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WSU Vancouver: Physical Plant Capacity Study 2010 to 2023

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1.0 EXECUTIVE SUMMARY

1.1 General Building Description

The purpose of this report is to examine how the growth plan for the WSU Vancouver campus impacts the existing physical plant. Specifically the plant's chilled water and emergency power systems. This report was originally issued in April of 2009 and has been revised as data showing actual chilled water demand from the summer of 2009 has been made available.

Washington State University started developing its Vancouver Campus in 1993 and has steadily added buildings. Currently (May 2010), the campus has ten operating buildings with approximately 460,000 gross square feet of floor area. Construction of the 58,000 square Applied Technology Center (ATC) building is expected to be completed in 2011. The current Campus Master Plan includes additional building development to 2023 with a goal of 1,265,500 square feet (Alternate 2 growth model).

To keep pace with the campus growth the physical plant building has periodically added chilled water capacity. In 1993 the plant consisted of two (2) 300-Ton chillers (and related equipment) and has since added a third 300-Ton chiller in 1997 and a 750-Ton chiller in 2005 for a current capacity of 1,650-Tons. If one additional 750 - 1000 Ton chiller is added to the plant in 2016, the plant will be able to support the Alternate 2 growth model to completion in 2023. Pumping capacity will also need to be added to the campus chilled water distribution system and the current 12" diameter mains from the plant will need to be supplemented with the 14" diameter piping that has recently been installed (as part of the ATC building project).

Growth beyond years 2023 will require an additional chiller plant building to serve concurrently with the current chiller plant. It is envisioned that the new plant and buildings would be situated east of the current plant building and have a distribution system to extend service to the north end of the campus to support the development in this area. The plant can be sited such that the access road to the WTC and ATC buildings will not be significantly impacted.

An opportunity to adopt a more sustainable approach for the campus exists when the current chiller plant is at maximum capacity in approximately 2023. The new campus piping loop could be designed to be a condenser water loop and the future buildings could be designed with chiller/heaters that are connected to the loop. The use of low temperature geothermal energy sources (open loop) presents an opportunity to eliminate the need for fossil fuels in these future buildings, and by generating electricity on site, or purchasing clean power, the campus can significantly reduce its carbon footprint.

Natural Gas System: The current utility service connection has the capacity sufficient for the proposed infrastructure growth to and beyond 2023. The current connected building load is approximately 24,000 Cubic Feet per Hour (CFH). The current meter (24,000 CFH maximum capacity) should be replaced with a larger meter to handle the additional load before the new ATC building is brought on line in 2011.

Electrical Emergency Power System: The current emergency power system is being updated with the addition of a new 1,000kW generator. The generator and additional emergency power distribution feeders are being provided under the ATC Emergency Generator Expansion Project. The new 1,000kW generator will complement the existing 350kW generator in supporting the projected loads through 2023. At that time the emergency power system should be reevaluated with the following system design changes considered: distributing central plant emergency power at a higher voltage to relieve constraints on the emergency distribution system, or a semi-distributed system with generators located at strategic locations around campus that will reduce the length of distribution feeders while limiting the number of generators required.

2.0 MECHANICAL

2.1 Chiller Plant

2.1.1 Summary of Existing Chilled Water Plant

Description

The existing campus chilled water plant is located in the physical plant building. The total installed capacity is currently at 1,650 Tons with provisions made to accommodate a future capacity increase of approximately 750 Tons. The chiller plant consists of three (3) 300-ton McQuay water-cooled centrifugal chillers and one 750-ton Carrier water-cooled centrifugal chiller. Two (2) 300-ton chillers were installed in 1993, a third was installed in 1997 and the 750-ton chiller was installed in 2005. The condenser water system for the chillers consists of three (3) 300-ton cooling towers and one 800-ton cooling tower and associated pumps, piping and heat exchangers. The three (3) 300-ton cooling towers are located on the south side of the physical plant and the 800-ton cooling tower is located adjacent to the plant on the east side. A 75-ton Plate and Frame Heat Exchanger was added to the plant in 1997 to provide a water side economizer to produce a limited quantity of chilled water during favorable outside temperature conditions. Each chiller has a dedicated primary pump which runs when its accompanying chiller is enabled. The primary pumps have flow rates of 450 GPM each for the 300-Ton chillers and 900 GPM for the 750-Ton Chiller. The last plant expansion provided space for an additional chiller inside the building and space for two cooling towers east of the building. A schematic drawing of the current plant lay-out is shown on attached drawing M100.

General Condition

The chillers and cooling towers have been well maintained, and appear to be in excellent condition. The Median Service Life, according to recent industry surveys (ASHRAE) is approximately 25 years for the chillers and slightly less for the cooling towers. In our opinion the chillers and cooling towers in this plant would be expected to have an economic service life of 30 years. The first two chillers and associated cooling towers are now approximately 15 years old, approximately 50% of their service life. The pumps and piping systems also appear to be in good condition.

Code Issues

There are no code issues foreseen at this time. The chiller room meets current code requirements for a refrigerant machine room.

Environmental Issues

All the chillers use refrigerant (R-134a), a non CFC. This refrigerant has become the unofficial industry standard and is commonly used in large centrifugal chillers by all the major manufactures (except Trane). This refrigerant does not have a phase out schedule.

Controls

1. Description: The chiller plant and the entire campus HVAC systems use Direct Digital Control (DDC) systems. Currently two controls companies (Siemens and Alerton) provide and install systems on the campus.
2. General Condition: The control systems are in good working condition with good trending capabilities. The main campus control center is located in the Facilities office.
3. Code Issues: None noted.

2.1.2 Existing Campus Distribution System

Chilled water is distributed throughout the campus by a variable flow secondary-chilled water system. There are three secondary chilled water pumps with a combined flow rate capacity of 2,250 Gallons per Minute (GPM). Each pump has a capacity of 750 GPM at 116' Head. Prior to the addition of the 750 Ton Chiller in 2005, only two of the three pumps were required for the distribution system. With the 2005 addition, the combined capacity of the three distribution pumps now matches the full capacity of the chiller plant. The secondary chilled water pumps are equipped with Variable Speed Drives (VFD's) which enable a variable volume flow rate in the secondary loop to match the cooling load requirement in the campus buildings.

The secondary pumps distribute chilled water to the campus from the chilled water plant through 12" diameter chilled water supply and return pipes to Manhole #1 in the Mount St Helens utility corridor. The flow rate, in the 12" diameter piping, from the plant, is currently limited only by the installed pumping capacity of 2,250 GPM. However, the 12" diameter main should be considered to be at capacity at approximately 2,500 GPM, due to the fluid velocity in the piping at 8 feet per second (original design condition). This would effectively limit the current chilled water plant maximum cooling capacity to approximately 2,000 Tons. (NOTE: A set of 14" diameter pipes that parallel the existing 12" pipes (not connected to the system), were installed in 2010 during the recent construction of the ATC building, to provide for future flow rates as high as 3,700 GPM.). The flow from the 12" mains is divided to serve the North and South areas of the campus, at Manhole #1. Both the North and South branches are in 10" diameter pipes. The 10" diameter chilled water pipes effectively have a maximum capacity to either the north or south branches to 1,800 GPM (1,500 Tons of cooling). The general layout of the chilled water distribution system is shown on the site plan drawing M200.

The capacity of the existing 12" distribution piping could be increased beyond the original design condition by allowing the maximum piping velocity to be increase to 10 feet per second during peak cooling times. This would provide a maximum flow rate of approximately 3,200 GPM. This would support a chiller plant capacity of up to 2,650 Tons.

Supplementing the current 12" diameter piping with the, recently installed, 14" diameter piping would increase the capacity of the distribution system from the existing plant building to support the campus growth up to and beyond 2023.

2.1.3 Summary of Existing Loads

Existing Connected Loads: The chiller plant currently has an installed capacity of 1650 tons and the current design cooling load for all the existing buildings is 1640 Tons. Data from 2009 indicates that the maximum campus cooling demand was approximately 900 Tons during several 100+°F days. This indicates that campus cooling diversity loading is less than 55%. Table 1 shows a summary of the existing connected cooling capacity (Tons) and the associated chilled water flow rates to the existing buildings. It also shows the connected and maximum capacities for the north and south main branches.

Assuming both the branches will have connected load with a 60% diversity (all buildings do not require design maximum cooling simultaneously), the south branch could accommodate an additional 1,100-Tons of connected load and the north branch 1,400-Tons of additional connected load. Note: The existing chiller plant building can only physically accommodate an additional growth of approximately 1,300-Tons.

BUILDING	Connected Cooling Load GPM	Connected Cooling Load TONS	Branch Maximum Capacity GPM ¹	Branch Maximum Cooling 60% Diversity TONS ²
South 10" Branch				
Administration	144	120		
Classroom	315	265		
Student Center (2 bldgs.)	133	111		
Library	160	135		
McClasky Bldg	65	55		
Multi Media	231	192		
Undergraduate Classroom	318	208		
South Branch SUB TOTAL	1366	1086	1800	2500
North 10" Branch				
Engineering & Life Sci.	450	375		
Clark Center	246	151		
ATC ³	270	180		
WTC ⁴	75	50		
North Branch SUB TOTAL	1041	756	1800	2500
Plant 12" Main				
Physical Plant Building	15	13		
Physical Plant Addition	18	15		
South Branch	1366	1086		
North Branch	1041	756		
	2440	1870	2500	3200
PLANT LOADING ⁵	2440	1870	2500	3200
¹ Based on a fluid velocity of 8 feet per second in supply and return piping. ² Assumes all buildings do not require design cooling load simultaneously. ³ (On Line 2010) Design Phase ⁴ Future Building (2011) ⁵ Total Connected Load Expected by Summer 2011				

Table 1: Existing Loads Summary

Chiller Plant Diversity: The total connected building chilled water requirements are usually higher than the chiller plant output even on the hottest days of the year. The ratio of peak chiller plant output to the connected load is defined as the Chiller Plant Diversity. Several reasons for this diversity are: All the campus buildings do not experience their design conditions simultaneously, design weather conditions seldom occur simultaneously with the design internal load cooling conditions, and buildings seldom contain the design maximum number of occupants.

During a previous study (2003) the chiller plant diversity was determined to be approximately 60% during July/August (summer student population) and predicted to be 78% during September (regular student population).

Actual usage data for the 2009 cooling season (May, June, July, August, and September) indicates that the campus peak cooling load is lower than previously predicted. In the summer of 2009, the highest diversity was approximately 55% during several 100+ °F days in late July. Graphical representation of this data is included in the Appendix.

Future Cooling Loads (2009-2023)

For estimating the future campus chilled water requirements, the campus growth model referred to as Alternative 2, as described in the 2005 Draft Supplemental Environmental Impact Statement (DSEIS) is used. Alternative 1 in the DSEIS describes a growth model that ends in 2013 and is not addressed in this report. Alternative 3 describes a growth model of 14% from 2014 to 2023 and is not addressed in this report. A previous Infrastructure study conducted in 2003 addressed campus growth to 2013 only.

Alternative 2

Assumes an increase of 12% annual student Head Count (HC) from 2003 to 2013 and 9% from 2014 to 2023. With a building program that will result in a gross floor area of 1,265,500 square feet in 2023.

For the purpose of this analysis we have assumed an even annual growth in building square footage from 2014 to 2023. Additionally we have assumed cooling loads in the future buildings that are similar to the existing. We believe this will be conservative assumption as the energy efficiency of future buildings is likely to increase.

Tables 2. Shows the predicted campus cooling and chilled water flow rate demand to 2023 using the Alternative 2 growth model. Campus chilled water demands for diversities of 65%, 60%, and 55% are shown. Forecasts for additions to the current chiller plant are made using the 60% diversity factor.

Campus Buildings	Year Built	Gross Square Feet	Cumulative Gross Square Feet	CHW GPM	Cooling Load Tons	Connected Cum Cooling Tons	Cum w/65% Diversity Tons	Cum w/60% Diversity Tons	Cum w/55% Diversity Tons	Installed Plant Capacity Tons ¹
1 Admin Building	1992	38,400	38,400	144	120	120	78	72	66	900
2 Classroom Building	1992	64,555	102,955	315	265	385	250	231	212	900
3 Library	1993	37,802	140,757	160	135	520	338	312	286	900
4 Student Commons	1993	29,921	170,678	60	50	570	371	342	314	900
5 Early Childhood	1994	17,000	187,678	65	55	625	406	375	344	900
6 Physical Plant	1992	4,160	191,838	15	13	638	415	383	351	900
7 Engr & Life Sci	2000	60,000	251,838	450	375	1013	658	608	557	900
8 Physical Plant Addn.	2005	9,000	260,838	18	15	1028	668	617	565	900
10 Multimedia Clsrm.	2001	49,200	310,038	231	192	1220	793	732	671	900
11 Student Services	2007	18,000	328,038	73	61	1281	833	769	705	900
12 Clark Center	2004	66,000	394,038	246	151	1432	931	859	788	1650
13 U Clsrm Bldg.	2009	60,000	454,038	318	208	1640	1066	984	902	1650
14 ATC	2010	58,000	512,038	270	180	1820	1183	1092	1001	1650
15 WTC	2011	10,000	522,038	75	50	1870	1216	1122	1029	1650
Future Bldgs.	2012	28,462	550,500	103	85	1955	1271	1173	1075	1650
Business	2013	60,050	610,550	257	214	2169	1410	1301	1193	1650
Future Bldgs.	2014	60,050	670,600	257	214	2383	1549	1430	1311	1650
Future Bldgs.	2015	66,100	736,700	238	198	2581	1678	1549	1420	1650
Future Bldgs.	2016	66,100	802,800	238	198	2779	1806	1667	1528	1650
2016 ADD NEW 750 TON CHILLER										
Liberal Arts	2017	66,100	868,900	238	198	2977	1935	1786	1637	2400
Future Bldgs.	2018	66,100	935,000	238	198	3175	2064	1905	1746	2400
Health Sciences +	2019	66,100	1,001,100	238	198	3373	2192	2024	1855	2400
Future Bldgs.	2020	66,100	1,067,200	238	198	3571	2321	2143	1964	2400
Future Bldgs.	2021	66,100	1,133,300	238	198	3769	2450	2261	2073	2400
Future Bldgs.	2022	66,100	1,199,400	238	198	3967	2579	2380	2182	2400
Future Bldgs.	2023	66,100	1,265,500	238	198	4165	2707	2499	2291	2400
TOTALS		1,265,500		5199		4165	2707	2499	2291	2400

¹ The existing chiller plant building has adequate space for one additional 750 to 1000 Ton chiller. The addition of a 750 Ton chiller would bring the campus chiller plant size to 2400 Tons and would serve the campus to 2023 (assuming a campus chilled water diversity of 60%.)

Table 2: Alternate 2 Growth Model

Plant Capacity (Tons Cooling)						
Year Installed	CH-1	CH-3	CH-3	CH-4	Future CH-5	Plant Total
1993	300	300				600
1997			300			900
2005				750		1650
(2016)					750	2400

Note:

- 2009 July recorded peak cooling demand: 900 tons
- Assumes growth model alternate 2 with 60% diversity factor

Table 3: Chiller Plant Capacity (Tons of Cooling) – Alternate 2 Growth

Plant Capacity (Tons Cooling)							
Year Installed	CH-1	CH-3	CH-3	CH-4	Future CH-5	Plant Total	
1993	300	300				600	
1997			300			900	
2005				750		1650	Note 1
(2016)					1000	2650	Note 2
(2023+)		1000				3050	Note 3, 4
Note: 1. 2009 July recorded peak cooling demand: 900 tons 2. Assumes growth model alternate 2 with 60% diversity factor 3. Plant Building at capacity 4. Option: Replace first two chillers with single large chiller							

Table 4: Chiller Plant Capacity (Tons of Cooling) – Current Chiller Plant Building Maximum

2.1.4 Recommendation for Expansion

Existing Chiller Physical Plant Building

Based on the assumptions that the chilled water demand diversity remains below 60%, as the campus continues to grow, the current chiller plant building (with the addition of a chiller in 2016) can accommodate the Alternative 2 growth to 2023. However, the campus chilled water distribution system (specifically the 12" diameter mains from the plant) will be required to operate beyond the original design capacity.

For the Alternative 2 growth model, an additional chiller, associated cooling tower, pumps and accessories will need to be added to the existing plant in the 2015 to 2016 time frame. At that time, we recommend that either a 750 Ton or 1,000 Ton chiller be added (depending on the campus cooling demand trends) to maximize the existing plant capacity.

The flow rate of the campus distribution system will need to be increased prior to the addition of the chiller in 2016. An additional secondary 1200 GPM pump (or two 750 GPM pumps to match the existing) will need to be added. Additionally, the 12" diameter piping in the plant building will need to be increased to 14" diameter and the 12" diameter piping from the plant to Manhole #1 will need to be replaced with or supplemented with the 14" diameter pipes that have been recently installed in the utility corridor to the north of the plant building.

In 2023, the first two (2) 300-Ton chillers installed (1993) will have been in service for 30 years. These chillers should be programmed for replacement at or near that time. It may be feasible to replace the three existing 300 Ton units with 400 Ton chillers to maximize the plant total capacity at 2,950 Tons. Optionally, replace the first two 300 Ton chillers with a 1,000 Ton chiller. This should essentially maximize the capacity of the current chiller plant building.

For significant campus growth beyond 2023 an additional Chiller Plant building and campus distribution system will be required.

Additional Chilled Water Physical Plant Building and Distribution

An additional chilled water physical plant building will be required for significant growth beyond 2023.

From discussions with Planning staff, the expansion of the campus beyond the current Master Plan will be to the predominantly to the north. Therefore the new chilled water plant building will need to serve this area. Two options would be:

1. A remote plant in the north part of the campus, or
2. A plant building adjacent to the current plant building with dedicated main distribution piping system for the north area of the campus.

The preferred chilled water plant location is adjacent to the existing plant building. This location removes the industrial nature of the plant from the academic areas of the campus and the nearby residential neighborhood areas. However, the distribution system will be more expensive to install.

Expansion of the current plant building to the north is restricted by the proposed locations for the new ATC and WTC buildings. Expansion to the east appears to be the best option and is not limited by existing or planned buildings.

The new chiller plant building is proposed to be independent from the existing and it is not necessary to maintain continuity or connection to the existing plant buildings or equipment. However, a Right of Way (ROW) for future distribution buried piping must be maintained on the north side of the new and existing plants.

Chilled Water Demand Monitoring

We recommend that the chiller plant demand capacity be continuously monitored and reported during peak months (July, August, and September) each year, to verify the campus diversity trend. This study has made recommendations regarding the dates of plant expansions based on a 60% diversity factor. Should monitoring determine that the diversity trends change as the campus grows, the time frame for plant expansions should be adjusted accordingly.

2.2 Gas Utilities

2.2.1 Summary of Existing Gas System

Description: In general the campus buildings are heated through a distributed heating plant system where each building has a dedicated boiler plant. An existing 45 psi natural gas service, provided by Northwest Natural, is provided from 29th Avenue to the Physical plant building in a 4" main line to a master meter at the physical plant. The master gas meter has a maximum capacity of approximately 24,000 Cubic Feet per Hour (CFH). The current connected load in the existing buildings is approximately 24,000 CFH. WSU owns the campus gas distribution system downstream from the master meter. Natural gas is then distributed through a 6" line from the plant to a point near manhole #1 and then splits to the north and south campus along the Mt St Helens corridor. A 6" line runs to the south, while a 4" line runs to the north. Each building is individually sub metered by the campus. A drawing of the current system is shown on drawing M100.

2.2.2 Summary of Existing and Future Loads

Gas Loads: The utility gas service connection to the campus (by Northwest Natural) currently has a capacity that will be adequate for the building program beyond 2023. However, the campus distribution capacity is limited by both the meter size and the distribution piping downstream from the meter. The meter can easily be replaced (by NW Natural) to increase the size of the campus capacity, however the campus distribution piping system will then become the limiting factor.

2.2.3 Recommendation for Expansion

The natural gas piping service, from Northwest Natural, to the campus master meter has the capacity to support the future ATC and WTC buildings and for growth beyond 2023. However, the current gas meter should be replaced to accommodate the campus connected load of, approximately 30,000 CFH, when the next three buildings come on line. Recommend that the meter be replaced in 2010 before the ATC Building is operational. NW Natural will provide and install this new meter.

Recommend that the existing WSU Vancouver owned campus gas distribution system be analyzed to determine adequacy to support the campus growth models to 2023 and beyond. Table 6 is a summary of the connected gas loads to the existing buildings and a projection for the future buildings, using the Alternative 2 growth model.

	Campus Buildings	Year Built	Gross Square Feet	BTUH/SF	Estimated Bldg Connected Load CFH	Connected Cum Gas Load CFH
1	Admin Building	1992	38,400	60	2,304	2,304
2	Classroom Building	1992	64,555	51	3,292	5,596
3	Library	1993	37,802	47	1,777	7,373
4	Student Commons	1993	29,921	77	2,304	9,677
5	Early Childhood & Ed	1994	17,000	76	1,292	10,969
6	Physical Plant	1992	14,532	57	828	11,797
7	Engr & Life Sci	2000	60,000	68	4,080	15,877
8	Physical Plant Addn.	2005	9,000	57	513	16,390
10	Multimedia Clsm.	2001	49,200	68	3,346	19,736
11	Student Services	2007	18,000	72	1,296	21,032
12	Clark Center	2004	66,000	50	3,300	24,332
13	UGrad Clsrm Bldg.	2009	60,000	40	2,400	26,732
14	ATC	2010	58,000	50	2,900	29,632
15	WTC	2011	10,000	80	800	30,432
	Future Bldgs.	2012	28,462	46	1,309	31,741
	Business	2013	70,200	46	3,229	34,970
	Future Bldgs.	2014	66,100	46	3,041	38,011
	Future Bldgs.	2015	66,100	46	3,041	41,051
	Future Bldgs.	2016	66,100	46	3,041	44,092
	Liberal Arts	2017	66,100	46	3,041	47,133
	Future Bldgs.	2018	66,100	46	3,041	50,173
	Health Sciences +	2019	66,100	46	3,041	53,214
	Future Bldgs.	2020	66,100	46	3,041	56,254
	Future Bldgs.	2021	66,100	46	3,041	59,295
	Future Bldgs.	2022	66,100	46	3,041	62,336
	Future Bldgs.	2023	66,100	46	3,041	65,376
	TOTALS		1,292,072	1405	65,376	

Table 5: Natural Gas Loads

2.3 Sustainability Considerations

2.3.1 Overview

Although not the main thrust of this report this section addresses sustainability considerations that may suggest an alternative approach to adding additional chilled water plant to the campus. This section of the report addresses how the Washington State University Vancouver Campus can address those considerations. This section covers:

1. National Sustainable design standards that the WSU has decided to follow.
2. Campus renewable energy opportunities.
3. One potential option for a carbon neutral campus.

2.3.2 National Sustainable Design Standards

USGBC LEED Silver Certification

Virtually all state funded projects in Washington State are now required to meet the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Silver certification requirements. For new construction projects this requires obtaining 33-38 points of the 69 possible LEED points. Points can be obtained in the following categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process.

Energy Efficiency

LEED Silver requires a minimum of 14% cost savings (2 points) over ASHRAE Standard 90.1. We encourage the design teams to exceed this minimum requirement by at least a factor of two. In addition, we recommend that WSU set specific Energy Use Index (EUI) goals for each different building type. Meeting these EUI goals for future buildings is a very important step if the campus wants to become carbon neutral.

Commissioning

We encourage future building projects to pursue the "enhanced commissioning" point in addition to the LEED pre-requisite for "fundamental commissioning"

Measurement and Verification (M&V)

We encourage future building projects to pursue the LEED M&V point in order to help future design teams predict the infrastructure needs for the campus and compare them to the goals indicated in this section of the master plan.

Architecture 2030

Architecture 2030, a non-profit, non-partisan and independent organization, was established in response to the global-warming crisis by architect Edward Mazria in 2002. Architecture 2030's mission is to rapidly transform the US and global Building Sector from the major contributor of greenhouse gas emissions to a central part of the solution to the global-warming crisis.

Their goal is straightforward: to achieve a dramatic reduction in the global-warming-causing greenhouse gas (GHG) emissions of the Building Sector by changing the way buildings and developments are planned, designed and constructed.

Architecture 2030 strives to meet its mission by galvanizing both the building industry and the nation to adopt and implement the 2030 Challenge, a global initiative stating that all new buildings and major renovations reduce their fossil-fuel GHG-emitting consumption by 50% by 2010, incrementally increasing the reduction for new buildings to carbon neutral by 2030.

The 2030 Challenge

Asking the global architecture and building community to adopt the following targets:

All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

The fossil fuel reduction standard for all new buildings shall be increased to:

1. 60% in 2010
2. 70% in 2015
3. 80% in 2020
4. 90% in 2025

Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to operate).

These targets may be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20% maximum) renewable energy and/or certified renewable energy credits.

The WSU Vancouver master plan currently does not directly address the Architecture 2030 challenge.

STARS by AASHE

The Association for the Advancement of Sustainability in Higher Education (AASHE) has recently introduced the Sustainability Tracking, Assessment, and Rating System (STARS), the first comprehensive standards for campus sustainability. One notable difference between STARS and other “Green” rating systems, is the holistic approach, which incorporates social and economic factors.

The rating system involves both prerequisites and credits in three categories:

1. Education and Research,
2. Operations and
3. Administration and Finances.

The pilot program consists of two phases. Phase One covers Operations and half of the Administration and Finance process. The other half of Administration and Finance is covered in Phase Two, along with Education and Research.

Like LEED, STARS also offers points for innovation, though the process is not yet solidified.

The WSU Vancouver master plan does not directly address the STARS systems but many of the Operations goals overlap with other systems we are following.

American College & University Presidents’ Climate Commitment

This commitment requires the university to develop a “comprehensive plan to achieve climate neutrality as soon as possible”. Many universities in the Northwest have signed onto this plan. Some of these include the Washington State University, University of Washington, Oregon State University and the University of Oregon.

Some items in this plan include:

1. Completing a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel).

2. Establishing a target date for climate neutrality.
3. Requiring all new campus buildings meeting at least a LEED Silver Standard.
4. Requiring all new appliances and computers meeting Energy Star requirements.
5. Encouraging the use of public transportation.
6. Purchasing or producing at least 15% of the institution's electricity consumption from renewable sources.
7. Making the action plan, inventory and periodic reports publicly available by providing them the Association for the Advancement of Sustainability in Higher Education (AASHE).

An option that might be considered for this campus is one that offers a potential path to carbon neutrality for the building heating and electricity component of the campuses CO₂ emissions. This option involves using a district condenser water loop instead of chilled water. For additional information, refer to the appendix for more details on the "American College and University Presidents Climate Commitment".

2.3.3 CARBON NEUTRAL CAMPUS OPTION

A "Carbon Neutral" option for the campus

If the following 6 items are implemented the University has a good chance of virtually eliminating the majority of carbon emissions from the operation of its buildings.

1. Set aggressive but achievable Energy Use Index (EUI) reduction goals for future buildings.
2. Implement a campus condenser water loop and connect to open loop geothermal wells to be used as the heat source and heat sink for the majority of the campus heating and cooling loads. Use heat pumps (heater chillers) in each building to provide heating and cooling instead of the current natural gas boilers and campus chilled water system.
3. Incorporate renewable energy generation in future buildings. A mix of solar thermal, PV and wind is recommended.
4. Purchase green power for any electricity needs not met by on campus generation.
5. Use biofuels or additional geothermal wells for campus heating needs beyond those served by the first two geothermal wells.
6. Remove the natural gas fired boilers in the existing heating plants when they reach the end of their useful life and add "fossil fuel free" heating plants in their place. (They can be heated through chiller/heaters tapped into the campus condenser water loop or using biofuel boilers).

One opportunity to switch to this approach will be when the existing chiller plant and piping is at maximum capacity in approximately 2015. The new campus piping loop could be designed to be a condenser water loop and the new buildings could be designed with chiller/heaters that are connected to the loop. That would eliminate the need for fossil fuels in all the new buildings.

3.0 ELECTRICAL

3.1 Emergency Power Distribution System

3.1.1 Existing System Conditions(*) (* existing systems conditions updated to include ATC Generator Expansion Project)

Description

The emergency power system consists of an existing 350kW diesel engine driven generator set in the physical plant and a 1,000kW diesel engine driven generator set (currently being installed under the ATC Generator Expansion Project) in a weather proof enclosure adjacent to the physical plant. Power is generated and distributed at 480V. The present configuration has one circuit to the south and two circuits to the north on the Mt. St. Helens corridor, with multiple taps off each circuit feeding automatic transfer switches in each building. The main circuit feeders in the corridors are oversized to reduce the amount of voltage drop associated with running long distances at 480V. Tap feeds to individual buildings are sized per circuit rating. The longest present feeder, Loop A, is to the Undergraduate Classroom Building (UCB) at approximately 1700 feet in length.

A system of ductbanks and vaults with three 4-inch conduits connecting each vault has been established along the Mt. St. Helens and Mt. Hood corridors for emergency power distribution. There are currently two empty 4-inch conduits available for future feeders to the south campus and one empty 4-inch conduit for a future feeder to the north campus. The Utility Corridor ductbank feeding this system from the Physical Plant has three spare 4-inch conduits available.

The campus standard for power monitoring is Square D PowerLogic and all emergency loads are monitored and recorded by this system. Existing emergency system loads obtained from the campus power monitoring system are shown in the table below, with the exception of the new Undergraduate Classroom Building whose emergency demand is calculated based on connected load and projected loads at future buildings. Emergency distribution feeder loads have been assigned to the planned added feeders identified in the ATC Generator Expansion Project. These loads are indicated in the table below.

EMERGENCY POWER SYSTEM LOAD SUMMARY - WITH FUTURE MASTER PLAN LOADS									
	Campus Buildings	Bldg Tag	Year Built	Gross Square Feet	NEC 700		NEC 702		
					VA/SF	Projected Demand (kVA)	Projected Demand (kVA)	Feeder	
Existing Generator Loads	1	Admin Building ¹	ADM	1992	38,400		5.0		A
	2	Classroom Building ¹	CLS	1992	64,555		49.0		A
	3	Library ¹	LIB	1993	37,802		6.0		A
	4	Student Commons ¹	FSC	1993	29,921		3.0		A
	5	Early Childhood & Ed ¹	MCB	1994	17,000		5.0		A
	6	Physical Plant ¹	PPB	1992	14,532		21.0		C
	7	Engr & Life Sci ¹	ELS	2000	60,000		56.0	29.0	H
	8	Physical Plant Addn. ²	PPB	2005	9,000		-		C
	10	Multimedia Clsrm. ¹	MMC	2001	49,200		13.0		A
	11	Student Services ¹	SSC	2007	18,000		5.0		F
	12	Clark Center ¹	CCW	2004	66,000		5.0		H
	13	UGrad Clsrm Bldg.	UCB	2009	60,000		12.0	88.7	A
	Future Generator Loads	14	Advance Technology Center	ATC	2010	37,000		40.0	215.0
15		WTC	WTC	2010	10,000		5.3	95.6	E
		Future Buildings	FS1/2	2012	28,462	0.25	7.1		F
		Business	FN1	2013	70,200	0.25	17.6		G
		Future Building	FN2	2014	110,000	0.25	27.5		E
		Future Building	FS3/4/5	2015	110,000	0.25	27.5		F
		Future Building	FN3	2016	110,000	0.25	27.5		G
		Liberal Arts	FSG	2017	110,000	0.25	27.5		F
		Future Building	FS7	2018	110,000	0.25	27.5		F
		Health Sciences	FN4	2019	110,000	0.25	27.5		G
		Future Building	FS8/9	2020	110,000	0.25	27.5		F
		Future Building	FS10	2021	110,000	0.25	27.5		F
		Future Building	FN5	2022	110,000	0.25	27.5		G
		Future Building	FN6	2023	110,000	0.25	27.5		G
		Future Bldg NEC 702						200.0	
		Future Parking Garage					10.0		G
	Future Parking Garage					10.0		E	
	Future Parking Garage					10.0		E	
TOTALS				1,710,072		555.0	628.3	Feeder Load in kVA	
							Feeder Load in Amperes at 480V 3PH		
Projected Campus Demand @ 0.9 P.F.:					1064.9	kW			
Proposed Generator Capacity:					1350	kW			
Percent Loading:					79%				
1	Projected demand based on data obtained from campus power monitoring system.								
2	Physical Plant Addition demand included in Physical Plant demand.								

Table 6: Campus Emergency Power Load Summary

General Condition: The existing emergency system is in good condition, with no known operational issues. The existing Caterpillar generator has low operating hours, is still being manufactured and parts are projected to be available long term. With the addition of the UCB, the existing 350 kW generator was loaded to approximately 77% of its rated power capacity. Because the UCB is a large emergency load at a great distance from the generator, the calculated emergency service voltage under full system demand load is approximately 456 volts. This represents a 5% voltage drop, which is higher than commonly accepted standards.

Code Issues

There are no known code issues with the existing emergency power distribution system.

3.1.2 Future Emergency System Loads

Future emergency system loads are based on Alternative 3 growth model. Life Safety loads, listed as NEC 700 loads, will consist almost exclusively of egress lighting and have been assigned a value of 0.25 VA/sq. ft. for purposes of this study. Optional Standby loads, listed as NEC 702 loads, will consist mainly of mechanical ventilation and data processing equipment identified by the owner as being connected to the emergency power system. Preliminary loads for the ATC and WTC buildings currently under construction were provided by the project design team and have been included in this study. No optional standby loads (NEC 702) have been identified for future buildings. Included in this study is 200 kVA of capacity to connect optional standby loads that may be desired at future buildings.

3.1.3 System Distribution

Existing Emergency Feeders

Existing campus Emergency Feeders A, B and C will supply power from the existing 350kW 600A distribution panel. Selected building loads will be moved from the existing feeders A and B to the new 1,000kW generator distribution feeders F, G and H.
New Emergency Feeders:

Five new campus Emergency Feeders (feeders D, E, F, G and H) are being installed under the ATC Generator Expansion Project. The new feeders will be fed from the 1,000kW Generator Emergency Distribution Panel. Three of the feeders will support the Mt. St. Helens Corridor loads and three will support the new Utility Corridor loads.

Distribution System Configuration

The two generators (350kW and 1,000kW) operate independent from each other. Each generator receives a call for power from the ATS's assigned to their distribution feeder. In addition the new 1,000kW distribution system will provide backup power to the existing 350kW distribution system with a Kirk-Key interlock feed. The Kirk-key interlock feed will permit the 1,000kW system to provide power to existing emergency feeders A, B and C if the 350kW generator has been pulled out of service. In addition, the 350kW generator can be used to provide "limited" backup power to "selected" loads on emergency feeders D, E, F, G and H if the 1,000kW generator is taken out of service.

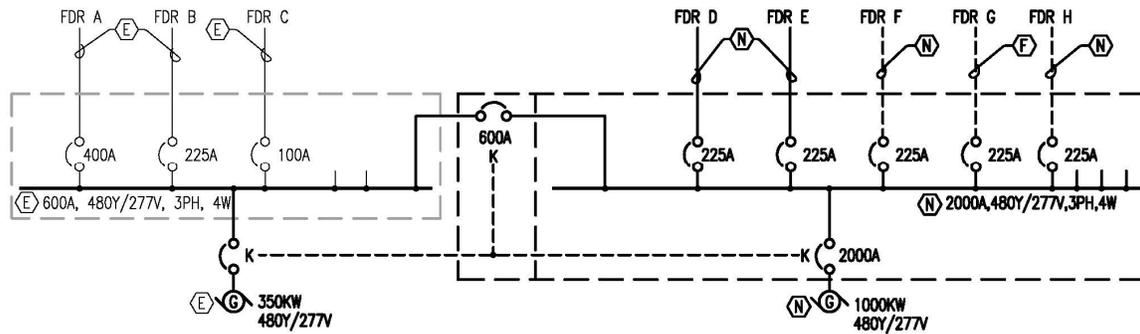


Figure 1: Campus Emergency Power Configuration

3.2 Normal Power Distribution System

3.2.1 Existing System Conditions

Description

The existing campus receives power from a connection with Clark Public Utilities District (CPUD) near the intersection of NE 50th and NE 159th. CPUD lines run underground along the campus access road to the primary metering and service disconnect switchgear located northwest of the intersection of the access road and the campus loop road. At the service disconnect, the service is fused at 400A, limiting the supply beyond this point to 8.6 MW.

From the service point, a single 400A, 12.47 kV, circuit runs to the physical plant 15 kV switchgear. At the physical plant, the switchgear provides two 200A circuits for the south loop, two 200A circuits for the north loop, a radial feeder to the physical plant's 1500 kVA transformer and two 200A circuits in the utility corridor to the ATC project and the future WTC project. The loops each run through a series of four position pad-mounted switches. For each of the loop's switches two of the positions are unfused switches used to segment the loops, the other two positions are fused switches used to feed building transformers. Each loop is operated with one loop switch open to limit the area impacted should there be a failure in one of the cable segments. If there is a cable fault, the affected segment can be isolated and the remainder of the loop operated as two radial circuits, allowing full redundancy at the loop level.

General Condition

The switches and building transformers should be cleaned and inspected periodically at recommended three to four year intervals. It was observed in the past that the insulators on some switches have become degraded due to a lack of cleaning. Otherwise the system is in good condition, with no known issues.

Code Issues

There are no known code issues with the existing normal power distribution system.

3.2.2 Projected Normal System Loads

The table below shows projected normal power system demand based on alternative 3 growth model. Total demand numbers for the existing loops were generated from the campus power monitoring system and are not broken down per building. Existing campus peak demand numbers calculate to 5 VA per square foot and this number has been used to project future normal power demand. Decreases in peak demand resulting from increases in energy efficiency have not been factored into future projections.

Campus Buildings	Year Built	Gross Square Feet	kVAD/SF	Projected Demand (kVA)	Feeder Loop	South Loop A/B Demand (kVA)	North Loop C/D Demand (kVA)	PP Loop Demand (kVA)	Existing 400A service Cap (kVA)	Load Gradient (kVA)	Existing 400A service Spare Cap (kVA)
1 Admin Building	1992	38,400			A/B						
2 Classroom Building	1992	64,555			A/B						
3 Library	1993	37,802			A/B						
4 Student Commons	1993	29,921			A/B						
5 Early Childhood & Ed	1994	17,000			A/B						
6 Physical Plant	1992	14,532			PP						
7 Engr & Life Sci	2000	60,000			C/D						
8 Physical Plant Addn.	2005	9,000			PP						
10 Multimedia Clrm.	2001	49,200			A/B						
11 Student Services	2007	18,000			A/B						
12 Clark Center	2004	66,000			C/D						
<i>(Existing Feeder 12 month demand, Note 1)</i>						1,880		649	844		8630
UGrad Clrm Bldg.	2009	60,000	5.0	300	A/B	300			8630	2,180	6450.0
ATC	2010	37,000	5.0	185	PP			185	8630	2,365	6265.0
WTC	2010	10,000	5.0	50	PP			50	8630	2,415	6215.0
Future Bldgs. - FS1/2	2012	28,462	5.0	142	A/B	142			8630	2,557	6072.7
Business - FN1	2013	70,200	5.0	351	C/D		351		8630	2,908	5721.7
Future Bldgs. - FN2	2014	110,100	5.0	551	C/D		551		8630	3,459	5171.2
Future Bldgs. - FS3/4/5	2015	110,100	5.0	551	A/B	551			8630	4,009	4620.7
Future Bldgs. - FN3	2016	110,100	5.0	551	C/D		551		8630	4,560	4070.2
Liberal Arts - FS6	2017	110,100	5.0	551	A/B	551			8630	5,110	3519.7
Future Bldgs. - FS7	2018	110,100	5.0	551	A/B	551			8630	5,661	2969.2
Health Sciences - FN4	2019	110,100	5.0	551	C/D		551		8630	6,211	2418.7
Future Bldgs. - FS8/9	2020	110,100	5.0	551	A/B	551			8630	6,762	1868.2
Future Bldgs. - FS10	2021	110,100	5.0	551	A/B	551			8630	7,312	1317.7
Future Bldgs. - FN5	2022	110,100	5.0	551	C/D		551		8630	7,863	767.2
Future Bldgs. - FN6	2023	110,100	5.0	551	C/D		551		8630	8,413	216.7
Future Parking Garage			1.0	10	C/D		10		8630	8,423	206.7
Future Parking Garage			1.0	10	C/D		10		8630	8,433	196.7
Future Parking Garage			1.0	10	C/D		10		8630	8,443	186.7
TOTALS		1,711,072		8,443		3844	3521	1079			

Notes:
 1 Loop demand numbers shown reflect existing 12-month demand from Campus Monitoring System
 2 Load gradient is the summation of loads added per future buildings

Table 7: Campus Normal Power Summary

The total normal system capacity of 8.6 MW should be adequate to serve the 8.44 MW total projected demand in 2023. At that time, it will likely be necessary to add additional capacity from the CPUD. Present Loop A/B and C/D capacities of 4.3 MW should also be adequate to serve projected demands through 2023, but system planning to add additional campus feeders can be expected at that time.

3.2.3 Alternate Normal Power Service

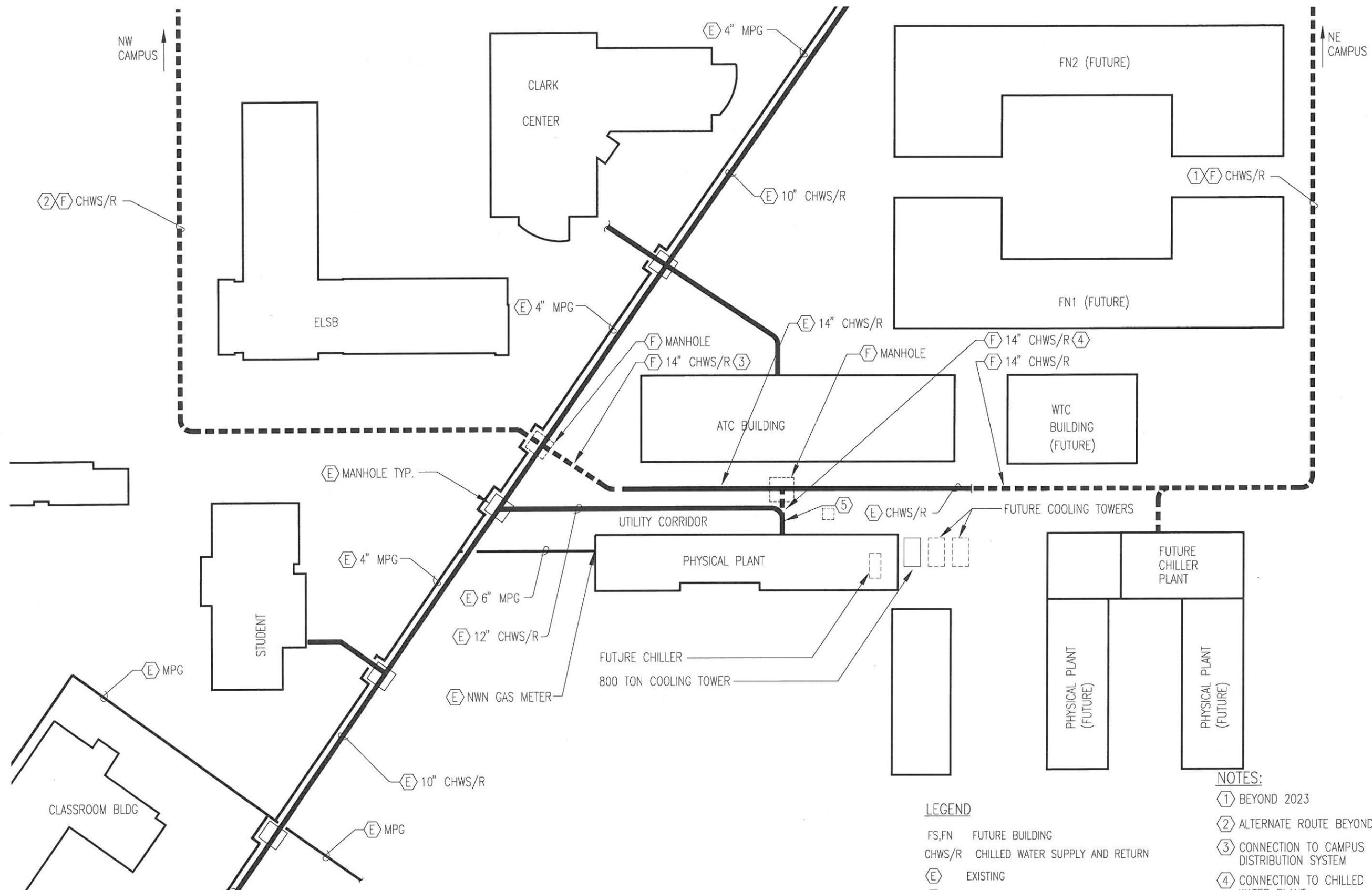
There is currently no normal power service redundancy between the campus entrance at NE 50th and NE 159th and the switchgear at the Physical Plant. Adding a second source of power from a separate CPU substation would add overall system capacity and provide a redundant source of power to the campus. The serving utility Clark Public Utility District (CPUD) has indicated that capacity with redundancy is available from the Jones Substation Feeder. The CPUD Jones feeder currently located west of the Campus will need to be upgraded (restrung) to provide the redundant capacity desired for the WSUV Campus loads. The CPUD feeder to upgrade is approximately 2 miles in overhead length. The new feeder would enter the campus from the west at NE 159th and feed new service switchgear adjacent to the existing medium voltage utility service disconnect. There is currently a spare 5-inch conduit along the St. Helens corridor terminating at the Physical Plant 15 kV switchgear that would bring the second source into the campus normal power distribution system.

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Appendix A

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1 M100 NTS **SITE PLAN - MECHANICAL - UTILITY** N

LEGEND

- FS, FN FUTURE BUILDING
- CHWS/R CHILLED WATER SUPPLY AND RETURN
- (E) EXISTING
- (N) NEW
- (F) FUTURE

NOTES:

- (1) BEYOND 2023
- (2) ALTERNATE ROUTE BEYOND 2023.
- (3) CONNECTION TO CAMPUS DISTRIBUTION SYSTEM
- (4) CONNECTION TO CHILLED WATER PLANT
- (5) EXISTING 12"Ø REPLACED WITH 14"Ø.

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 Project No. 09-1011

WASHINGTON STATE UNIVERSITY

 VANCOUVER, WA

WSU PHYSICAL PLANT MASTER PLAN

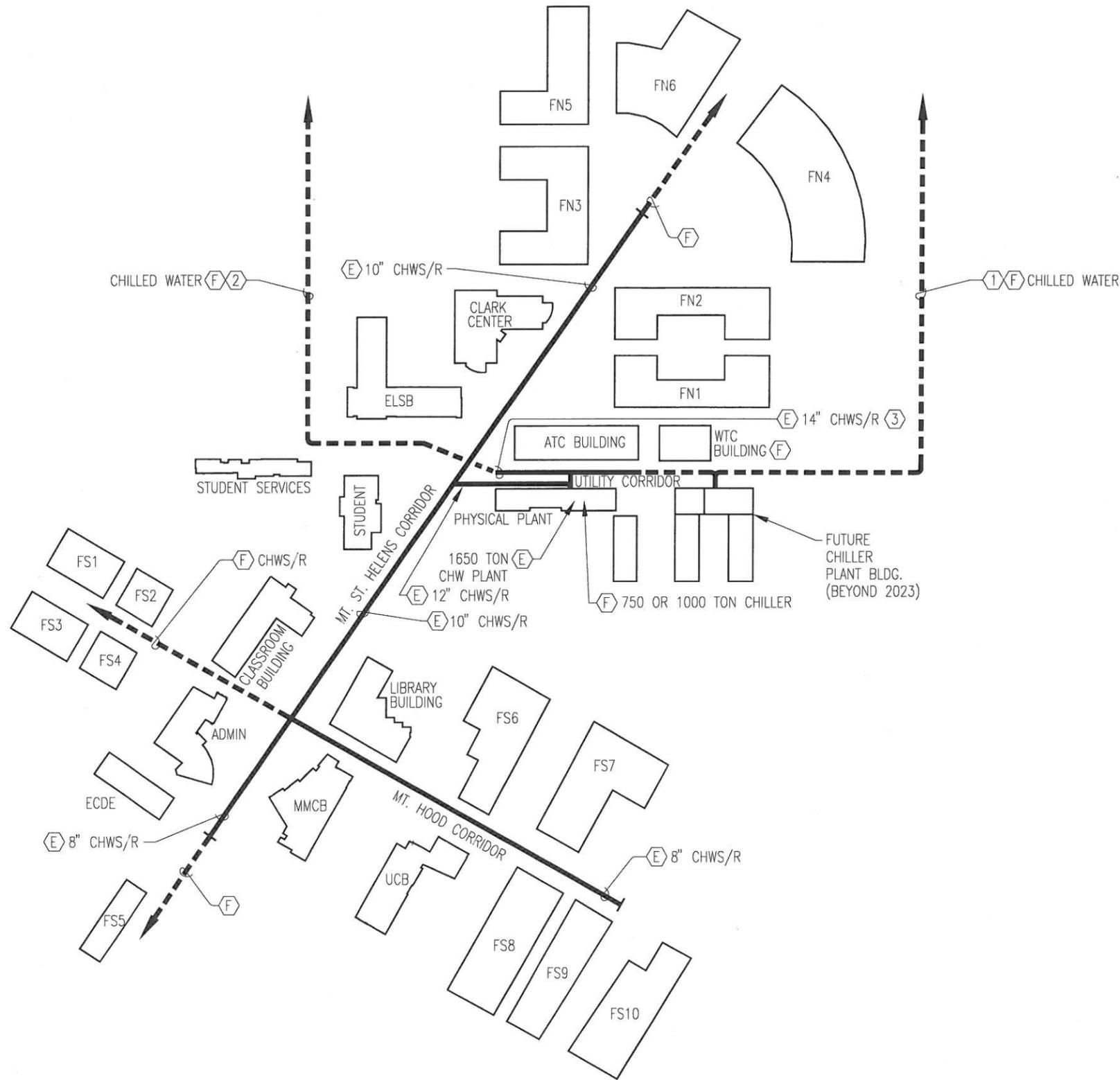
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TITLE
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M100

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GENERAL NOTES:

1. ALTERNATE 3 GROWTH PLAN SHOWN.

NOTES:

- ① FUTURE EXPANSION TO NORTH (BEYOND 2023).
- ② ALTERNATE EXPANSION TO NORTH (BEYOND 2023).
- ③ CURRENTLY INSTALLED 14" CHW FOR FUTURE CONNECTION.

LEGEND

- FS, FN FUTURE BUILDING
- CHWS/R CHILLED WATER SUPPLY AND RETURN
- ⓔ EXISTING
- Ⓝ NEW
- ⓕ FUTURE

1 SITE PLAN - MECHANICAL - CHILLED WATER DISTRIBUTION
M200 NTS

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WASHINGTON STATE UNIVERSITY
VANCOUVER, WA

WSU PHYSICAL PLANT MASTER PLAN

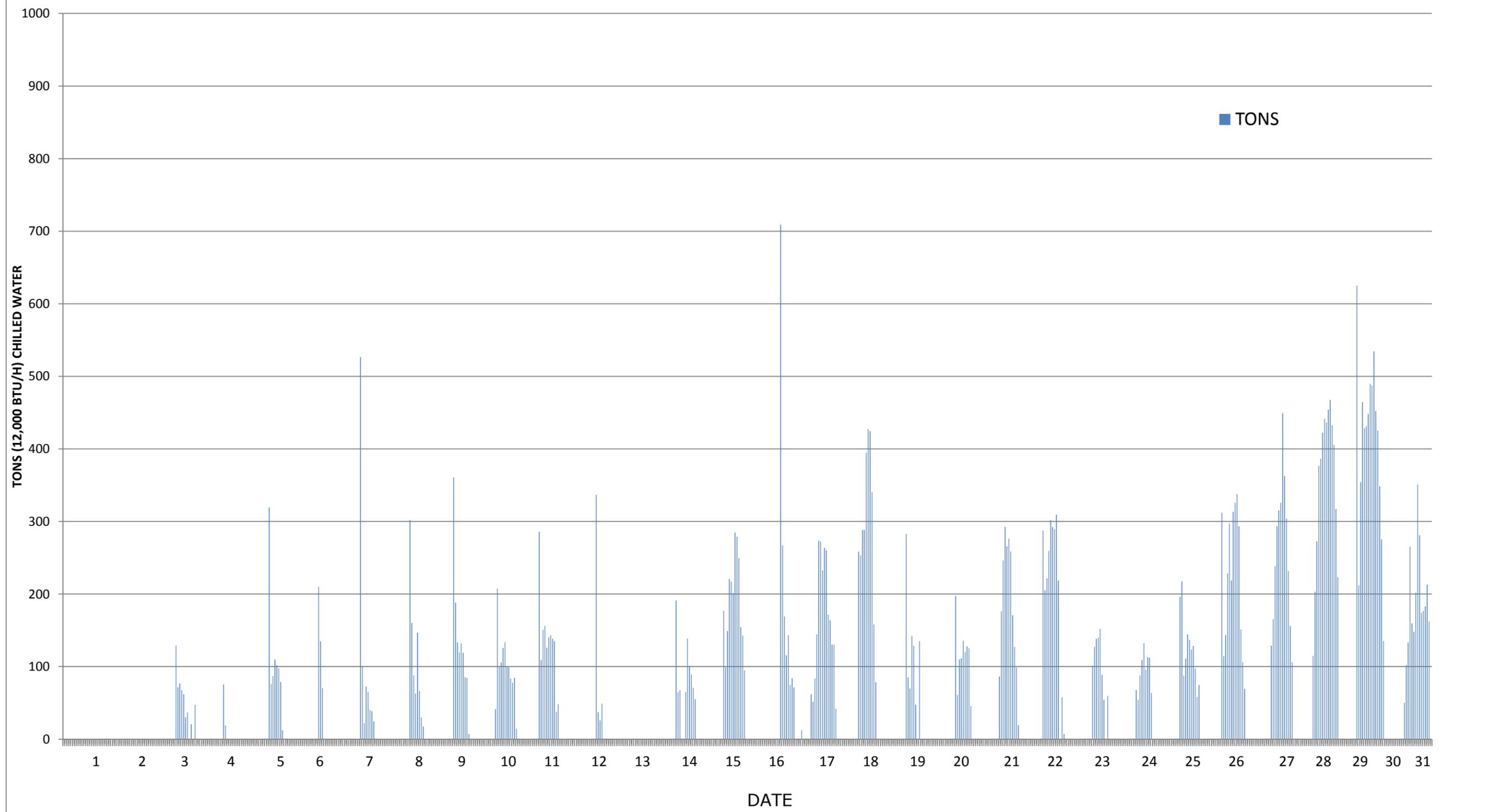
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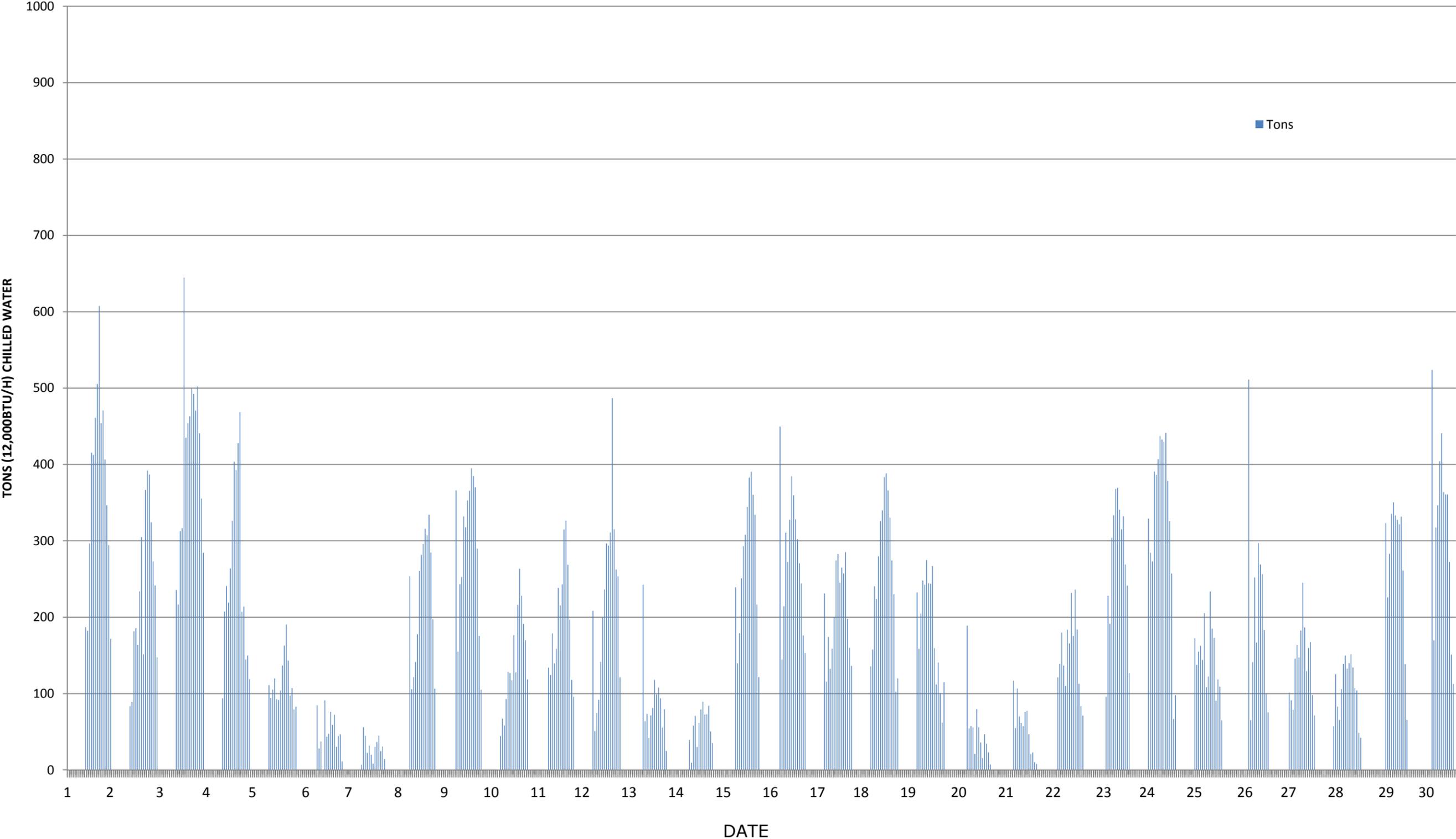
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MECHANICAL
SITE PLAN

M200

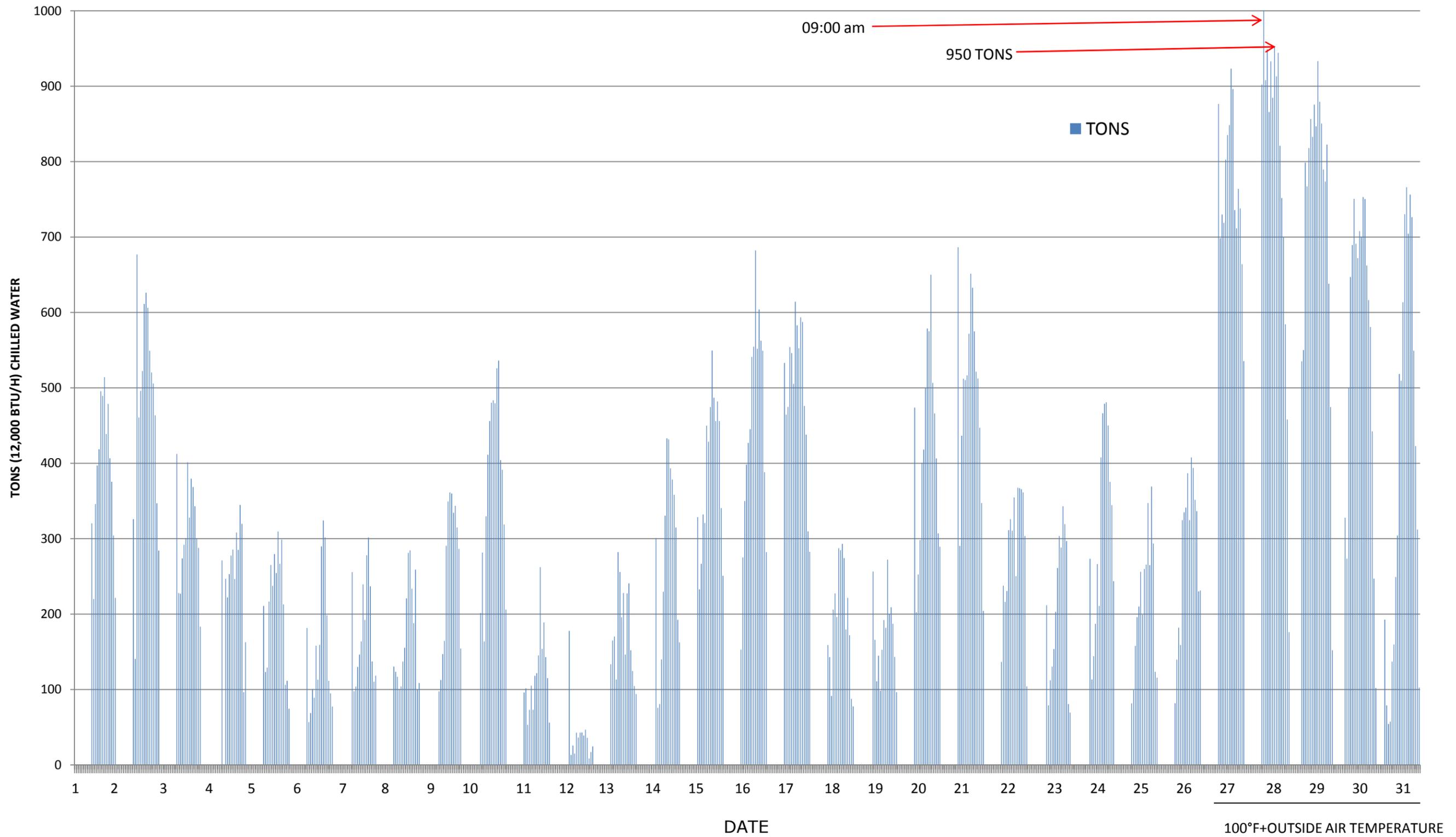
Chiller Plant Output (May 2009)



Chiller Plant Output (June 2009)

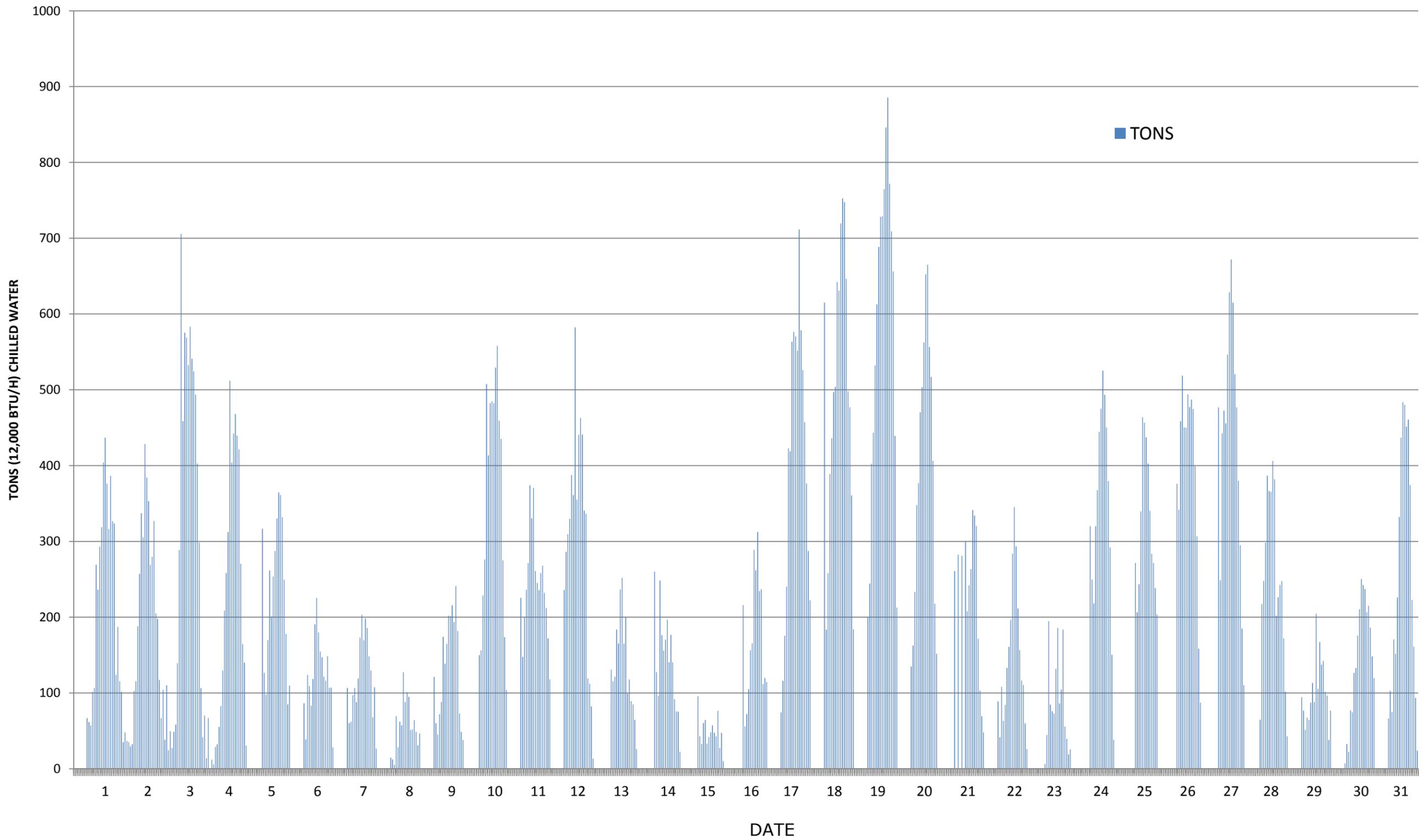


Chiller Plant Output (July 2009)



100°F+OUTSIDE AIR TEMPERATURE

Chiller Plant Output (August 2009)



Chiller Plant Output (September 2009)

