

Utility System Infrastructure

**THE
COLLEGE
OF** 2015 Campus Master Plan
**WILLIAM
& MARY**

SUPPORTING DOCUMENTATION

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UTILITY SYSTEM INFRASTRUCTURE

ELECTRICAL UTILITY INFRASTRUCTURE

The main electrical service and distribution for the campus electrical utility is owned and maintained by Dominion Virginia Power. The main campus is fed from two utility-owned sub-stations. The medium-voltage cables are direct-bury which is common for an Electric Utility. There are four primary switches, four electrical revenue meters, and underground distribution. The distribution is divided into an inner loop and an outer loop for the main campus. Refer to figure E-1 for a map of the two electrical loops. Dominion Virginia Power owns and maintains all 34.5 KV cables, switches and transformers. When new buildings are built, the utility provides a new transformer for the building and ties it into one of the two loops.

There is a separate electrical service to the Law School. The School of Education campus has its own site loop. There is a separate connection to the Sorority Court and other smaller buildings not on main campus. Metering inside buildings is limited.

The electrical utility's capacity for the future West Chiller Plant and the Fine and Performing Arts Complex needs to be studied by Dominion Power in order to decide the best way to provide electrical service. The rest of the distribution and condition is good and well maintained by Dominion Power. The total capacity of the transformers connected to the two loops and the total peak electrical load for the campus are as follows:

- Outer Loop transformers total – 16.9 MVA
- Inner Loop transformers total – 15.85 MVA
- Total Peak load on both loops – 13 MW

The emergency power to the campus consists of multiple stand-by electric powered generator sets. Here is a list of the specifics:

Emergency Power Generators

- 37 Emergency Generators
- 28 Diesel, 6 Natural Gas, 3 Propane
- Sizes vary from 15 to 600 KW
- Commons, Rec Sports, FM bldg. have full back-up
- Other buildings with generators are life safety and/or research preservation

- Tennis Court – State Emergency Center with external connection for portable generator
- The emergency power system has some issues, such as:
- Blow Hall – Has increased load requirements, IT Equipment and the Campus Emergency Center require emergency generator back-up power.
- Muscarelle Museum – Requires a connection for a portable generator
- Adair Hall – Replace existing 50 KW generator with a new one due to age.

Information Technology Infrastructure

The service and distribution for the IT infrastructure comes from four (4) CORE network buildings. (Blow Hall, Jones Hall, SWEM, SOE). The IT distribution is underground and is configured in a star network with central nodes. Blow Hall has the long distance and internet head-end equipment, Jones Hall has the data head-end equipment, SOE has local phone and back-up internet pipe.

The condition and capacity of the underground conduits are at 90%. The Fire Alarm system uses IT fiber network which slows down IT transmissions. One possible solution would be to install a new and separate fire alarm network. This would solve two problems at once. It would speed up the internet traffic and provide a dedicated and more reliable path for the life safety system. Refer to figure E-2 for a map of the existing IT data infrastructure.

Some current and/or identified projects are to provide a new IT/network building to support the campus and new projected buildings. Additional fiber loop would be required around campus and additional conduits required for future loads. Below is an issues list with more info. Some of these issues are electrical or HVAC in nature but effect the reliability of the IT and data network for the campus.

IT/Telecom Issues

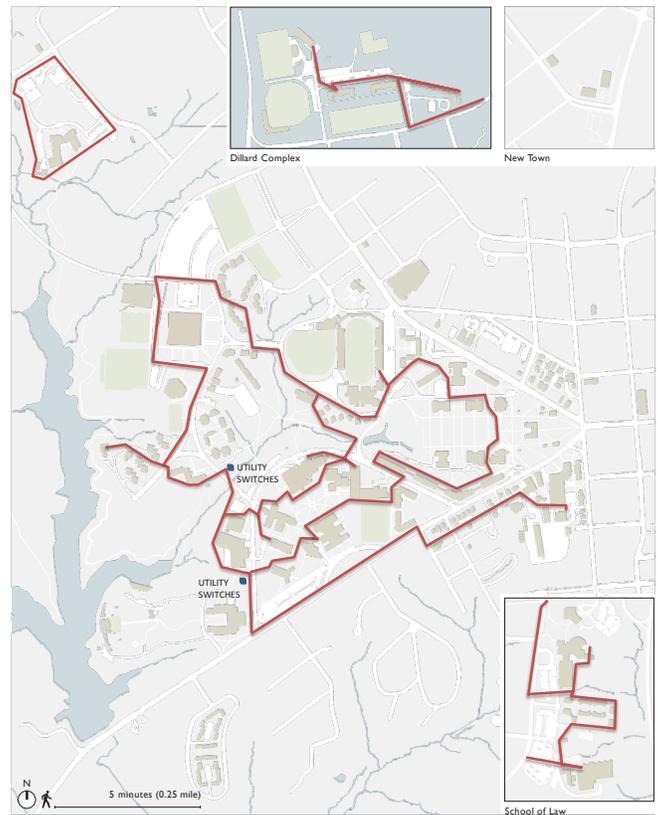
- Blow Hall – Only one UPS, dual electrical busses (A & B bus) are required, old CRAC (HVAC) units are at end of their useful life and need to be replaced.
- Jones Hall – (3) existing CRAC units, no redundancy for A/C, UPS has no redundancy. Reliability is low if any units fail or during regular maintenance.

- SOE – The conduits are full into campus, no room for future growth.
- College Apartments – The main IT closet is in a damp location and has no generator.
- Fraternity Community Building – No generator to back up IT closet.
- Lambert House – Location of IT closet is bad and no generator to back up power.
- Ludwell 500 – No generator to back up power.
- Alumni House – IT closet is at capacity, new design required to support stadium addition
- Barrett Hall – Heat issues, additional cooling required in IT closet.
- Busch Field – No IT design for Busch, required by NCAA
- Campus Center – Entire data system and IT rooms require redesign
- DAS – Redesign required for better coverage
- New Town and Dillard Complex – Conduit unusable back to main campus
- Law school – IT network runs thru public, not college system. Relying on public infrastructure instead of dedicated campus IT cables.
- Randolph Complex – IT data room in basement, water issues
- Sorority Court – Conduit system is broken throughout to college apartments
- Tribe Square – Conduit system from 327 Richmond Rd collapsed

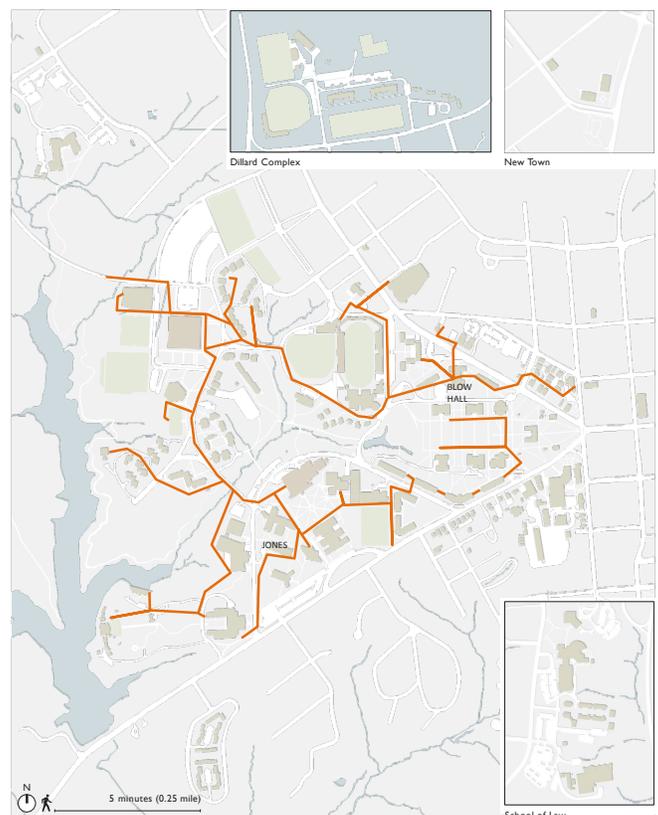
Recommendations

The campus electrical system is owned and operated by Dominion Virginia Power. The college should work with them and provide a list of future projected building loads in order to decide if additional capacity or redundancy is needed on the primary power feed to the campus. A third loop may be required for the West Plant and Fine and Performing Arts Complex.

The fire alarm system for the campus should have a dedicated fiber link between all buildings and not rely on the campus IT network. This project would require new conduits, fiber optic cabling and fire alarm system changes for all buildings.



Electrical Utility Power Underground System



IT and Data Utility System

The IT infrastructure needs major upgrades. The data system should be housed in a Tier II data center building. This means that the electrical system has N+1 redundancy with a minimum of two generators, two UPS and dual busses to feed the server racks. The HVAC for the data center should have N+1 redundancy. Also, there should be a fiber link to a disaster recovery (D-R) data center which mirrors the primary data center and provides a full back-up. This D-R site should be housed in a Tier II building. These buildings should be separated by some distance for security reasons. The primary could be in one of the new buildings being planned and the D-R site could be on the Education campus. A system as described would provide very reliable data and IT service for the foreseeable future. Across the country, the data system on campus has become the lifeblood of the college system.

WEST HEATING AND COOLING PLANT SUMMARY

Current Conditions

The Swem Heating and Cooling Plants serves a cluster of buildings on the south part of campus. Those buildings and associated loads are:

Building	Cooling Load (Tons)	Heating Load (MBH)
Swem Library	680	4,000
Small Hall	412	2,160
Small Hall NMR	15	80
Jones Hall	164	1,200
Morton Hall	134	1,200
Andrews Hall	75	720
Phi Beta Kappa	141	Cooling Only
Millington Hall	Heating Only	1,200
ISC – Phase I	836	6,696
ISC – Phase II	290	2,328
Miller Hall	290	2,880
CURRENT TOTAL	3,037	22,464

These loads are the summary loads that the College of William & Mary developed as part of the 2013 West Plant Feasibility Study. And, these are the diversified loads at the Plant and not the individual building peak loads.

Relative to chilled water, the Swem Chilled Water Plant has four (4) 750 chillers and one (1) 1,000 ton chiller. The chillers are relatively new and in good condition. The peak capacity is 4,000 tons and the firm capacity is 3,000 tons. Firm capacity is defined as plant capacity without the availability of the largest chiller. With a load of 3,037 tons and a firm capacity of 3,000 tons, the Swem Chilled Water Plant is running at capacity. The Plant cannot assume additional load without putting the firm capacity at risk.

Relative to hot water, the Swem Hot Water Plant has five (5) 250 boiler horsepower (BHP) hot water generators. Each generator is capable of 8.4 million BTUH (MBH) of hot water. The peak capacity is 42,000 MBH and the firm capacity is 33,600 MBH. With a load of 22,464 MBH and a firm capacity of 33,600 MBH, the Swem Hot Water Plant has remaining heating capacity. The Plant can support additional load without putting the firm capacity at risk.

South Campus Expansion

The College of William and Mary has identified changes in the south campus area that impact the Swem Heating and Cooling Plant. Those changes and the impact are:

Building	Cooling Load (Tons)	Heating Load (MBH)
Existing Loads	3,037	22,464
Andrews Hall (Demo)	(75)	(720)
Phi Beta Kappa (Demo)	(141)	Cooling Only
Future Performing Arts	1,250	6,000
ISC – Phase III	650	6,464
Millington Replacement	71	600
PROJECTED TOTAL	4,792	34,808

Again, these loads are the summary loads the College of William & Mary developed as part of the 2013 West Plant Feasibility Study. As with the current loads, these are the future diversified loads at the Plant rather than individual building peak loads.

Relative to chilled water, a 4,792 ton load exceeds both the 3,000 ton firm capacity and the 4,000 peak capacity. Even if firm capacity was not a consideration, the Swem Chilled Water Plant cannot support the anticipated south campus growth.

Relative to hot water, the peak demand of 34,808 MBH slightly exceeds the firm capacity of 33,600 MBH. With a peak capacity is 42,000 MBH, the Hot Water Plant can nearly support the anticipated south campus growth without any changes.

There is insufficient room in the Swem Plant to increase chilled or hot water capacity. In fact, the College has already replaced smaller equipment with the largest equipment that can fit inside the plant. In short, chilled and hot water generation at the Swem Plant has been maximized.

West Campus Cooling and Heating Plant

As noted above, the Swem Plant is already at maximum capacity and cannot be expanded. With the success of central chilled and hot water systems, the next step is a second regional plant. And while this second plant could be limited to addressing the loads described above, the

College has identified a number of buildings on the western part of campus that could be connected to a central system. Those buildings and associated loads are:

Building	Cooling Load (Tons)	Heating Load (MBH)
Adair Gymnasium	105	2,400
Muscarella Museum (on south campus)	39	720
Randolph Complex	174	2,772
Botetourt Complex	142	5,680
W&M Hall & Kaplan	545	7,600
Commons Dining Hall	119	2,400
DuPont Hall	100	1,589
Yates Hall	83	1,319
Units Housing (Future Replacement)	223	3,538
FUTURE TOTAL	1,530	28,018

Again, these loads are the summary loads that the College of William & Mary developed as part of the 2013 West Plant Feasibility Study. As with the current loads, these are the future diversified loads at the Plant rather than individual building peak loads. The loads reflect the full build out load and related diversity. The loads will be added over time as existing building systems have to be replaced and as funding allows. In reality, this is at least a 10 year look ahead.

Based on these future loads, the ultimate loads are:

Area	Cooling Load (Tons)	Heating Load (MBH)
South Campus	4,792	34,808
West Campus	1,530	28,018
PROJECTED TOTAL	6,323	62,826

These ultimate loads are well beyond the Swem Plant and will require a second plant currently identified as the West Plant. Previous planning has identified the corner of Landrum Drive and Ukrop Way adjacent to Adair Gymnasium as the appropriate location for a new heating and cooling plant.

To meet the chilled water demand, the ultimate chiller plant capacity should be 7,600 tons consisting of the following:

Chillers	Chiller Size (Tons)	No. of Chillers	Chiller Capacity (Tons)
Swem	750	4	3,000
Swem	1,000	1	1,000
West Plant	900	4	3,600
TOTAL CAPACITY			7,600
FIRM CAPACITY			6,600
PEAK (PLANT) DEMAND			6,323

Implied with this summary is the observation that the Swem Plant and West Plant will operate as a virtual plant with the plants connected by 12" supply and return distribution piping. In addition to sharing redundancy, the interconnection will allow one plant to be out of operation during the winter for extended maintenance. The new chillers are likely variable speed with variable primary pumping.

To meet the hot water demand, the ultimate hot water plant capacity should be 92,000 MBH consisting of the following:

Boilers	Boiler Size (MBH)	No of Boilers	Boiler Capacity (MBH)
Swem	8,400	5	42,000
West Plant	10,000	5	50,000
TOTAL CAPACITY			92,00
FIRM CAPACITY			82,00
PEAK (PLANT) DEMAND			62,826

Implied with this summary is the observation that the Swem and West plants will operate as a virtual plant with the plants connected by 8" supply and return distribution piping. In addition to sharing redundancy, the interconnection will allow one plant to be out of operation during the summer for extended maintenance.

The West Plant will be a combined chilled water and hot water plant. The plant will be approximately square and 11,000 to 12,000 SF in size. The plant will include separate areas for the hot and chilled water plant, control room, rest room and interior electrical room. As currently planned, the cooling towers will be on the roof.

This first phase should be configured to allow additional equipment to be added in the future without interruption to existing operations. The first phase in the development of the West Plant includes:

- entire plant shell
- 12" chilled water supply and return piping between the plants
- 8" hot water supply and return piping between the plants
- first chiller, cooling tower, chilled water pumps and condenser water pumps
- first hot water generator and hot water pumps
- major chilled and hot water piping headers in the plant
- chilled, condenser and hot water chemical treatment systems

And, as the chilled and hot water loads increase, additional chillers, towers, hot water generators and pumps would be added. Rather than a discrete second phase that adds the remaining equipment at once, plant capacity is likely to grow incrementally in response to increasing loads. It is likely that full build out of the Plant will take at least 10 years.

