energy efficiency in mind. Functioning controls are fundamental to operating a central plant efficiently and can reduce the number of man hours required for oversight when compared to manually operating a plant.

6 Cooling Tower Relocation

We investigated potential sites for cooling tower placement during our site visit on February 25. The 3-cell cooling tower used to cool the central plant condenser water loop is located 30 feet southwest of Building E across a fire access lane that is also used for parking. Condenser water is piped from the chiller room below the fire access lane. The cooling towers, condenser water pumps, and water treatment skid sit in a concrete well on the northeastern edge of the footprint of the future Laney Library and Learning Resource Center and will require relocation prior to construction of the library. Based on the age of the cooling towers (21 years old), the lack of consistent water treatment, and visual inspection of the tower fill which showed signs of scaling, we recommend demolishing the existing cooling towers and installing new cooling towers in an alternate location.

Relocating the cooling towers is complicated by the density of underground utilities in this portion of the campus. This area contains the campus service entrance for gas, electrical, and domestic water. Depending on final location, some utilities may need to be relocated and design and construction may require close coordination with a civil engineer. Adding to this complication is the desire for the area around Building E to serve as an inviting entrance to the campus—cooling towers inherently conflict with this intent because they generate noise and are not considered an aesthetic focal point.

We have determined 5 potential locations for the cooling towers. See Figure 5. We describe the location, benefits, and drawbacks for each potential location below. We used the footprint of the existing cooling tower well as an approximation for space requirements—final space required is dependent upon final design capacity and cooling tower model. We considered an additional location under the Building E overhang adjacent to the existing boiler room. This is not a viable location due to legionella concerns, potential for mold growth under the overhang, and the high probability of needing to use a centrifugal cooling tower, which reduces efficiency. We also considered leaving the cooling towers in place, which would require modifying the footprint of the future Library to accommodate the towers, but eliminated this option due to legionella concerns, noise concerns, and potential for mold growth due to the proximity to the future Library.

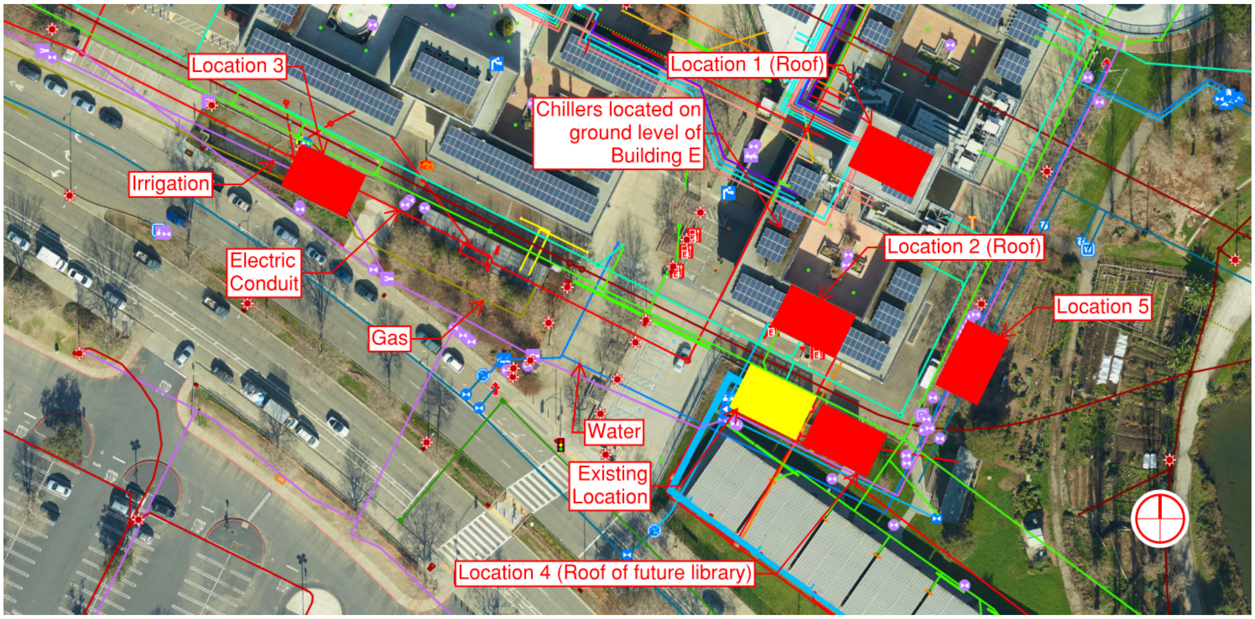

Figure 5. Potential sites for cooling tower relocation.

6.1 Location 1—Building E Penthouse Roof

Locate the cooling towers on top of the Building E penthouse that contains supply and exhaust fans serving building E. Cooling towers would require vibration isolation. A screen could be constructed around the cooling towers to prevent direct line of site. Noise is a concern in this location due to proximity to classrooms on the second floor of Building E, though the area is already quite noisy due to the existing supply and exhaust fans. See Figure 6. Existing building exhaust ductwork that terminates through the roof the penthouse would need to be relocated. Existing photovoltaics would need to be demolished and a roof hatch would need to be installed for access. Condenser water pipe risers could be routed from the chiller room to the penthouse roof via an existing shaft. See Table 3 for a list of pros and cons.

Table 3

Pros
• Close proximity to chillers means minimal condenser water piping • No coordination with underground utilities required • No additional space at grade required
Cons
• Building would likely require structural improvements to support new load • Cooling towers will generate noise audible from the courtyards • Cooling towers will either be visible from the courtyards or an equipment screen will be required • Photovoltaics would need to be relocated or demolished

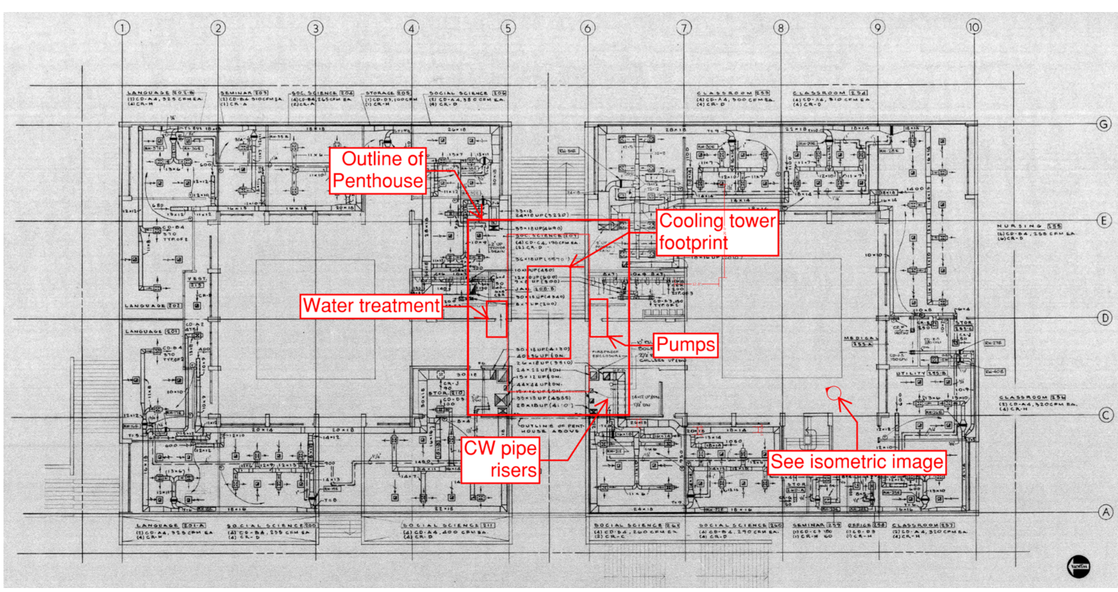

Figure 6. Plan view of potential cooling tower on Building E penthouse roof. Location 1.

Figure 7. Field image of potential cooling tower on Building E penthouse roof. Location 1.

6.2 Location 2—Building E Level 2 Roof

Locate the cooling towers on top of the Building E level 2 roof above existing classrooms. See Figure 8 and Figure 9. Cooling towers would require vibration isolation. A screen could be constructed around the cooling towers to prevent direct line of site. Existing photovoltaics would need to be demolished and a roof hatch would need to be installed or the stairs extended to the roof for access. Condenser water pipe risers could be routed from the chiller room to the penthouse roof via Storage Room 255-C. See Table 4 for a list of pros and cons.

Table 4

Pros
• Close proximity to chillers means minimal condenser water piping • No coordination with underground utilities required • No additional space at grade required
Cons
• Building may require structural improvements to support new load • Cooling towers will generate noise audible from the courtyards • Cooling towers will either be visible from the courtyards or an equipment screen will be required • Photovoltaics would need to be relocated or demolished • Location is directly above classrooms where vibrations and noise could be a nuisance • Location is near boiler flue, which could lead to accelerated cooling tower fill and basin corrosion

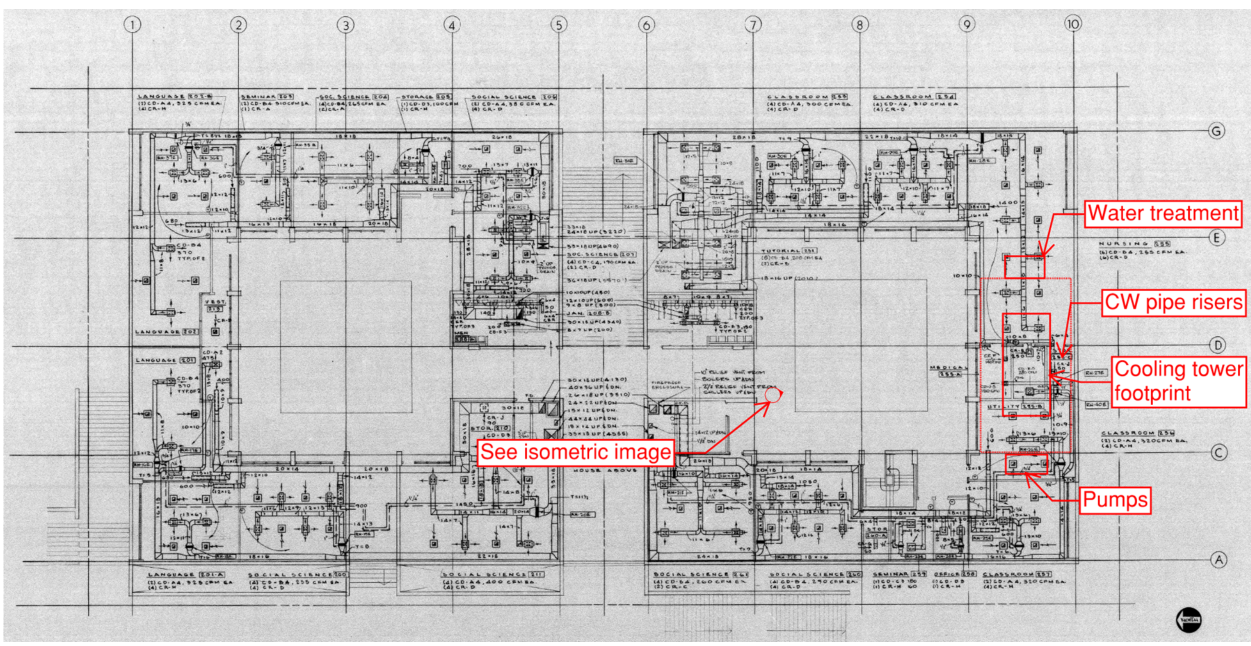

Figure 8. Plan view of potential cooling tower on Building E roof. Location 2.

Figure 9. Field image of potential cooling tower location on Building E roof. Location 2.

6.3 Location 3—Adjacent to Building F

Locate the cooling towers adjacent to Building F in setback between 8th Street and the fire access lane. See Figure 10 and Figure 11. A survey of underground utilities shows a utility owned gas main, district owned electrical conduit, and district owned irrigation within the proposed footprint of the cooling towers. See Figure 12. Locate cooling towers on grade to reduce or eliminate conflicts with underground utilities. Alternatively, cooling towers could be located in a well with similar construction to existing cooling tower well, but existing underground utilities would need to be relocated outside of the footprint of the cooling tower well. Pipe condenser water underground from cooling towers to Building E chiller room. Construct a screen around the cooling towers to prevent tampering. See Table 5 for pros and cons list.

Table 5

Pros
• No structural upgrades required • Located away from classrooms
Cons
• Requires trenching and the longest run of condenser water piping • May require relocation and coordination of underground utilities including gas and electrical if cooling towers are located in a well • Cooling towers will be visible from the entrance of Building F

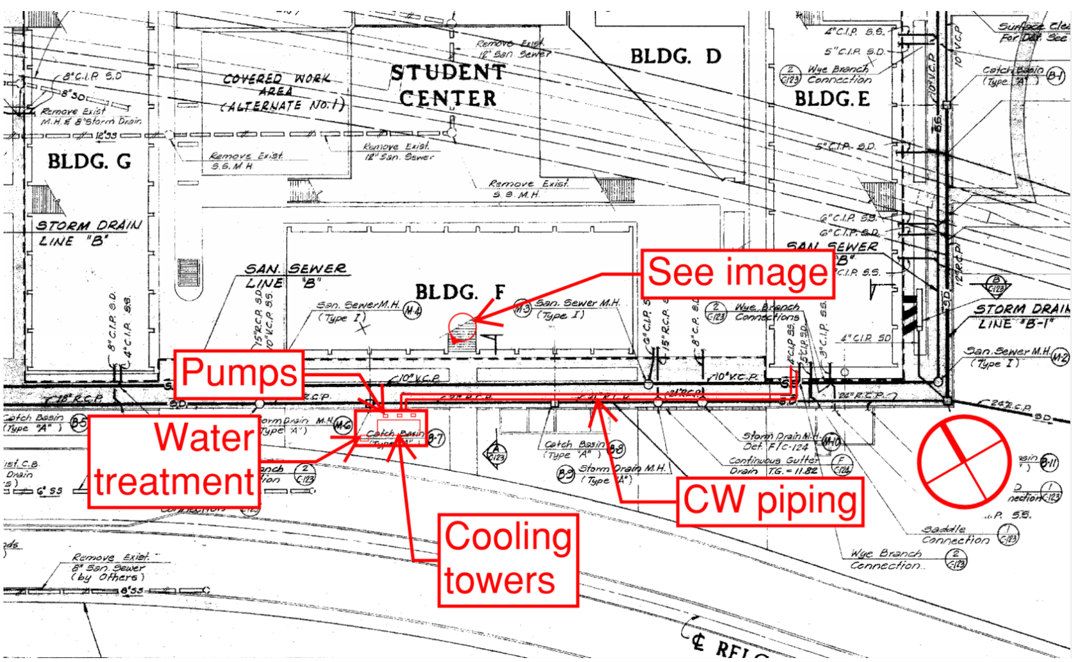

Figure 10. Plan view of potential cooling tower location adjacent to Building F. Location 3.

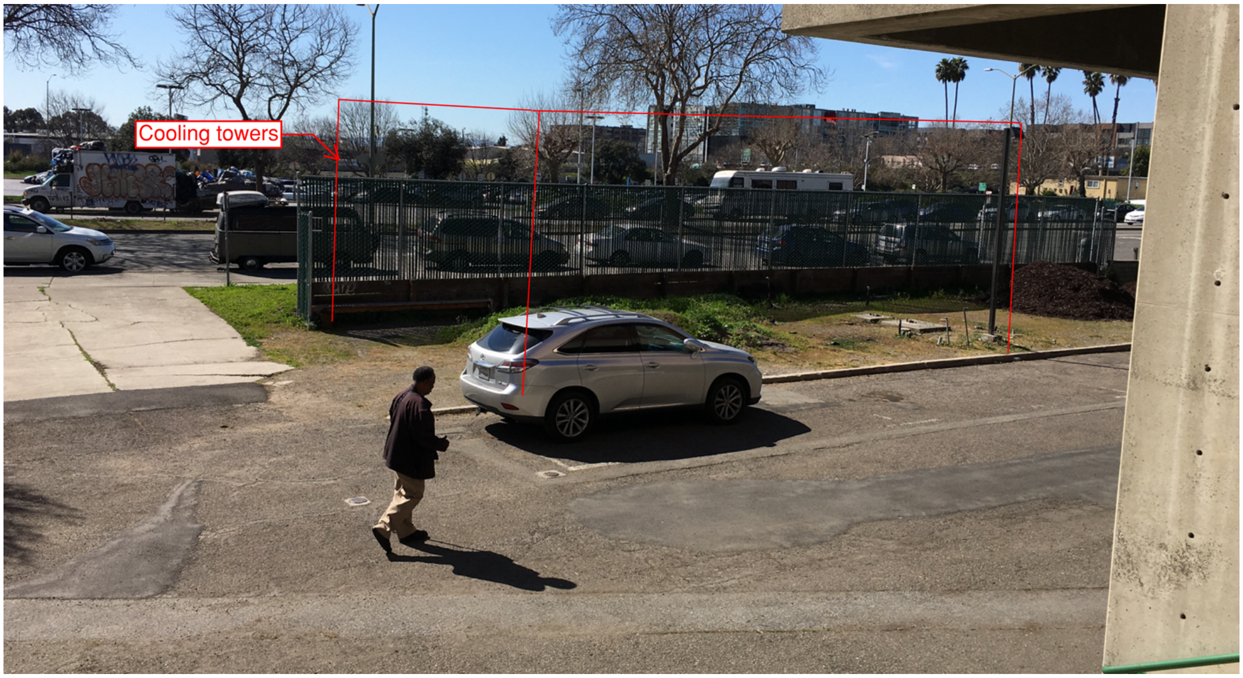

Figure 11. Field image of potential cooling tower location adjacent to Building F. Location 3.

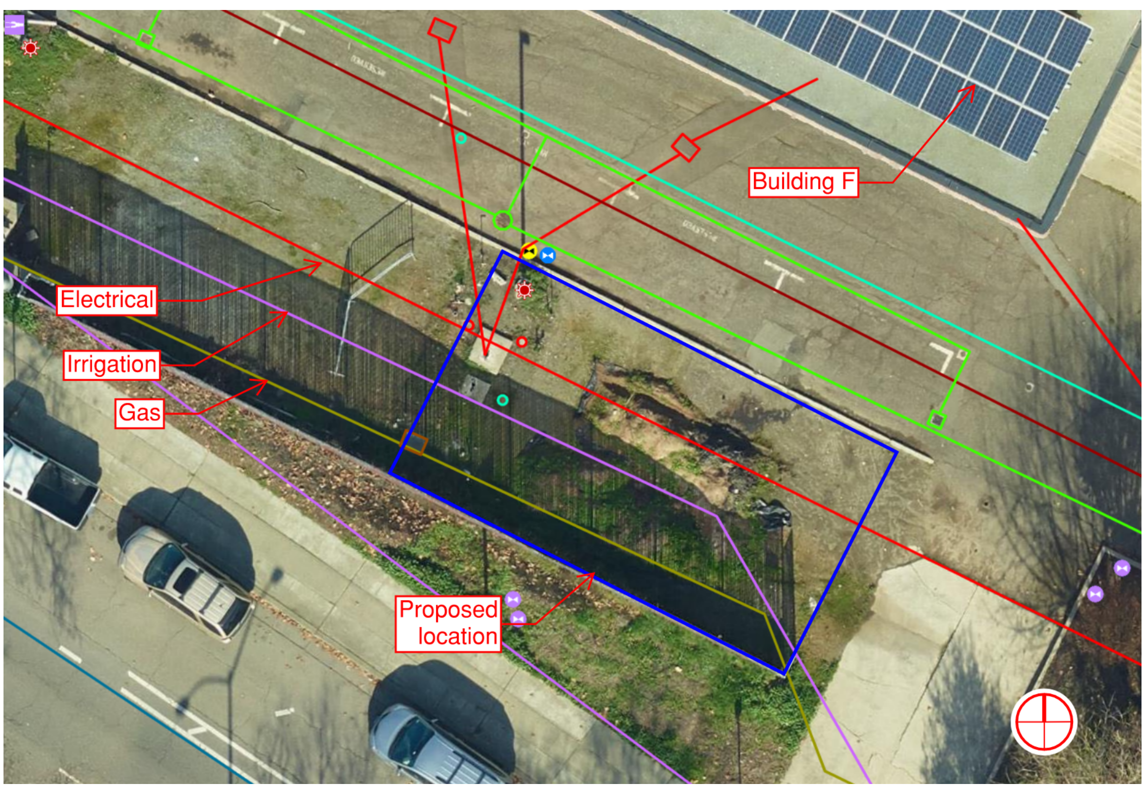

Figure 12. Proximity to underground utilities. Location 3.

6.4 Location 4—On Library/Resource Center Roof

Locate cooling towers on future Library Resource Center roof. See Figure 13 and Figure 14. Provide roof screen and vibration isolation. Tie in condenser water pipes from library to existing underground condenser water pipes. Provide temporary air-cooled chiller or cooling tower to serve the central plant during construction while future cooling towers are non-operational. See Table 6 for pros and cons list.

Table 6

Pros
• Cooling tower structural load can be integrated into structural design of library. No structural retrofits required • No coordination with underground utilities required • Cooling towers would be located in close proximity to chillers in Building E
Cons
• Requires temporary source for chilled water production

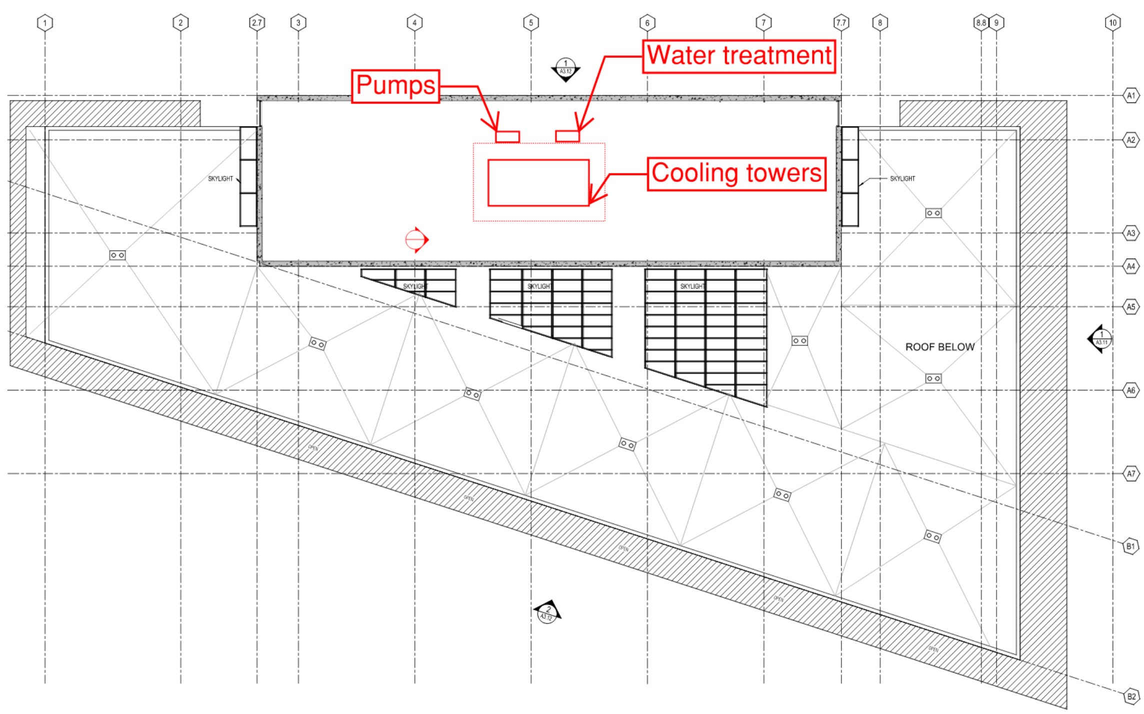

Figure 13. Plan view of potential cooling tower on future library roof. Location 4.

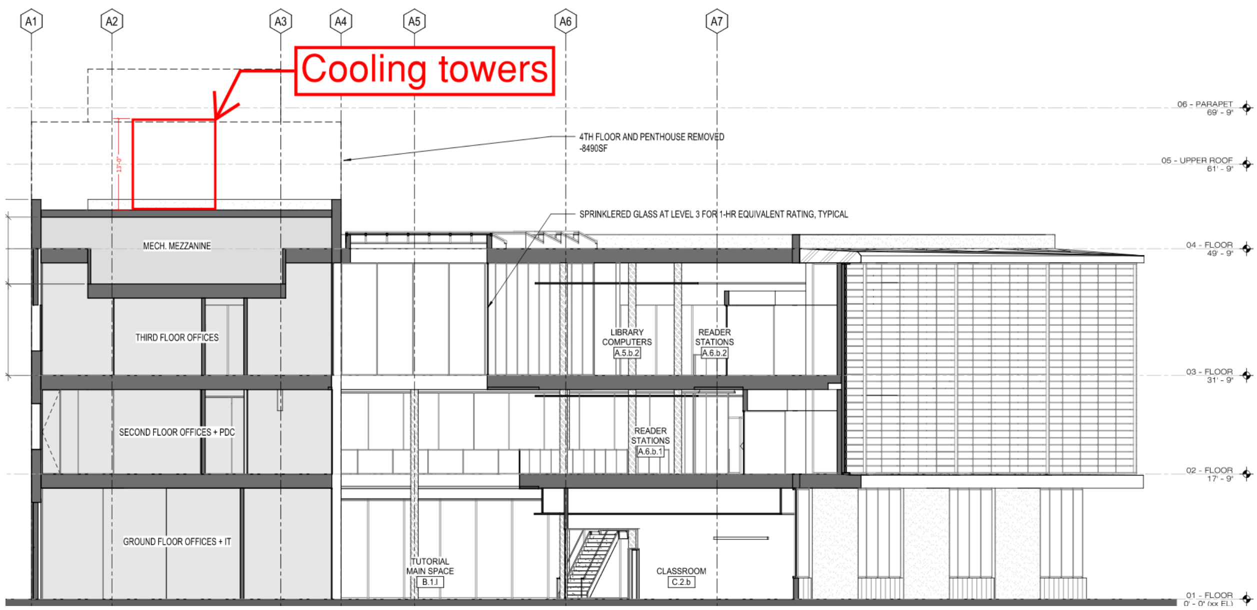

Figure 14. Section view of potential cooling tower on future library roof. Location 4.

6.5 Location 5—East of Building E

Locate cooling towers east of Building E across the fire access lane adjacent to future transformer location. Cooling towers can be constructed at grade or in a well similar to existing installation. See Figure 15. This location conflicts with the existing 40′ easement for the 36″ East Bay Municipal Utility District (EBMUD) water main and a 6″ cast in place domestic water line. Final design of the cooling towers will require coordination with underground utilities including the future relocation of the EBMUD water main to ensure that the cooling towers do not interfere with any easement rights exercised by EBMUD.

Table 7

Pros
• No structural retrofits required • Cooling towers would be located in close proximity to chillers in Building E
Cons
• Adjacent to existing garden • Coordination with underground utilities and EBMUD required

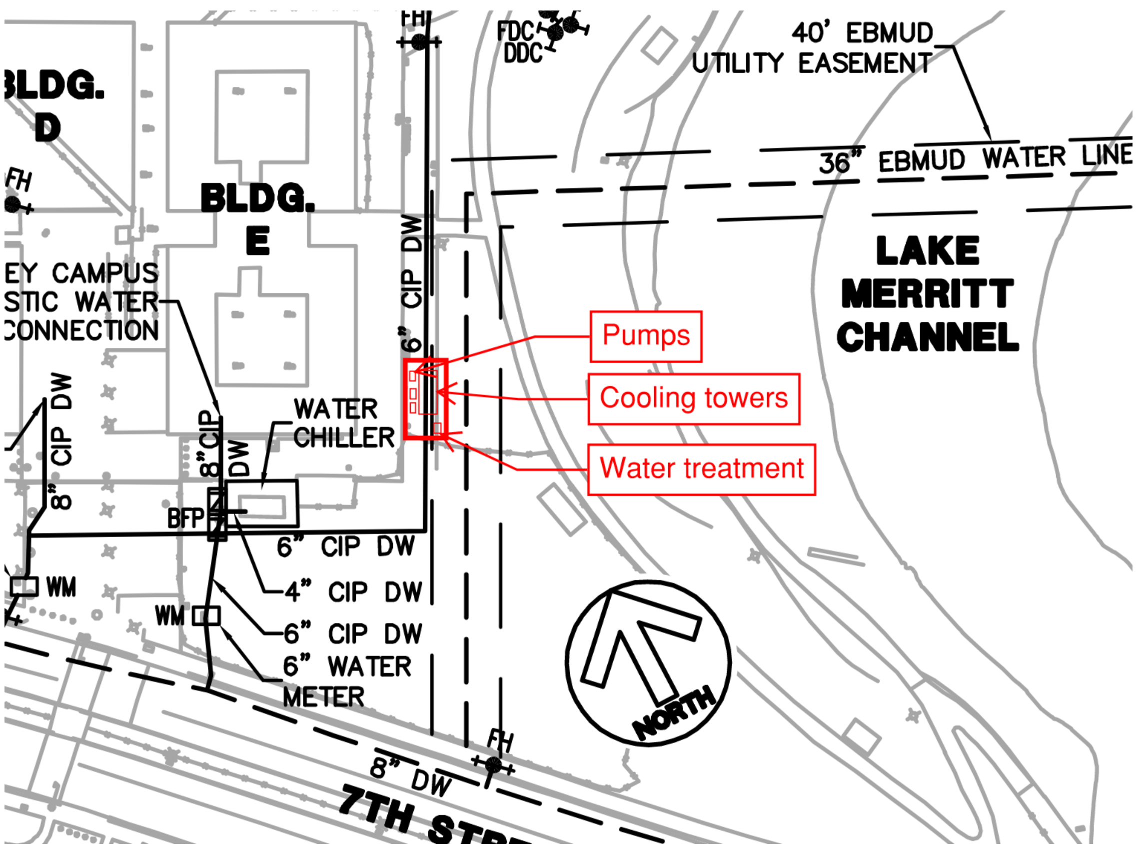

Figure 15. Plan view of potential cooling tower adjacent to Building E. Location 5.

Appendix A: Campus Conditioned Area and Coil Flow Summary

Building	Floor Area	Services Available at Building		Chilled Water			Hot Water					
				Design Flow	Design Temperature		Design Flow	Pumps			Design Temperature	
					EWT	LWT				Head	EWT	LWT
	sf	HW	CHW	GPM	F	F	GPM	Quantity	GPM	Ft H_2O	F	F
Building A	61,600	Yes	Yes	40	44	56	380	2	190	101	180	160
Building B	32,100	Yes	No	0	0	0	276	2	138	72	180	160
Building C	12,900	Yes	No	0	0	0	126	2	63	27	180	160
Building D	7,200	Yes	Yes	37	44	56	120	2	60	31	180	160
Building E	29,000	Yes	Yes	8.7	44	56	252	2	126	58	180	160
Building F	32,900	Yes	No	0	0	0	220	2	110	52	180	160
Building G	52,500	Yes	Yes	75	44	56	372	2	186	62	180	160
Administrative	50,400	Yes	Yes	166	44	56	270	2	135	85	180	160
Tower	--	--	--	--	--	--	90	2	45	38	180	160
Forum	11,430	Yes	Yes	0	44	56	50	2	25	30	180	160
Gym	13,600	Yes	No	0	0	0	0	0	0	0	See	Locker
Library	43,700	Yes	Yes	310	44	56	144	2	72	51	180	160
Locker	23,000	Yes	No	0	0	0	80	2	40	35	180	160
Student Center	46,100	Yes	Yes	277	44	56	142	2	190	50	180	160
Theatre	38,100	Yes	Yes	150	44	56	133	2	--	--	--	--
Art Center	--	No	No	--	--	--	--	--	--	--	--	--
Total	454,530	--	--	1064	--	--	2655	--	--	--	--	--